Maternal Deaths in Australia 1997–1999

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Preface

The 1997–99 report on maternal deaths in Australia is the twelfth in a series of triennial reports on maternal deaths dating back to 1964. Under-ascertainment of maternal mortality is of national concern. In an effort to improve ascertainment of maternal deaths, this report has used two data sources: states and territories confidential maternal death enquiries and Australian Bureau of Statistics (ABS) death data.

This report includes data on 90 deaths reported to the National Advisory Committee on Maternal Mortality (34 direct, 28 indirect and 28 incidental) which satisfied the definition of maternal mortality, for the triennium 1997–99. The 34 direct deaths represent a decrease from the 46 direct deaths recorded in the previous triennium and a return to the trend of declining direct maternal deaths seen over the previous 15 years. The leading principal causes of direct maternal deaths were obstetric haemorrhage (8), amniotic fluid embolism (7) and deaths due to thromboembolism (6).

The number of indirect deaths increased compared with the previous triennium (28 in 1997–99), while the number of incidental deaths decreased (28 in 1997–99). This is in part due to a change in the classification of deaths due to psychiatric causes from incidental to indirect, consistent with international reporting practices. The incidence of deaths due to psychiatric causes is increasing. This trend coupled with the probability that psychiatric deaths are underestimated is of concern.

The maternal mortality ratio (MMR) is used for international comparisons. It is calculated on the number of direct and indirect deaths in the reporting period. Because of historical difficulties in classification of some maternal deaths between indirect and incidental, Australia has in the past calculated MMR including incidental deaths. This practice is not consistent with international reporting protocols. Using the WHO definition, the MMR for this triennium is 8.2 deaths per 100,000 confinements, compared with the recalculated ratio of 9.1 deaths per 100,000 confinements in the 1994–96 triennium. The MMR of 8.2, while not as low as that observed in the 1991–93 triennium, is a return to the steady decline of the MMR observed in the past 24 years.

The maternal mortality ratios for direct and indirect deaths were 4.5 and 3.7 per 100,000 confinements respectively. These figures compare with those of 5.0 and 6.4 per 100,000 confinements for direct and indirect deaths respectively, published in the Report on Confidential Enquiries into Maternal Deaths in the United Kingdom for the triennium 1997–99 (NICE 2001). In Australia in the 1997–99 triennium, the incidental maternal mortality ratio was 3.7 per 100,000 confinements, a ratio that has remained steady over the past 24 years.

It is important to note that the absolute risk of maternal death during pregnancy and the puerperium remains very small, being 1 in 8,423 confinements in the 1997–99 triennium. Improved general health status and reproductive patterns, together with access to appropriate general and specialised health care, has greatly reduced the incidence of maternal mortality in the last century.

The risk of death was highest for women aged 40-44 years who had an MMR of 23.2 deaths per 100,000 confinements and lowest for women aged 20-24 years who had an MMR of 4.0 deaths.

There has been a decrease in the number of deaths in which avoidable factors were considered to be possibly or certainly present. Avoidable factors were considered to be

possibly or certainly present in 34% of cases compared with 48% of cases in 1994–96. The presence of avoidable factors is not uniformly considered and recorded by State Committees but these data give an indication of the proportion of maternal deaths with avoidable factors.

Despite overall general improvements in MMR, it is important to note that life-threatening complications still occur, often unpredictably. Seeking to avoid loss of women's lives in childbearing, and minimising damage to their health, remain issues of critical importance for obstetric and midwifery practice in Australia. The higher maternal mortality rate among Aboriginal and Torres Strait Islander childbearing women should be of continuing concern to the Australian community, and demands attention as a priority from all relevant agencies.

There has been a change to the format of the report. The Committee decided to include illustrative cases in the report rather than profiles of all cases in order to maximise confidentiality and to provide a more concise report.

Maternal mortality data for 2000–02 have been requested and preliminary preparation of the thirteenth maternal mortality report has begun. It is expected to be released mid 2005.

It is hoped that this report will assist in the development of improved practice in obstetric care and provide information to obstetric care practitioners to improve the quality and safety of health care during pregnancy and the puerperium.

Associate Professor James King
Chair
AIHW National Advisory Committee on Maternal Mortality

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Professor William Walters retired as Chair of the Committee in June 2004. The Advisory Committee would like to take the opportunity to acknowledge the contribution that Professor Walters has made to AIHW National Advisory Committee on Maternal Mortality. Professor Walters was the inaugural chair of Committee and through his leadership and commitment, there has been a significant improvement in national maternal mortality data reporting.

AIHW National Perinatal Statistics Unit is a formally affiliated institution of the University of New South Wales and is linked to the School of Women's and Children's Health. We would like to acknowledge the support of NPSU by the School of Women's and Children's Health, UNSW and the Sydney Children's Hospital.

Abbreviations

ABS	Australian Bureau of Statistics
AFE	Amniotic Fluid Embolism
AIHW	Australian Institute of Health and Welfare
ARIA	Accessibility/Remoteness Index of Australia
BMI	Body Mass Index
DIC	Disseminated Intravascular Coagulation
DVT	Deep Vein Thrombosis
HELLP	Haemolysis, Elevated Liver Enzymes and Low Platelet Count
ICD-9	International Classification of Diseases Ninth Revision
ICD-10	International Classification of Diseases Tenth Revision
MMR	Maternal Mortality Ratio
MMRWG	Maternal Mortality Review Working Group
NACMM	(AIHW) National Advisory Committee on Maternal Mortality
NCIS	National Coroners Information System
NHMD	(AIHW) National Hospital Mortality Database
NPDC	(AIHW) National Perinatal Data Collection
NPSU	(AIHW) National Perinatal Statistics Unit
PTE	Pulmonary Thromboembolism
RANZCOG	Royal Australian and New Zealand College of Obstetricians and Gynaecologists
RANZCP	Royal Australian and New Zealand College of Psychiatrists
RCOG	Royal College of Obstetricians and Gynaecologists
WHO	World Health Organization

Key findings

- There were 90 maternal deaths in the triennium 1997–99, and there were 758,030 confinements, indicating one maternal death per 8,423 confinements.
- The maternal mortality ratio (MMR) of 8.2 deaths per 100,000 confinements, while not as low as the ratio for 1991-93, is a return to the steady decline of the MMR in the past 24 years.
- The risk of death was highest for women aged 40-44 years who had an MMR of 23.2 deaths per 100,000 confinements and lowest for women aged 20-24 years who had an MMR of 4.0 deaths.
- There were 34 direct maternal deaths, compared with 46 deaths in the previous triennium; 71% of direct deaths occurred at a gestational age of 37 weeks or more.
- There were no deaths due to termination of pregnancy during this triennium.
- There were 28 indirect maternal deaths, compared with 20 in the previous triennium. This increase is partially a result of a change in classification practice, with deaths due to psychiatric causes now being classified as indirect rather than incidental.
- Incidental deaths are no longer included in the MMR calculation but are considered to be an important category of maternal mortality and will continue to be routinely collected. There were 28 incidental deaths compared with 34 in the previous triennium.
- The most common cause of direct death was obstetric haemorrhage (eight deaths) compared with five from the previous triennium. This category continues to be of concern and may be increasing. The other most common causes of direct death were amniotic fluid embolism, pulmonary thromboembolism and hypertensive disorders.
- The most common category of indirect death was death due to psychiatric causes (eight deaths). The change in classification of these deaths from incidental to indirect reflects increasing concern about the contribution of psychiatric disorders to maternal mortality, for which preventive strategies are being evaluated.
- The most common causes of incidental death were deaths from motor vehicle accidents, deaths due to infection and drug-related deaths. These categories often present opportunities for prevention.
- There is a need to implement a systematic process for considering and reporting the presence of potentially avoidable factors by the State and Territory Committees.
- The MMR for Aboriginal and Torres Strait Islander women continues to be higher than the rate for non-Indigenous women. In the current triennium, the MMR for Aboriginal and Torres Strait Islander women was 23.5 deaths per 100,000 confinements compared with 7.2 for non-Indigenous women. There is justification for continuing concern about this disparity.
- The reduced health status of the Aboriginal and Torres Strait Islander community is reflected in the threefold higher MMR; severe co-morbidities were present in five of the seven Aboriginal and Torres Strait Islander maternal deaths.

- There is a need for improvement in the ascertainment of Indigenous status in maternal mortality surveillance.
- Evidence-based clinical practice guidelines are available for prevention and management of several of the major obstetric complications and should be uniformly utilised in Australian maternity institutions.
- 59% of direct maternal deaths and 54% of indirect maternal deaths were the subject of coronial inquests indicating suboptimal coronial referral practices.

Section A Introduction

Aims of this report

The aims of the 1997–99 report on maternal deaths, as agreed by the AIHW National Advisory Committee on Maternal Mortality, are to:

- collate maternal mortality data for the period 1 January 1997 to 31 December 1999 from the State and Territory Maternal Mortality Committees;
- provide an epidemiological overview of trends in maternal deaths across Australia using maternal mortality ratios and including causes of death, classification of death, age, parity and Indigenous status;
- situate Australia in an international context in terms of maternal mortality ratios with the provision of ratios which are comparable with those used internationally;
- provide information to assist all maternity care providers in efforts to reduce maternal mortality;
- identify patterns of suboptimal care and avoidable factors and, where possible, make recommendations concerning improvements to maternity care practices and services in Australia;
- identify relevant evidence-based maternity care guidelines that may be referenced in the report;
- validate completeness of data ascertainment including data matching with AIHW National Death Index and the AIHW National Hospital Morbidity Database; and
- provide relevant information to assist practitioners in counselling women of reproductive age who are contemplating pregnancy.

Australian definitions of maternal mortality

A maternal death is defined by the World Health Organization (WHO 1993) as:

> The 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.

This definition includes deaths of women from terminations of pregnancy, spontaneous abortion, miscarriage and ectopic pregnancy, but excludes deaths from assisted reproduction technologies where pregnancy has not occurred.

In line with international conventions, the maternal mortality ratio will be calculated using direct and indirect deaths, excluding incidental deaths. In all previous reports on maternal deaths in Australia, incidental deaths have been included in the definition and calculation of maternal mortality. *From this triennium, Australia will report the maternal mortality ratio in accordance with the World Health Organization (WHO) recommendations excluding incidental deaths in all calculations of the maternal mortality ratio.* Caution must therefore be made when comparing MMR from previous triennia.

A *late* maternal death is defined by WHO as:

> The death of a woman from direct or indirect obstetric causes more than 42 days but less than one year after termination of pregnancy.

It must be emphasised that the definition of a late maternal death does not include deaths from incidental causes. Late maternal deaths have not routinely been collected by Australia. This report however contains information on several late maternal deaths which were notified to the NPSU although this cannot be considered a comprehensive ascertainment. These deaths are presented in Appendix 7. In line with current international trends, late maternal deaths will be routinely collected and reported from 2000–02.

Classification of maternal deaths in Australia

The four maternal death classifications used in Australia are presented in Table D1.

Table D1: Classifications for maternal deaths occurring in Australia

Direct deaths *Result from obstetric complications of the pregnant state* (pregnancy, labour and puerperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above. They are complications of the pregnancy itself. e.g. eclampsia, amniotic fluid embolism, rupture of the uterus, postpartum haemorrhage
Indirect deaths *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 the physiological effects of pregnancy*. e.g. heart disease, diabetes, renal disease
Incidental deaths Result from 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. e.g. road accidents, malignancies
Late maternal death Death of a woman from *direct or indirect* obstetric causes more than 42 days but less than one year after termination of pregnancy.

It is often difficult for the expert committees to assign the maternal death classification. For example, death from an asthma attack in some instances may have been due to some effect of the pregnant state of the woman, but in others, it may be unrelated and thus may be classified as an indirect death in the former example and an incidental death in the latter. A difficult area is also psychiatric-related deaths, where a self-administered overdose could be unintentional or suicide, and may or may not have been due to some effect of the pregnant state on the woman. This is discussed further in Chapter 12.

Definitions

Parity is defined as the number of previous pregnancies resulting in livebirths or stillbirths (of ≥20 weeks gestation), including the current pregnancy unless undelivered.

Livebirth is defined as a liveborn infant weighing at least 400g, or if the weight is not known, born after at least 20 weeks gestation.

Stillbirth is defined as a stillborn infant weighing at least 400g, or if the weight is not known, born after at least 20 weeks gestation. A stillborn infant is one that does not breathe or show any other sign of life after birth.

Undelivered in this report refers to a pregnancy of any gestation which does not result in a delivery. This includes fetal deaths in utero which are not delivered and early pregnancy losses.

Confinements are the number of pregnancies of 20 weeks gestation or more resulting in a livebirth or a stillbirth.

Denominators used in calculations of maternal mortality

Maternal mortality ratios reported worldwide tend to use a denominator of livebirths, since in many developing countries these are the best data available. This report uses confinements as a denominator in the calculation of maternal mortality rates.

Table D2 shows the denominator data of total confinements used in this report.

Table D2: Confinements by maternal age, Australia, 1997–99

Age group (years)	1997	1998	1999	Total
<20	13,235	12,897	12,997	39,129
20–24	43,260	41,516	40,862	125,638
25–29	83,217	82,083	81,351	246,651
30–34	75,508	75,144	76,733	227,385
35–39	32,661	33,931	35,226	101,818
>=40	5,260	5,766	6,168	17,194
Not stated	65	96	54	215
Total	**253,206**	**251,433**	**253,391**	**758,030**

Source: National Perinatal Data Collection, AIHW National Perinatal Statistics Unit.

Rates and ratios

In line with international conventions (WHO 1993), this report will use the term 'maternal mortality ratios' instead of 'maternal mortality rates'. The most appropriate denominator for estimating maternal mortality rates is the number of women at risk, that is, the number of pregnant or recently pregnant women. However, this figure is not accurately known, the unknown component being the number of pregnancies ending before 20 weeks gestation. WHO defines maternal mortality ratio as the number of maternal deaths, related to the number of livebirths, as this denominator is available in most countries. In Australia, reliable data are available on the number of confinements resulting in at least one birth (including livebirths and stillbirths). In this report, the maternal mortality ratios have been calculated as:

$$\frac{\text{Number of direct and indirect maternal deaths}}{\text{Total number of confinements}} \times 100{,}000$$

The number of livebirths in Australia in 1997–99 was 763,766. For the purpose of comparisons with published MMR for other countries, using livebirths as the denominator, the MMR for 1997–99 is 8.1 deaths per 100,000 livebirths.

1 Epidemiology of maternal deaths

Cohort of maternal deaths

There were 90 maternal deaths in the triennium 1997–99 which met the pre-specified inclusion criteria as defined in the previous section.

Maternal mortality ratio

Apart from an increase in 1994–96, the MMR has been steadily declining over the last 27 years and was 8.2 deaths per 100,000 confinements in the 1997–99 triennium.

Table 1.1: Maternal mortality ratios in each triennium, Australia, 1973–99

Triennium	Direct deaths	Indirect deaths	Confinements	Maternal Mortality Ratio*
1973–75	60	32	726,690	12.7
1976–78	52	35	678,098	12.8
1979–81	54	34	682,880	12.9
1982–84	42	25	713,985	9.4
1985–87	32	30	726,642	8.5
1988–90	37	33	754,468	9.3
1991–93	27	22	769,253	6.2
1994–96	46	20	767,448	9.1
1997–99	34	28	758,030	8.2

*Per 100,000 confinements. Ratio calculated using direct and indirect deaths.

Demographic profile

Maternal age

The women who died in this triennium were aged from 17 to 42 years. 22% of all the maternal deaths were aged less than 25 years, 49% were aged 25–34 years and 29% were aged 35 years and older (Table 1.2). The risk of death was highest for women aged 40-44 years who had an MMR of 23.2 deaths per 100,000 confinements and lowest for women aged 20-24 years who had an MMR of 4.0. Data for all Australian confinements showed that 22% of women who gave birth in 1997-99 were less than 25 years of age, 62% between 25 and 34 years of age, and 16% aged 35 years and older (Table D.2). This demonstrates the well-documented relationship between maternal age and maternal mortality which should be an important consideration for pregnancy risk management.

Table 1.2: Maternal death by age, 1997–99

Age group (years)	Number	Per cent	Per cent total confinements	MMR*
15–19	10	11.1	5.2	7.7
20–24	10	11.1	16.6	4.0
25–29	23	25.6	32.5	6.1
30–34	21	23.3	30.0	7.0
35–39	21	23.3	13.4	18.7
40–44	5	5.6	2.3	23.2
Total	**90**	**100.0**	**100.0**	**8.2**

*Per 100,000 confinements. Ratio calculated using direct and indirect deaths.

Maternal deaths among Aboriginal and Torres Strait Islander women

There were seven deaths of Aboriginal and Torres Strait Islander women in the 1997-99 triennium, again demonstrating the over-representation of Aboriginal and Torres Strait Islander women in maternal death cohorts. These deaths are discussed in detail in Chapter 16.

Maternal deaths among overseas-born women

Of the 90 maternal deaths, 62 of the women (69%) were born in Australia. Twenty of the deaths (22%) were of women born overseas in: New Zealand (2), United Kingdom (2), India (2), and one maternal death from East Asia, New Caledonia, Samoa, Channel Islands, Burma, Singapore, Indonesia, Philippines, China, Japan, Maldives, South America, Uruguay and Somalia. The country of birth was not recorded for 8 (9%) women. The distribution of maternal deaths by country of birth corresponds with the distribution of confinements in Australia by country of birth indicating that there is no disproportionate representation of women born overseas in the maternal death cohort. No subgroup analyses were undertaken due to small numbers.

Place of residence

The ABS has classified postcodes to categorise geographical areas into Remoteness Areas. ASGC (Australian Standard Geographical Classification) Remoteness was released in 2001 by the ABS, and was based on an enhanced measure of remoteness (ARIA+) developed by GISCA (National Key Centre for Social Applications of Geographic Information Systems). These categories are based on road distance from a locality to the closest service centre in each of the five classes of population size (AIHW 2004b). The classes are: major cities of Australia, inner regional Australia (such as Ballarat, Vic or Albury, NSW), outer regional Australia (such as Townsville, Qld or Broome, WA), remote Australia (Katherine, NT or Port Lincoln, SA) and very remote Australia (Bourke, NSW or Cunnamulla, Qld). Table 1.3 presents the deaths by place of residence. More than half of the deaths occurred in major cities in Australia. Only 2% of maternal deaths occurred in women who resided in remote/very remote Australian regions. These data require further analyses in order to establish any relationship between risk of death and place of residence. Australia-wide data of confinements by place of residence are not available.

Table 1.3: Maternal death by residential region, 1997–99

Residential region	Number	Per cent
Major city of Australia	49	54.4
Inner regional Australia	19	21.1
Outer regional Australia	12	13.3
Remote/very remote Australia	2	2.2
Not stated	8	8.9
Total	**90**	**100.0**

Gestational age at death

Of the direct deaths, the majority occurred at gestations of 37 weeks or more. In contrast, 13/28 (46.4%) of the incidental deaths occurred at gestations of less than 20 weeks. Indirect deaths appear to be equally distributed across all gestational ages (Table 1.4).

Table 1.4: Gestational age and type of maternal death, 1997–99

Gestational age	Direct	Indirect	Incidental	Total
<20 weeks	2	7	13	22
20–27 weeks	5	6	2	13
28–36 weeks	3	8	10	21
>=37 weeks	24	7	3	34
Total	**34**	**28**	**28**	**90**

Stage of pregnancy at death

Forty women died undelivered. 53% (N=21) of these deaths were of gestational ages 20 weeks or less and 28% (N=11) were in pregnancies of viable gestational age (Table 1.5). Fifty women died following delivery, 60% of whom died within the first 24 hours after delivery.

Table 1.5: Stage of pregnancy at death by gestational age, 1997–99

	Gestational age (weeks)				
Stage of pregnancy at death	<20	20–27	28–36	>=37	Total
Died undelivered	21	8	8	3	40
Within 24 hours of delivery	1	5	8	16	30
2–6 days postpartum	—	—	1	5	6
7–28 days postpartum	—	—	4	10	14
Total	**22**	**13**	**21**	**34**	**90**

Outcome of deliveries

Of the 50 women who delivered prior to their death, 36 (72%) delivered liveborn infants, 13 (26%) infants were stillborn and there was one death following a spontaneous abortion (Table 1.6).

Table 1.6: Birth outcomes*, 1997–99

Birth outcome	Number	Per cent
Livebirth	36	72
Stillbirth	13	26
Spontaneous abortion	1	2
Total	**50**	**100**

* For women who delivered (N=50)

Maternal death classification

In the triennium 1997–99, there were 34 direct maternal deaths, 28 indirect deaths and 28 incidental deaths (Table 1.7).

Table 1.7: Classification of maternal deaths, 1997–99

Classification	Number	Maternal mortality ratio*
Direct	34	4.5
Indirect	28	3.7
Incidental	28	3.7
Total	**90**	**8.2**

*per 100,000 confinements.

Table 1.8 demonstrates trends in proportions of direct, indirect and incidental maternal deaths over the last 27 years. Apart from an increase in direct deaths in 1994–96 triennium, the ratios have continued to decline over this entire period in all three categories.

Table 1.8: Maternal mortality ratios by classification, 1973–99

Triennium	Direct maternal mortality ratio*	Indirect maternal mortality ratio*	Incidental maternal mortality ratio*
1973–75	8.3	4.4	6.2
1976–78	7.7	5.2	2.8
1979–81	7.9	5.0	1.5
1982–84	5.9	3.5	3.5
1985–87	4.4	4.1	3.3
1988–90	4.9	4.4	3.4
1991–93	3.5	2.9	4.7
1994–96	6.0	2.7	4.4
1997–99	4.5	3.7	3.7

*per 100,000 confinements.

Avoidable factors

This report presents results of the State and Territory Committees' considerations concerning the presence of avoidable or substandard care factors for individual cases. However, the NACMM is aware of inconsistencies between (and even within) states and territories approaches to this topic and is therefore unable to report comprehensively about the

contribution of avoidable or potentially avoidable factors to the burden of maternal mortality. This issue is discussed further in Chapter 21.

Consideration of avoidable factors was reported as having been undertaken by State and Territory Committees in 84% (N=76) of cases. Of these, an avoidable factor was considered to be 'possibly or certainly present' in 26 (34%) of all cases. Of the direct maternal deaths (N=31), 48% of cases (N=15) were thought to have avoidable factors 'possibly or certainly present'. For indirect deaths with avoidable factors ascertained (N=24), 38% (N=9) were thought to have avoidable factors 'possibly or certainly present' and for incidental deaths with avoidable factors ascertained (N=21), 9% were thought to have avoidable factors 'possibly or certainly present' (N=2). The reasons for avoidable factors given by the State and Territory Committees are listed in Table 1.9.

Table 1.9: Avoidable factors as determined by the State and Territory Committees, 1997–99

System	Examples	Number
Health personnel	Inappropriate/inadequate management	9
	Lack of expertise, training or education	2
	Inappropriate/inadequate diagnosis	1
	Delay in referral to consultant	2
Facilities	Lack/delay in access to health services due to rural location	1
Personal/family	Refusal of treatment or admission	4
	Domestic violence issues	2
	Risk taking behaviour	2
Logistical systems	Communication breakdown between health services	1
Other		2
Total		**26**

Acknowledging the incompleteness of these data, it is clear that there is considerable room for improvement in the management of women with major obstetric complications, with the potential for further reducing the risk of maternal mortality.

Other considerations

Postmortem examinations

In 77% (N=69) of all the maternal deaths, postmortem examinations were undertaken. Of direct maternal deaths, 29 (85%) had postmortem examinations. Of the indirect deaths, 20 (71%) had postmortem examinations and 20 (71%) of incidental deaths had postmortem examinations.

Coronial inquests

Coronial inquests are held for all violent deaths, all unnatural deaths, all deaths within 24 hours of having an anaesthetic and all deaths where the hospital cannot give a cause of death. In the 1997–99 maternal death cohort, only 50 of the deaths (56%) were investigated by a state or territory coroner: 20 direct deaths, 15 indirect deaths and 15 incidental deaths. Of the 34 direct deaths, 59% (N=20) had coronial inquests; of 28 indirect deaths, 54%(N=15) had coronial inquests; and of the 28 incidental deaths, 54%(N=15) had coronial inquests.

Age-specific and age-standardised mortality rates

For this report, age-specific mortality rates have been separately calculated for direct deaths, indirect deaths and combined direct and indirect deaths. Table 1.10 presents age-specific mortality rates for direct maternal deaths and the overall age-standardised rate. The rates have been weighted to take into account the deaths where age was not known or not stated. The age-standardised rate for direct maternal deaths has decreased by over 50% from 0.74 to 0.27 deaths per 100,000 population over the 27 year period 1973–99. There has been considerable fluctuation in rates in most age groups. There were decreases in rates over all age groups, the most significant being in women aged 20–24 years, where the rate decreased from 1.10 to 0.20 deaths per 100,000 population. These age-standardised mortality rates need to be compared with referent data for deaths in all non-pregnant women to enable a more meaningful examination of these rates.

Table 1.10: Total deaths, age-specific and age-standardised maternal mortality rates—direct maternal deaths, 1997–99

Triennium	Total direct deaths	15–19 years	20–24 years	25–29 years	30–34 years	35–39 years	40–44 years	Age-standardised rate*
1973–75	66	0.25	1.10	1.14	0.42	0.57	1.00	0.74
1976–78	52	0.22	0.58	0.70	0.80	0.41	0.73	0.58
1979–81	54	0.17	0.80	0.60	0.74	0.39	0.54	0.54
1982–84	42	0.11	0.75	0.62	0.23	0.45	0.08	0.37
1985–87	32	0.20	0.25	0.40	0.52	0.27	0.00	0.28
1988–90	37	0.05	0.35	0.52	0.59	0.26	0.06	0.31
1991–93	27	0.00	0.09	0.44	0.28	0.34	0.16	0.22
1994–96	46	0.11	0.33	0.48	0.69	0.47	0.10	0.37
1997–99	34	0.00	0.20	0.27	0.37	0.58	0.14	0.27

*Age-standardised to the Australian 2001 female population aged 15 to 44 years.
Rates expressed per 100,000 population.

For indirect deaths, the age-standardised rate has decreased from 0.35 to 0.22 deaths per 100,000 population over the 27 year period 1973–99. The most significant changes have occurred in the 20 to 24 year age group (Table 1.11).

Table 1.11: Total deaths, age-specific and age-standardised maternal mortality rates—indirect maternal deaths, 1997–99

Triennium	Total indirect deaths	15–19 years	20–24 years	25–29 years	30–34 years	35–39 years	40–44 years	Age-standardised rate*
1973–75	30	0.06	0.42	0.57	0.31	0.53	0.19	0.35
1976–78	35	0.11	0.64	0.53	0.27	0.25	0.46	0.37
1979–81	34	0.17	0.39	0.65	0.36	0.30	0.09	0.33
1982–84	25	0.11	0.27	0.34	0.29	0.32	0.00	0.22
1985–87	30	0.30	0.20	0.75	0.16	0.11	0.00	0.25
1988–90	33	0.05	0.20	0.52	0.54	0.26	0.06	0.27
1991–93	21	0.15	0.09	0.24	0.32	0.15	0.05	0.17
1994–96	20	0.00	0.10	0.19	0.55	0.09	0.00	0.16
1997–99	28	0.16	0.05	0.41	0.37	0.27	0.05	0.22

*Age-standardised to the Australian 2001 female population aged 15 to 44 years.
Rates expressed per 100,000 population.

For the combined direct and indirect category, the maternal mortality age-standardised rate has declined from 1.09 to 0.49 deaths per 100,000 population over the 27 year period 1973–99 (Table 1.12).

Table 1.12: Total deaths, age-specific and age-standardised maternal mortality rates—direct+indirect maternal deaths, 1997–99

Triennium	Direct + indirect deaths	15–19 years	20–24 years	25–29 years	30–34 years	35–39 years	40–44 years	Age-standardised rate*
1973–75	96	0.30	1.52	1.71	0.74	1.11	1.17	1.09
1976–78	87	0.33	1.22	1.23	1.07	0.65	1.20	0.95
1979–81	88	0.33	1.19	1.25	1.10	0.69	0.63	0.86
1982–84	67	0.23	1.03	0.97	0.53	0.77	0.08	0.59
1985–87	62	0.51	0.46	1.15	0.68	0.38	0.00	0.52
1988–90	70	0.10	0.56	1.04	1.13	0.52	0.11	0.58
1991–93	48	0.15	0.19	0.68	0.60	0.49	0.21	0.39
1994–96	66	0.11	0.43	0.67	1.23	0.56	0.10	0.53
1997–99	62	0.16	0.25	0.68	0.75	0.84	0.19	0.49

*Age-standardised to the Australian 2001 female population aged 15 to 44 years.
Rates expressed per 100,000 population.

Section B Direct maternal deaths

2 Direct maternal deaths summary

There has been a decline in the direct maternal mortality ratio from when the first report was published for the 1964–66 triennium. Since 1982, the ratio has remained relatively stable. It was 4.5 deaths per 100,000 confinements in the 1997–99 triennium (Table 2.1).

Table 2.1: Direct maternal mortality ratios, 1964–99

Triennium	Total confinements	Direct maternal deaths	Direct maternal mortality ratio*
1964–66	667,649	202	30.3
1967–69	713,064	166	23.3
1970–72	790,818	150	19.0
1973–75	726,690	60	8.3
1976–78	678,098	52	7.7
1979–81	682,880	54	7.9
1982–84	713,985	42	5.9
1985–87	726,642	32	4.4
1988–90	754,468	37	4.9
1991–93	769,253	27	3.5
1994–96	767,448	46	6.0
1997–99	758,030	34	4.5

*per 100,000 confinements.

Causes of direct death

There were 34 direct maternal deaths in the triennium. This is a decrease from the previous triennium, which had 46 direct maternal deaths. The main causes of direct death were obstetric haemorrhage (N=8), amniotic fluid embolism (N=7), pulmonary thromboembolism (N=6) and deaths due to hypertensive disorders of pregnancy (N=6). There were three deaths due to anaesthesia, one death associated with ectopic pregnancy and one due to a sagittal vein thrombosis. Two other deaths were due to puerperal cardiomyopathy and disseminated intravascular coagulation (Table 2.2).

Table 2.2: Direct causes of maternal death, 1997–99

Direct causes of death	Number	Total
Obstetric haemorrhage		**8**
Postpartum haemorrhage	7	
Acute cerebral infarction	1	
Amniotic fluid and air embolism		**7**
Amniotic fluid embolism	7	
Thrombosis and thromboembolism		**6**
Pulmonary thromboembolism	6	
Hypertensive disorders of pregnancy		**6**
Acute left ventricular failure	1	
Cerebral haemorrhage	1	
Cerebral infarction	1	
Sub arachnoid haemorrhage	1	
Pre-eclampsia	1	
Unascertained	1	
Deaths associated with anaesthesia		**3**
Failed intubation	2	
Anaphylaxis	1	
Other direct causes		**2**
Disseminated intravascular coagulation	1	
Puerperal cardiomyopathy	1	
Early pregnancy deaths		**2**
Ectopic pregnancy	1	
Sagittal vein thrombosis	1	
Total direct deaths	**34**	**34**

Birth outcomes

Of the 34 direct maternal deaths, 72% of infants were liveborn (N=23), 24% of infants died undelivered (N=8), 6% were stillborn (N=2) and there was one ectopic pregnancy. For a more comprehensive examination of the outcomes, the data are presented by gestational age (Table 2.3). Of the infants that were undelivered, three were of a gestational age of 28 weeks or more.

Table 2.3: Direct maternal deaths by gestational age and birth outcomes, 1997–99

Gestational age	Livebirth	Undelivered	Stillbirth	Spontaneous abortion/ ectopic pregnancy	Total
<20 weeks	—	1	—	1	2
20–27 weeks	1	4	—	—	5
28–36 weeks	2	1	—	—	3
>=37 weeks	20	2	2	—	24
Total	**23**	**8**	**2**	**1**	**34**

Parity by age group

Parity presented in this report is the number of previous pregnancies resulting in livebirths or stillbirths (of ≥20 weeks gestation) including the current pregnancy unless undelivered. A multiparous woman has a parity of 1–3 and a grand multiparous woman has a parity of 4 or more. For the direct maternal deaths in this triennium, 38% (N=13) were primiparous, 50% (N=17) were multiparous and 9% (N=3) were grand multiparous women.

Table 2.4: Direct maternal deaths—parity by age group, 1997–99

	Parity				
Age group	0	1–3	>=4	Missing	Total
15–19	—	—	—	—	—
20–24	4	—	—	—	4
25–29	5	1	—	—	6
30–34	2	4	2	—	8
35–39	1	10	1	1	13
40–44	1	2	—	—	3
Total	**13**	**17**	**3**	**1**	**34**

3 Obstetric haemorrhage

Introduction and definition

Obstetric haemorrhage was the leading cause of direct maternal mortality in the triennium 1997–99. Antepartum haemorrhage is uterine bleeding during pregnancy arising from placental abruption, placenta praevia or haemorrhage of unknown origin. Postpartum haemorrhage occurs after the third stage of labour and is based upon a visual estimation of blood loss of 500ml or more (Gülmezoglu & Hofmeyr 2002). It is the consequence of excessive bleeding from the placental implantation site, trauma to the genital tract and adjacent structures or both. Women particularly at risk for postpartum haemorrhage include those who have had a previous postpartum haemorrhage or previous retained placenta, an antepartum haemorrhage, an over-distended uterus, or a prolonged labour in the current pregnancy (Humphrey 1995).

Placenta accreta and percreta are forms of abnormal placentation in which the placenta is morbidly adherent to the uterine wall and surrounding structures and predisposes to severe antepartum and postpartum haemorrhage and consequent hysterectomy. Placenta accreta and percreta are more common in women who have had one or more prior Caesarean section deliveries and, for this reason, appear to be increasingly common causes of severe obstetric haemorrhage. Although pregnancy itself is a state of hypercoagulability, pregnant women are particularly vulnerable to the interactions between haemorrhage, disseminated intravascular coagulation, and irreversible coagulopathy.

Epidemiology

There were eight direct maternal deaths primarily attributed to obstetric haemorrhage, in all of which postpartum haemorrhage was judged to be the principal cause of death (Table 3.1). In one other death (due to amniotic fluid embolism), postpartum haemorrhage was recorded as a contributing factor. There were no deaths due to antepartum haemorrhage in the current triennium. In 1994–96, there were five direct maternal deaths attributed to obstetric haemorrhage. The apparent increase in numbers is justification for continuing concern about the contribution of obstetric haemorrhage to mortality and severe maternal morbidity. There were 11 other deaths in 1994–96 in which utero-placental haemorrhage was a contributory cause of death.

Among the eight women whose principal cause of death was postpartum haemorrhage, all delivered infants vaginally. Two women died after refusing blood products for religious reasons. One woman died after a planned home birth and another died at home, having delivered a term infant unattended after concealing her pregnancy. Two of the women had retained adherent placentas and two had pregnancy-induced hypertension as contributing causes of death.

Table 3.1: Deaths due to obstetric haemorrhage, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
3.1	34	Postpartum haemorrhage	Gestational hypertension	38	Induced labour, spontaneous vaginal	—
3.2	31	Acute cerebral infarction	Postpartum haemorrhage	40	Augmented labour, vacuum extraction	Adherent retained placenta
3.3	32	Postpartum haemorrhage	Home birth	40	Spontaneous vaginal	—
3.4	28	Postpartum haemorrhage	—	Term	Spontaneous vaginal	Unattended delivery
3.5	29	Postpartum haemorrhage	Refused blood products	41	Spontaneous vaginal	—
3.6	35	Postpartum haemorrhage	Gestational hypertension	37	Induced labour, vacuum extraction	—
3.7	40	Postpartum haemorrhage	Refused blood products	38	Induced labour, spontaneous vaginal	—
3.8	34	Postpartum haemorrhage	Adherent placenta, twin pregnancy	25	Spontaneous vaginal, elective Caesarean	—
4.3	35	Amniotic fluid embolism	Postpartum haemorrhage	38	Induced labour, spontaneous vaginal	—

Illustrative cases

Case 3.1

This 34 year old para 1 woman developed hypertension at about 32 weeks gestation. She presented to labour ward at 38 weeks gestation feeling unwell, was induced and proceeded to normal vaginal delivery nine hours later. Her uterus became atonic about one hour after delivery with 1,000 ml of blood clot expressed from the uterus. Six hours post delivery she had a second 1,000 ml of blood clot expressed from the uterus. An examination under anaesthesia was carried out. There was no evidence of trauma found, no retained products, the uterus 'somewhat' atonic. She developed acute severe pulmonary oedema in the recovery room and had a cardio-respiratory arrest about two hours later. Attempts to resuscitate her for several hours were unsuccessful.

Cause of death: Postpartum haemorrhage
Contributing cause of death: Gestational hypertension
Classification: Direct

Case 3.2

A 31 year old para 0 woman with no prior medical problems had an uncomplicated antenatal course. She was given augmentation for slow progress of first stage of labour and delivered a live infant by rotational vacuum extraction following a two-hour second stage of labour. The patient was transferred to the operating theatre for manual removal of placenta, after no signs of separation after 25 minutes following administration of intramuscular syntometrine. Although no excessive haemorrhage was described, on arrival in the operating theatre, she was described as pale, tachycardic and hypotensive. The placenta was removed

with difficulty, under general anaesthetic. She continued bleeding following the procedure and was unresponsive to intravenous ergometrine and intramyometrial prostaglandin $F_2\alpha$. She was transferred to intensive care, where haematology indicated coagulopathy. She received transfusions (fresh frozen plasma and whole blood), following which her coagulation profile improved. Three hours after admission to the intensive care unit, she became hemiplegic. A CAT scan revealed right cerebral infarct and cerebral haemorrhage with midline shift. Shortly after, her pupils were fixed and dilated. She died 30 hours post delivery.

Cause of death: Acute cerebral infarction
Contributing cause of death: Postpartum haemorrhage
Classification: Direct

Case 3.5

This 29 year old para 0 woman had an uneventful pregnancy. After a spontaneous delivery of a live infant, she had a retained placenta and postpartum haemorrhage. She was also found to have fundal inversion of the uterus. She was transferred to theatre where manual removal of placenta was carried out and uterine inversion corrected under general anaesthetic. Her bleeding continued post operatively. She was returned to theatre the next day where further attempts to stop the bleeding were unsuccessful. The patient had stated on admission to hospital that she did not wish to receive blood products due to her religious beliefs. She was transferred to intensive care, where her case was discussed with staff and no further options for treatment were identified. Her relatives continued to refuse blood transfusions. She died three hours later. Between the time of delivery and death—27 hours—9,000mls of Haemaccel had been infused.

Cause of death: Postpartum haemorrhage
Classification: Direct

Clinical comment

In these three illustrative cases, the severity of the blood loss appears to have been underestimated and, as a consequence, adequate resuscitation and in particular early invasive monitoring was suboptimal. Blood loss needs to be measured accurately. In situations where it is known that blood product transfusion will be refused on religious grounds, the most senior medically qualified person should attend the delivery and oversee subsequent management.

Best practice

A RANZCOG statement entitled the 'Management of the Third Stage of Labour' was published in November 2003 (RANZCOG 2003) and the Cochrane Library contains systematic reviews on this topic recommending active management according to standard regimens. No published protocols or college statements were found regarding the management of women undergoing hospital procedures that cover the issue of refusal of blood products for religious reasons. Nevertheless some institutions have written protocols for the management of such circumstances which should be considered best practice at the hospital level.

There is a RANZCOG Statement on Home Births detailing recommendations for women who choose to delivery in a domiciliary environment (RANZCOG 2002).

This chapter has been reviewed and clinical commentary provided by Professor Michael Bennett.

4 Amniotic fluid and air embolism

Introduction and definition

Amniotic fluid embolism (AFE) is a dramatic, rare and often fatal complication which remains a leading cause of maternal mortality. Over the past eight triennia in Australia, it has remained the second most common cause of maternal mortality (11.6% of all deaths). There are sometimes identifiable risk factors (grandmultiparity, uterine hyperstimulation), but the event often occurs in the absence of these factors. The diagnosis of AFE is often one of exclusion or one made at postmortem (Tuffnell 2002). However, in many cases, a characteristic series of events is highly suggestive of the diagnosis. As stated in the previous report, an autopsy diagnosis of AFE requires a pathologist with special training in obstetric pathology and the use of the appropriate stains to show the presence of mucin and fetal squames in the pulmonary arterioles. In patients who survive a clinical episode of amniotic fluid embolism it is very difficult to establish the diagnosis with certainty.

Epidemiology

There were seven deaths in which amniotic fluid embolism was judged to be the principal cause of death (Table 4.1). No women died in this triennium from air embolism. Examining trends and potential risk factors in a group of only seven deaths is virtually impossible. AFE was diagnosed by autopsy for all seven women. The women were aged between 28 and 36 years and all were at the end of the third trimester of pregnancy. One woman had a cardiac arrest at home at 37 weeks gestation and did not deliver. Six of the women delivered infants, four by Caesarean section, and two had vaginal deliveries. Labour was either augmented or induced for five of the women who delivered.

Table 4.1: Deaths due to amniotic fluid embolism, 1997–99

Case	Age	Principal cause of death	Gestational age	Type of delivery	Onset of Labour
4.1	36	Amniotic fluid embolism	42	Perimortem Caesarean	Induced
4.2	31	Amniotic fluid embolism	39	Emergency Caesarean	Induced
4.3	35	Amniotic fluid embolism	38	Vaginal	Induced
4.4	35	Amniotic fluid embolism	37	Undelivered	Not applicable
4.5	28	Amniotic fluid embolism	41	Forceps	Induced
4.6	29	Amniotic fluid embolism	41	Emergency Caesarean	Induced
4.7	36	Amniotic fluid embolism	38	Elective Caesarean	No labour

Illustrative cases

Case 4.3

A 35 year old para 2 woman presented at 38 weeks with a history of no fetal movements for one day, which was confirmed by ultrasound. Labour was induced by amniotomy and syntocinon. Three hours later, the patient requested analgesia and became cyanosed, tachypnoeic and disorientated. Tachycardia and hypotension were noted. Her condition improved after an intravenous line was inserted and she was transferred to the intensive care unit. She proceeded to a rapid spontaneous vaginal delivery followed by a major postpartum haemorrhage. She was managed with whole blood, coagulant replacement therapy and oxytocics. Ongoing blood loss led to a laparotomy and a postpartum hysterectomy. She developed intraoperative bradycardia and became unresponsive to further resuscitative efforts including cardiac massage, and subsequently died.

Cause of death: Amniotic fluid embolism
Classification: Direct

Case 4.5

A 28 year old woman had an uncomplicated first pregnancy with spontaneous onset of labour at 41 weeks gestation. Her labour was augmented with oxytocin and amniotomy. Eight hours after augmentation, she became semi-conscious and centrally cyanosed. She was given oxygen and was transferred to operating suite for emergency Caesarean section. She was found to be fully dilated and delivered a live born infant by forceps. She had a postpartum haemorrhage of three litres and was transfused. She continued to bleed vaginally and underwent a laparotomy. Resuscitation attempts were unsuccessful and she died during the operation.

Cause of death: Amniotic fluid embolism
Classification: Direct

Clinical comment and best practice

The amniotic fluid embolism syndrome is a clinical diagnosis that must be made with alacrity, usually in the absence of confirmatory information, if the affected woman is to survive. The only chance for survival in a severe case lies in anticipation of major haemorrhage when the characteristic premonitory signs appear, preparation for and management of the bleeding and hypoxia, and timely transfer to an intensive care unit where the cardio-respiratory consequences can be dealt with. Clinical diagnosis must be suspected in any woman who becomes cyanosed and displays altered mental state, loss of consciousness or seizure in labour. These observations were apparent in nearly all of the cases reported this triennium. The initial collapse with cyanosis and obtundation, almost always in labour but sometimes before (or even during delivery at Caesarean as in one case described here), is accompanied immediately by signs of severe fetal distress and followed within minutes by severe intractable haemorrhage. At the same time there is severe hypoxia and left, then right sided heart failure.

Resuscitation requires a full team of obstetrician, anaesthetist, haematologist, physician, intensivist, neonatologist, midwife and laboratory staff. Every maternity unit must have a

'disaster plan' to deal with such cases and drills should be held at intervals, with appropriate codes in place that allow no delay in managing this critical situation. The full process should be activated as soon as a woman collapses with cyanosis in labour, which usually precedes the second phase of the syndrome, major bleeding, by a critical period of several minutes during which time senior staff may be summoned, blood ordered and large cannulae inserted. Many of these cases arise entirely unheralded, after a normal pregnancy, normal (but often induced) labour, and with a well-grown baby (Clark et al. 1995).

This chapter has been reviewed and clinical commentary provided by Associate Professor Barry Walters.

5 Thrombosis and thromboembolism

Introduction and definition

Pulmonary thromboembolism (PTE) is a leading cause of maternal mortality in Australia. PTE arises from deep venous thrombosis (DVT) which is frequently not recognised clinically before PTE occurs. As well as the acute morbidity and mortality of venous thromboembolism, PTE carries a risk of subsequent pulmonary hypertension (Greer 2002). The major risk factors for venous thromboembolism in pregnancy include age of 35 years or older, Caesarean section, particularly as an emergency in labour, operative vaginal delivery, a body mass index (BMI) greater than 29, heritable or acquired thrombophilia, a history of DVT or PTE, gross varicose veins, pre-eclampsia, immobility or a significant current medical problem (Greer 2002).

Epidemiology

There were six deaths in the 1997–99 triennium in which PTE was judged to be the principal cause of death (Table 5.1). All six deaths were classified as direct maternal deaths. This is a decrease from eight deaths observed from pulmonary thromboembolism in the previous triennium.

Of the six women who died from PTE, four were aged 35 years and over and two were delivered by Caesarean section. The remaining pregnancies were at 22, 24 and 29 weeks gestation. In two of the women with PTE, DVT was identified as a contributing cause of death, one had muscular dystrophy and one had knee surgery four weeks prior to her death. The weight of four women was recorded as being between 77 and 84 kilograms. Without height measurements, it is not possible to calculate BMI for these women. Of the six women, five had identified risk factors for thromboembolism.

Table 5.1: Deaths due to thrombosis, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
5.1	36	Pulmonary thromboembolism	DVT	38	Elective Caesarean	Prior immobilisation
5.2	36	Pulmonary thromboembolism	Muscular dystrophy	41	Spontaneous vaginal	—
5.3	36	Pulmonary thromboembolism	—	29	Not applicable	DVT in previous pregnancy
5.4	35	Pulmonary thromboembolism	Semi elective knee surgery	24	Not applicable	Knee surgery 4 weeks prior to death
5.5	20	Pulmonary thromboembolism	—	22	Not applicable	Twin pregnancy, obesity
5.6	29	Pulmonary thromboembolism	DVT	41	Emergency Caesarean	—

Illustrative cases

Case 5.1

A 36 year old para 3 woman had an uneventful pregnancy to 38 weeks gestation. She had an elective Caesarean section under epidural anaesthetic for breech presentation at a tertiary hospital. Two days following delivery, she became faint in the shower and then suffered a cardiac arrest. Resuscitation was commenced, with pulmonary embolus suspected. Her pulse, colour and perfusion improved. She was transferred to an intensive care unit where a second cardiac arrest occurred and vaginal bleeding commenced. Resuscitation was unsuccessful.

Cause of death: Pulmonary thromboembolism, with deep leg vein thrombosis as an antecedent cause
Classification: Direct

Case 5.3

A 36 year old para 2 woman weighing 77kg, with a history of left calf DVT, was treated with heparin after emergency Caesarean section in her last pregnancy. In the present pregnancy, Doppler and clinical examination of her legs showed no abnormality, and a haemostatic screen showed no underlying thrombotic reason for thrombosis. She declined medical advice to undergo heparin treatment. At 29 weeks gestation, she presented to hospital with persistent vomiting. Clinical examination was normal, but she collapsed soon afterwards. She did not respond to resuscitative measures.

Cause of death: Massive bilateral pulmonary thromboembolism
Classification: Direct

Case 5.4

A 35 year old woman para 2 underwent a surgical operation for treatment of a fractured patella. Four weeks later at 24 weeks gestation, she collapsed at home after complaining of breathlessness and chest pain. Ambulance officers commenced resuscitation, but neither pulse nor blood pressure was detectable. On arrival at hospital, because her pupils were fixed and dilated, no surgical intervention was considered appropriate. She died one hour after the initial call to the ambulance service.

Cause of death: Pulmonary thromboembolism and deep vein thrombosis within the venous system of the left calf
Classification: Direct, although there was not consensus by the NACMM of the classification of this death (direct or indirect)

Case 5.6

A 29 year old woman para 0 weighing 79kg, had a spontaneous onset of labour at 41 weeks gestation. An emergency Caesarean was performed for non-progression of labour, despite oxytocin augmentation and an epidural. There were no operative difficulties. On day two, she suddenly collapsed with dyspnoea and rapidly deteriorated. Resuscitation efforts were not successful. There were no other apparent risk factors for thromboembolism.

Cause of death: Acute pulmonary thromboembolism with bilateral deep vein thrombosis as a contributing cause
Classification: Direct

Clinical comment

Based upon a preliminary analysis of hospital discharge data from 1997–99, it is likely that there were 500–600 cases of pulmonary embolism associated with pregnancy and the puerperium. The case fatality rate is approximately 1%. The occurrence of six deaths from PTE in the 1997–99 triennium is consistent with these estimations. This would equate to 70 cases per year per 100,000 confinements or one case in every 1,500 pregnancies. Are these cases of pulmonary embolism avoidable? Almost certainly they are not all avoidable, as some do not have recognisable risk factors. Moreover, routine prophylaxis would involve thromboprophylaxis of many women who were destined to survive without problems. Even so, in none of the women described above, was thromboprophylaxis instituted, but several had risk factors. These included advanced maternal age, obesity, recent knee surgery, previous thrombosis in pregnancy, and status post emergency Caesarean. These are described in the guidelines referred to below (RCOG 2001), and prophylaxis should be given when risk factors exist.

Undoubtedly an increasing proportion of women are receiving prophylaxis, and the mortality rate would be higher without that. Whether systematic application of the RCOG guidelines will further reduce mortality in Australia remains to be seen.

Finally, in one case there was undiagnosed 'back pain' the day before sudden death. Even in the busy antenatal clinic, the possibility of unusual presentations of pelvic and iliac thrombosis should be kept in mind when considering the causes of such symptoms.

Best practice

Clinical guidelines regarding the investigation and management of women in whom venous thromboembolism is suspected were first published in the UK in 1995 (RCOG 2001). After the guidelines were first published, the number of deaths due to thrombosis among pregnant women following Caesarean section fell dramatically (Greer 2002). New guidelines regarding thromboprophylaxis during pregnancy, labour and after vaginal delivery were published in January 2004 (RCOG 2004).

A position statement published in 2001 on behalf of the Obstetric Medicine Group of Australasia entitled 'Anticoagulation in pregnancy and the puerperium' addresses similar issues (OMGA 2001).

This chapter has been reviewed and clinical commentary provided by Associate Professor Barry Walters.

6 Hypertensive disorders in pregnancy

Introduction and definition

Hypertensive disorders in pregnancy rank with thromboembolism as the third most common cause of maternal mortality in the current triennium. The definitions used in this report are those recommended in the Consensus Statement of the Australasian Society for the Study of Hypertension in Pregnancy (Brown et al. 2000). Hypertension during pregnancy may develop as a result of the pregnancy (as pre-eclampsia) or follow pre-existing hypertension. Hypertension in pregnancy is diagnosed when systolic blood pressure is ≥140mmHg and/or diastolic blood pressure is ≥90mmHg. Hypertension arising for the first time after 20 weeks gestation may be an isolated finding (gestational hypertension) or part of a multi-system disorder, such as pre-eclampsia. A clinical diagnosis of pre-eclampsia will include gestational hypertension and one or more of the following: proteinuria, renal insufficiency, liver disease, neurological symptoms or signs, haematological disturbances and fetal growth restriction. Eclampsia is the occurrence of convulsions during pregnancy or in the first ten days after delivery in association with pre-eclampsia.

The major risk factors for pre-eclampsia/eclampsia include primiparity, age younger than 20 years or older than 35 years, obesity, multiple pregnancy, pre-eclampsia/eclampsia in a previous pregnancy, family history of pre-eclampsia/eclampsia, and pre-existing hypertension or renal disease (Robson 2002). The most common cause of death among women with pre-eclampsia/eclampsia is intracranial haemorrhage. Other causes include renal or hepatic failure, pulmonary oedema and pre-eclampsia with hepatic and haematological abnormalities (previously referred to as HELLP syndrome).

Epidemiology

There were six deaths in which hypertensive disorders in pregnancy were judged to be the leading cause of death (Table 6.1). Another death due to postpartum haemorrhage had pre-eclampsia as a contributing factor as did a death due to amniotic fluid embolism. All eight deaths were classified as direct maternal deaths. In the 1994–96 triennium, there were nine deaths with pre-eclampsia, eclampsia or gestational hypertension as the principal cause of death and an additional 11 deaths in which these conditions were contributing factors.

Of the six deaths in which an hypertensive disorder was deemed to be the principal cause of death, two resulted from cerebral haemorrhage, one from a cerebral infarct, one from renal failure and in one the cause of death was not ascertained. The death with a contributing cause of death of gestational hypertension was as a result of ventricular fibrillation.

Five of the women who died from hypertensive diseases delivered by Caesarean section, two elective, and three emergency. The remaining woman reached 23 weeks gestation. The women were aged between 22 and 42 years of age.

The weight was known for five women and ranged from 59 to 87 kilograms. Height is not routinely collected and BMI can therefore not be calculated. One woman was described at autopsy as being ‘obese’.

Table 6.1: Deaths due to hypertensive disorders in pregnancy, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Parity	Type of delivery	Additional factors
6.1	42	Ventricular fibrillation	Gestational hypertension	38	2	Elective Caesarean	Obesity
6.2	29	Sub arachnoid haemorrhage	Pre-eclampsia	23	2	Not applicable	Non compliance
6.3	30	Cerebral haemorrhage	Pre-eclampsia	34	1	Elective Caesarean	—
6.4	22	Unascertained	Pre-eclampsia	36	1	Emergency Caesarean	—
6.5	35	Cerebral infarction	Sagittal sinus thrombosis, pre-eclampsia	29	2	Emergency Caesarean	Severe pre-eclampsia in previous pregnancies
6.6	33	Renal failure	Pre-eclampsia	30	Unknown	Emergency Caesarean	Puerperal cardiomyopathy, diabetes mellitus
3.1	34	Post partum haemorrhage	Gestational hypertension	38	1	Spontaneous vaginal	—
4.6	29	Amniotic fluid embolism	Disseminated intravascular coagulation, pre-eclampsia	41	1	Emergency Caesarean	–

Illustrative cases

Case 6.2

A 29 year old woman para 2 had a past history of essential hypertension not requiring medication. At 19 weeks with a recorded blood pressure 160/90 mm Hg, she was seen by a physician, who prescribed atenolol. She presented at 24 weeks with right upper quadrant pain. She discharged herself against medical advice but six days later was re-admitted with generalised seizures and a blood pressure of 240/120 mm Hg. She was treated with hydralazine magnesium sulphate and mannitol then transferred to a tertiary centre moribund. A CAT scan showed extensive sub arachnoid and intraventricular haemorrhage.

Cause of death: Sub arachnoid haemorrhage
Contributing cause of death: Pre-eclampsia
Classification: Direct

Case 6.3

A 30 year old woman para 1 had her antenatal care provided by her general practitioner. In this second pregnancy, she was admitted to hospital at 33 weeks with a blood pressure of 140/90 mmHg. She was referred to a specialist obstetrician. She was commenced on oral anti-hypertensive therapy and had diastolic blood pressure levels of 90–105 mm Hg. Other tests showed proteinuria; uric acid 0.36; creatinine 79; platelets 153; and fetal intrauterine growth restriction with high resistance umbilical artery flow.

She was given steroids to promote fetal lung maturity prior to delivery by Caesarean section which was carried out under epidural anaesthesia and a liveborn infant was delivered. In the recovery ward, she became hypertensive (180/120 mmHg), and had a respiratory arrest. She was ventilated and found to have suffered a brainstem haemorrhage. She was in intensive care for four days after which time life support was withdrawn.

Cause of death: Cerebral haemorrhage
Underlying cause of death: Pre-eclampsia
Classification: Direct

Case 6.5

A 35 year old woman para 2 had severe pre-eclampsia in both her previous pregnancies, delivering before 31 weeks each time. In this pregnancy, she was transferred from a remote rural centre for management at 29 weeks when she developed eclampsia. She was managed at a major obstetric hospital and delivered a liveborn infant by emergency Caesarean section. There was post operative evidence of a cerebral event and so she was transferred to a major general hospital. A CAT scan confirmed a cerebral infarction. She died 11 days postpartum.

Cause of death: Cerebral infarction/sagittal sinus thrombosis
Contributing cause of death: Eclampsia/severe pre-eclamptic toxaemia
Classification: Direct

Clinical comment

Pre-eclampsia in its various permutations features prominently in this and other reports of maternal mortality throughout the world. It should not be forgotten, however, that for every mortality there are hundreds of cases of severe morbidity for mother and baby, with complications requiring intensive care. Among these are cerebral complications, in particular haemorrhage causing permanent morbidity for the woman. For the baby, pre-eclampsia results in placental failure, growth restriction and extreme prematurity.

Survey of these maternal deaths is always instructive. Ergometrine should not be administered to women with severe pre-eclampsia. One obese woman aged 42 years with hypertension and two children was treated with IVF to conceive. She developed severe hypertension and died of pulmonary oedema and arrhythmia soon after delivery. In another case, a woman aged 35 years died of cerebral haemorrhage after her third experience of severe pre-eclampsia, the other two pregnancies also requiring delivery before 32 weeks.

Recent emphasis on the hepatic and haematologic aspects of severe pre-eclampsia may have diverted attention from the primacy of severe hypertension as a life threatening risk in these women, particularly when combined with proteinuria. Normality in blood tests does not preclude the possibility of cerebral haemorrhage from severe hypertension. One 34 year old woman was discharged at 37 weeks despite having hypertension severe enough to require treatment with high-dose triple drug therapy. She presented to the labour ward a week later with severe problems and died soon after delivery from haemorrhage and heart failure.

In summary:

Prevention of maternal death for high-risk women begins with preconception counselling. Women with a history of recurrent severe early pre-eclampsia should be cautioned about the risks of further pregnancy, as should elderly obese hypertensive multiparous women.

Severe hypertension should always be treated vigorously. Every hospital should have a standard protocol to deal with episodes of severe hypertension, defined as systolic blood pressure of 170 mmHg or more, or diastolic blood pressure of 110 mmHg or more. Lower 'action levels' should be considered in young women and those with low blood pressures at the booking visit.

Best practice

A consensus statement on the detection, investigation and management of hypertension in pregnancy was published in 2000 by the Australasian Society for the Study of Hypertension in Pregnancy (Brown et al. 2000).

Two international multi-centered clinical trials have provided best practice recommendations for the prevention and treatment of eclamptic seizures. Magnesium sulphate has been shown to be the anticonvulsant agent of choice for these two circumstances (ETCG 1995; MTCG 2002).

This chapter has been reviewed and clinical commentary provided by Associate Professor Barry Walters.

7 Early pregnancy deaths

Introduction and definition

For the purpose of this report, an early pregnancy death is defined as a direct maternal death during the first trimester (the first 14 weeks). This chapter contains information on this category for direct maternal deaths only.

Epidemiology

There were two direct deaths in this category during this triennium: a ruptured ectopic pregnancy and a death from sagittal vein thrombosis (Table 7.1). There were no reported direct deaths related to termination of pregnancy or to spontaneous abortion. In the 1994–1996 triennium, there were nine early pregnancy deaths—five deaths were due to ectopic pregnancy, three relating to termination of pregnancy and one related to a spontaneous abortion.

The first direct early pregnancy death is discussed below. The second early pregnancy death occurred in a 34 year old multiparous woman at seven weeks gestation. She collapsed at home and was admitted unconscious to a tertiary hospital. She had hyperemesis gravidarum in this pregnancy. The underlying cause of death (diagnosed by CAT scan) was sagittal vein thrombosis presumed to be secondary to dehydration and the hypercoagulable state of pregnancy. There was not consensus regarding the classification (direct vs indirect) of this death by NACMM.

Table 7.1: Early pregnancy deaths, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Additional factors
7.1	37	Ruptured ectopic pregnancy	—	5	Polycystic ovarian syndrome
7.2	34	Sagittal vein thrombosis	Hyperemesis gravidarum	7	—

Illustrative case

Case 7.1

A 37 year old woman para 0 had a history of polycystic ovarian syndrome. She was not aware of the current pregnancy. She collapsed at home and was transported to hospital by ambulance. She had a cardiac arrest on arrival at hospital. Her abdomen was noted to be distended. Resuscitation attempts were unsuccessful. At autopsy, three litres of blood were found in the abdominal cavity and a ruptured right fallopian tube.

Cause of death: Ruptured ectopic pregnancy
Classification: Direct

Clinical comment

While ectopic pregnancies are rare, they are still potentially fatal, and should always be part of the differential diagnosis in women of childbearing age who present with abdominal pain.

Best practice

Clinical practice guidelines for the management of suspected ectopic pregnancy are published by the Royal Women's Hospital in Victoria (RWH 2002). No guidelines or statements emanating from the clinical colleges have been found addressing the optimal management of ectopic pregnancy.

This chapter has been reviewed and clinical commentary provided by Professor Michael Bennett.

8 Deaths due to anaesthesia

Introduction and definition

For the purpose of this report, deaths due to anaesthesia are defined as direct maternal deaths where the death is directly attributable to the anaesthetic agent or procedure.

Epidemiology

There were three deaths in the current triennium which were directly related to anaesthesia. There were two cases in which failed intubation was judged to be the primary cause of death (Table 8.1). One other death was due to an anaphylactic reaction of uncertain aetiology. In the previous triennium 1994–96, there was one death directly attributed to the administration of an anaesthetic.

Table 8.1: Deaths due to anaesthesia, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
8.1	35	Hypoxia	Failed intubation	41	Emergency Caesarean	—
8.2	23	Anaphylactic reaction of unknown aetiology	—	41	Elective Caesarean	—
8.3	34	Hypoxia	Failed intubation	Term	Spontaneous vaginal	Retained placenta

Other deaths associated with anaesthesia

Of the 50 women who died following delivery, 34 delivered by Caesarean section and therefore had an anaesthetic procedure, but the anaesthetic was not thought to be a contributing factor in the death. There were five other deliveries, which had an associated anaesthetic procedure. Two women underwent postpartum hysterectomies prior to dying from postpartum haemorrhage and amniotic fluid embolism (with associated postpartum haemorrhage). Two other women died after a general anaesthetic for manual removal of placenta. The fifth woman had a general anesthetic for uterine evacuation after fetal death. She died from disseminated intravascular coagulation.

The three deaths in which anaesthesia was directly related to the cause of death are described as illustrative cases below.

Illustrative cases

Case 8.1

A 35 year old woman para 4 weighing 86kg had labour induced at 41 weeks gestation by amniotomy and Syntocinon infusion. Vaginal haemorrhage then occurred on account of which an emergency Caesarean section was undertaken at a district hospital. There was

difficulty with intubation during induction of general anaesthesia. This led to cardiovascular collapse and the woman died despite resuscitative efforts. The infant survived.

Cause of death: Hypoxic cardiac arrest
Contributing cause: Failed intubation
Classification: Direct

Case 8.2

A 23 year old woman para 0 weighing 88kg was admitted for elective Caesarean section for high head at term at a district hospital. Spinal anaesthetic was administered using lignocaine, morphine and fentanyl after Haemaccel preload, following which she developed hypotension and seizures. IV ephedrine was administered. She was intubated and ventilated. An emergency Caesarean section delivered a live infant. Resuscitation efforts continued with CPR and administration of adrenaline. She was unable to be resuscitated. The coroner considered the cause of death to have been an anaphylactic reaction of uncertain aetiology, but probably a reaction to Haemaccel.

Cause of Death: Anaphylactic reaction of uncertain aetiology
Classification: Direct

Case 8.3

A 34 year old woman para 5 underwent general anaesthesia for a manual removal of retained placenta following spontaneous delivery of a healthy infant at a district hospital. There was failed intubation at induction of anaesthesia with subsequent respiratory arrest. The woman was transferred to intensive care for life support which was subsequently withdrawn. Autopsy showed global brain damage.

Cause of death: Hypoxic cardiac arrest
Contributing cause: Failed intubation
Classification: Direct

Clinical comment

Of these three deaths, one was considered to be due to anaphylaxis, probably as a result of the administration of colloidal solution. Anaphylaxis associated with anaesthesia can be severe. No intervention reliably prevents hypotension, but vasopressor drugs are an effective alternative to intravenous fluid administration (Emmett 2003). Two deaths were due to failed airway management. The incidence of difficult intubation among pregnant women is reported to be approximately 1 in 50 and that of failed intubation 1 in 250–750, several times higher than in the general surgical population (Yeo et al. 1992; Barnardo & Jenkins 2000). The risks associated with general anaesthesia for pregnant and postpartum women have been emphasised for many years. All medical practitioners providing anaesthetic services to pregnant women must be familiar with algorithms for the management of difficult intubation, relevant airway equipment and should have regularly practised a failed intubation drill.

Best practice

Guidelines are published by the Australian and New Zealand College of Anaesthetists for the conduct of major regional analgesia in obstetrics (ANZCA 1998). The guidelines cover pain relief during labour to enhance safety during these procedures.

The American Society of Anesthesiologists difficult airway algorithm is the basis for management of the difficult airway in anaesthesia worldwide (ASA 2003). The Australian and New Zealand College of Anaesthetists Professional Documents T1 and T2, Recommendations on Minimum Facilities for Safe Anaesthesia Practice, both include a statement that: 'In every anaesthetising location there must be available: equipment for managing difficult intubations in all locations where endotracheal intubation is electively performed' (ANZCA 2000a, 2000b).

This chapter has been reviewed and clinical commentary provided by Associate Professor Michael Paech.

9 Other direct maternal causes of death

Introduction and definition

There was a total of 34 direct deaths in the 1997–99 triennium. Of these, eight (24%) were due to obstetric haemorrhage, seven (21%) due to amniotic fluid embolism seven (21%) were due to thrombosis, five (15%) due to hypertensive disorders of pregnancy, three (9%) associated with anaesthesia and one due to a ruptured ectopic pregnancy. There were two cases (6%) which were not classified into these separate chapters and are discussed in this chapter, one due to disseminated intravascular coagulation and the other due puerperal cardiomyopathy. Puerperal cardiomyopathy is defined in the UK report as a dilated cardiomyopathy that typically occurs in the month before or after delivery. The condition is diagnosed when no other cause can be found for the cardiac dilatation (NICE 2001). The pathogenesis of puerperal cardiomyopathy remains unknown (De Swiet 2002).

Epidemiology

Table 9.1: Other direct maternal deaths, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery
9.1	42	Puerperal cardiomyopathy	—	35	Emergency Caesarean
9.2	24	Disseminated intravascular coagulation	—	25	Evacuation of uterus under anaesthesia

Case reports

A 42 year old woman para 0 treated for threatened preterm labour at 33 weeks gestation, delivered by Caesarean section at 35 weeks gestation at a district hospital. She had a cardiac arrest on day four postpartum and died of puerperal cardiomyopathy 14 days postpartum. No autopsy was performed and the case was not the subject of a coronial investigation.

A 24 year old woman para 0 presented at 24 weeks gestation with headache, blurred vision and a small amount of vaginal bleeding in a tertiary level hospital. Ultrasound confirmed fetal death in utero. Labour was induced and she developed disseminated intravascular coagulopathy followed by a cardiac arrest. She was unable to be resuscitated. Coronial autopsy confirmed complications from fulminating disseminated intravascular coagulation, presumed secondary to fetal death in utero, cause unknown.

Clinical comment and best practice

Early multi-disciplinary consultation is advisable in the management of pregnant women presenting to emergency departments in order to optimise management. All unexpected obstetric deaths should be referred to the coroner with the expectation that autopsies will be performed.

This chapter was reviewed and clinical commentary provided by Associate Professor James King.

Section C Indirect maternal deaths

10 Indirect maternal deaths summary

Indirect maternal deaths

There has been a decline in the indirect maternal mortality ratio since 1973 (Table 10.1). Between 1964 and 1973, indirect and incidental deaths were not separated and can therefore not be reported as an individual indirect maternal mortality ratio. The ratio has increased since the last triennium, which is in part due to the reclassification of deaths due to psychiatric causes from incidental to indirect. This is discussed further in Chapter 12.

Table 10.1: Indirect maternal mortality ratios, 1973–99

Triennium	Total confinements	Indirect maternal deaths	Maternal mortality ratio*
1973–75	726,690	32	4.4
1976–78	678,098	35	5.2
1979–81	682,880	34	5.0
1982–84	713,985	25	3.5
1985–87	726,642	30	4.1
1988–90	754,468	33	4.4
1991–93	769,253	22	2.9
1994–96	767,448	20	2.7
1997–99	758,030	28	3.7

*per 100,000 confinements.

Indirect maternal causes of death

There were 28 indirect maternal deaths in the triennium. This is an increase from the previous triennium, which had 20 indirect maternal deaths. This increase is partially due to the reclassification of deaths due to psychiatric causes from incidental to indirect. The main causes of indirect death were deaths from psychiatric causes (N=8) and deaths due to cardiac disease (N=7). The majority of indirect deaths (N=13) could not be grouped into categories. There were three deaths due to sepsis and two deaths due to sub arachnoid haemorrhage. The other deaths were due to asthma, retroperitoneal haemorrhage, Crohn's disease, hypovolemic shock, hypoxic encephalopathy, pneumonia, pulmonary hypertension, and ruptured dissection of the thoracic aorta (Table 10.2).

Table 10.2: Indirect causes of maternal death, 1997–99

Indirect causes of death	Number	Total
Cardiac disease		**7**
Aortic valve disease	1	
Arrythmogenic right ventricular dysplasia	1	
Cardiac arrest	1	
Myocardial infarction	1	
Cardiac arrythmia	1	
Cardiac disease	1	
Sub acute endocarditis	1	
Deaths from psychiatric causes		**8**
Drug overdose	4	
Suicide	4	
Other indirect causes		**13**
Sepsis	3	
Sub arachnoid haemorrhage	2	
Asthma	1	
Retroperitoneal haemorrhage	1	
Crohn's disease	1	
Hypovolemic shock	1	
Hypoxic encephalopathy	1	
Pneumonia	1	
Pulmonary hypertension	1	
Ruptured dissection of thoracic aorta	1	
Total	**28**	**28**

Birth outcomes

Of the 28 indirect maternal deaths, more than half of the infants (54%) were undelivered (N=15), 32% of infants were liveborn (N=9), and 14% were stillborn (N=4). Of the infants that were undelivered, four were at a gestational age of 28 weeks or more (Table 10.3).

Table 10.3: Indirect maternal deaths by gestational age and birth outcomes, 1997–99

Gestational age	Livebirth	Undelivered	Stillbirth	Spontaneous abortion/ ectopic pregnancy	Total
<20 weeks	—	7	—	—	7
20–27 weeks	—	4	2	—	6
28–36 weeks	4	2	2	—	8
>=37 weeks	5	2	—	—	7
Total	**9**	**15**	**4**	**—**	**28**

Parity by age group

For the indirect maternal deaths in this triennium, 36% (N=10) were primiparous, 36% (N=10) were multiparous and 11% (N=3) were grand multiparous women. Parity was missing for five women (Table 10.4).

Table 10.4: Indirect maternal deaths—parity by age group, 1997–99

	Parity				
Age group	0	1–3	>=4	Missing	Total
15–19	3	—	—	—	3
20–24	—	1	—	—	1
25–29	4	1	1	3	9
30–34	2	5	—	1	8
35–39	1	3	1	1	6
40–44	—	—	1	—	1
Total	**10**	**10**	**3**	**5**	**28**

11 Cardiac disease

Introduction and definition

Cardiac disease has remained the leading cause of indirect maternal mortality in the 27-year period 1973–99: 40% of all indirect deaths were due to cardiac disease. The most common types of cardiac disease in this period were peripartum cardiomyopathy (20%), primary pulmonary hypertension (16%) and mitral/aortic valvular disease (10%).

In the previous triennium 1994–96, there were ten indirect deaths due to cardiac disease, being 50% of all indirect deaths.

The number of women with cardiac disease who subsequently become pregnant is increasing because of advances in surgery and medical therapy which now allow more at-risk women to survive into the reproductive age. The frequency of cardiac disease in pregnancy is reported to vary from 0.4% to 4.0% of all pregnancies and remains a leading cause of maternal mortality in the UK, USA and Australia. Haemodynamic changes pre-exist in women with cardiac disease and the physiological circulatory changes of pregnancy further add to this burden by increased blood volume and a requirement for increased cardiac output (Ramsey et al. 2001).

Epidemiology

There were seven deaths in the current triennium in which cardiac disease was judged to be the principal cause of death (Table 11.1). All seven deaths were classified as indirect maternal deaths. One cardiac death classified as a direct death was due to puerperal cardiomyopathy. Two other deaths due asthma and a drug overdose recorded cardiac disease as a contributing factor.

All seven women were aged between 18 and 38 years of age. The causes of death were arrythmogenic right ventricular dysplasia, infective endocarditis, cardiac arrhythmia, aortic valve disease, myocardial infarction, cardiac disease, and cardiac arrest in an obese woman who was a heavy smoker. There were three deliveries, two perimortem Caesarean section deliveries, which delivered two stillborn infants, and one elective Caesarean section delivery, which resulted in one liveborn infant.

Table 11.1: Deaths due to cardiac disease, 1997–99

Case	Age	Principal cause of death	Contributing cause	Gestational age	Type of delivery	Classification
11.1	31	Cardiac arrhythmia	Cardiac conduction defect	21	Perimortem Caesarean	Indirect
11.2	32	Cardiac arrest	Obesity, smoking, asthma	24	—	Indirect
11.3	18	Infective endocarditis	Intravenous drug user	29	Elective Caesarean	Indirect
11.4	27	Aortic valve disease	—	31	Perimortem Caesarean	Indirect
11.5	24	Cardiac disease	Marfan's syndrome, pregnancy	36	Undelivered	Indirect
11.6	25	Arrythmogenic right ventricular dysplasia	Systemic lupus erythematosus	23	—	Indirect
11.7	38	Myocardial infarction	Coronary atherosclerosis, smoking	25	—	Indirect
12.2	26	Drug overdose	Hypertophic obstructive cardiomyopathy	9	—	Indirect
13.10	37	Asthma	Ischaemic heart disease	12	—	Indirect
9.1	42	Puerperal cardiomyopathy	—	35	Emergency Caesarean	Direct

Illustrative cases

Case 11.2

A 32 year old woman had pre-eclampsia in her first pregnancy. She had a history of severe asthma, hypertension, cigarette smoking and her weight was 119kg. In her second pregnancy at 24 weeks gestation she became distressed and dyspnoeic at home and collapsed. Ambulance staff provided resuscitation and transfer to an intensive care unit but she could not be revived. Autopsy revealed cardiomegaly.

Cause of death: Cardiac arrest
Contributing cause: Asthma, obesity, smoking
Classification: Indirect

Case 11.4

This 27 year old woman para 0 had her antenatal care overseas. She had a congenital aortic stenosis which was managed with an aortic valve replacement. Her medication included warfarin prior to pregnancy, which was replaced by heparin. She developed gestational diabetes. At 31 weeks, she was admitted to a tertiary hospital with a provisional diagnosis of thrombosed prosthetic valve and infection. She was managed in the coronary care unit. Two days after admission, she developed dyspnoea, tachycardia and had a cardiac arrest one hour later. A Caesarean section was carried out to deliver a stillborn infant followed by cardiac surgery. Her prosthetic heart valve was found to be mobile with a sub valvular thrombus. The valve was replaced but she died shortly afterwards.

Cause of death: Aortic valve disease
Classification: Indirect

Clinical comment and best practice

There are no recurring themes in these accounts of unfortunate women with cardiac disease. Perhaps the Australian practitioner may take some solace from the relatively low number of cardiac deaths, given the increasing number of women with cardiac disease who present for care in pregnancy. However, there are some salutary lessons. In one case of a woman with a prosthetic aortic valve, death occurred related to valve thrombosis. Warfarin had been replaced by heparin before pregnancy. Heparin is a relatively poor substitute for warfarin, and pregnancy is always hazardous in this situation. It may be necessary to continue warfarin, and if not, low molecular weight heparin must be administered in an adequate dose and frequency, particularly with prosthetic aortic valves, that are known to predispose to thrombosis. The advisability of preconception counselling is again exemplified in a case of a woman with Marfan's syndrome who died of aortic dissection at 36 weeks. Echocardiographic evidence of aortic root dilation may have forewarned of the risk to the aorta intrinsic in pregnancy.

The determination of the contribution of cardiac disease to maternal mortality will require continuing consideration in subsequent reports. As more women with 'corrected' congenital heart disease and older women with ischaemic heart disease (related to diabetes, hypertension, obesity and smoking) appear for antenatal care, more complications are likely.

This chapter was reviewed and clinical commentary provided by Associate Professor Barry Walters.

12 Deaths from psychiatric causes

Introduction and definition

A maternal death from psychiatric causes is one in which the psychiatric condition was a major contributor or cause of death and where the death would not have occurred if the woman had not been suffering from a psychiatric disorder (Oates 2002). These deaths have historically been classified as incidental, but it is now considered best practice to classify them as indirect maternal deaths. Psychiatric deaths of women in pregnancy, the puerperium and the 12-month period following the birth encompass the wider issues of domestic violence, psychiatric illnesses and substance abuse.

On a death certificate, women who die from psychiatric-related causes are coded with ICD-10 F codes, which correspond to Mental and Behavioural Disorders. The coding policy of the Australian Bureau of Statistics (ABS) has been for women with an F53 code (Mental and Behavioural Disorders associated with the Puerperium) not to receive a maternal death flag. This has lead to a potentially significant under-ascertainment of pregnant women who died from psychiatric-related causes. The NPSU has made representation to the ABS to review the omission of maternal death flags for F53 codes.

Because of the shift in classification of psychiatric deaths from incidental to indirect, comparisons with previous triennia must be undertaken with caution. In the 1994–96 triennium, there were two deaths due to suicide which were classified as indirect. Two other cases of suicide and one of self-administered drug overdose were classified as incidental deaths.

Suicide is most likely to occur in patients suffering from depression and the childbearing years, especially pregnancy and the postpartum period. This is the peak risk period for women to develop a depressive disorder. As noted by both Oates (2003) and Appleby et al (1998), although pregnancy is overall protective against suicide, there appear to be subgroups in whom there is an elevated risk of suicide by violent means, in particular those who are psychotically depressed. This picture is reflected in our case series where four of the eight women died by violent means.

In contrast to earlier opinion that pregnancy was protective of mental health problems, we now know that the number of women scoring in the clinical range on the Edinburgh Depression Scale in pregnancy is almost as high as postpartum (Evans et al. 2001), with up to 40% of high scorers in pregnancy remaining high in the postpartum. This suggests that there may be value in screening and offering appropriate interventions to women antenatally. Indeed this is illustrated by the range of the eight maternal deaths across the perinatal period in this review.

Epidemiology

There were eight deaths in which a psychiatric cause was judged to be the principal cause of death (Table 12.1). All eight deaths were classified as indirect maternal deaths. Five deaths occurred in the first trimester of pregnancy; two deaths occurred one month postpartum and one death at term. A further five drug-related deaths were classified as incidental deaths.

The eight women were aged between 19 and 35. Five of them were between 6 and 16 weeks gestation and one at 39 weeks. A liveborn infant was delivered by a perimortem Caesarean section in the mother at 39 weeks gestation. Two of the deaths occurred at 29 and 32 days postpartum after delivering live infants by elective Caesarean section. Four women died from a drug overdose, two suicided by hanging, one suicided by gunshot wound and one by drowning. Six of the women had a known history of depression or drug use.

Table 12.1: Deaths from psychiatric causes, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
12.1	25	Suicide by hanging	Bipolar disorder	15	—	—
12.2	26	Drug overdose	Hypertrophic obstructive cardiomyopathy	9	—	—
12.3	33	Drug overdose	—	6	—	History of drug use
12.4	19	Suicide by drowning	Acute reactive depression	16	—	—
12.5	29	Drug overdose	Drowning	9	—	Previous depression, chronic drug abuse
12.6	28	Suicide by gunshot wound	Depression	39	Perimortem Caesarean	History of depression
12.7	35	Suicide by hanging	Depression	Death at 32 days postpartum	Elective Caesarean	History of depression
12.8	34	Drug overdose	Postnatal depression	Death at 29 days postpartum	Elective Caesarean	Previous severe postnatal depression

Clinical comment

Because of increasing awareness of the contribution of psychiatric disorders to maternal mortality, a brief summary of all eight cases is provided in this chapter.

Case 12.1

This woman suffered severe depressive relapse of bipolar disease in the context of cessation of psychotropic medication around time of conception. Relapse was so severe that she needed psychiatric admission; suicide took place while on leave from psychiatric unit. There are no details available as to whether she was on an adequate regimen and/or compliant with medication; whether she was psychotic; whether she had made recent or past suicide attempt(s); or whether her partner was made aware of her suicidal risk when she went on leave.

The case highlights the need for close, assertive psychiatric follow-up of women with known severe mood disorder throughout pregnancy, especially as they are likely to want to cease medication at this time and thus more likely to relapse (Viguera et al. 2000). While mood stabilisers (especially anticonvulsants) are associated with an increase in teratogenicity with first trimester use, this risk needs to be weighed up against the risk of severe relapse and associated morbidity and mortality (Austin & Mitchell 1998a).

Case 12.2

There appears to be no history of mental illness but it is possible this woman was depressed in the context of life-threatening illness. There is insufficient detail to comment further.

Case 12.3

This woman's partner reported she had 'mild' depression but was looking forward to the baby. One would want to know if there was any past history of self-harm/suicide attempts, alcohol abuse, or mood disorder even though she denied the latter; there may have been complicating issues in the marital relationship or some other major stressor not reported. Early psychosocial evaluation (such as described in the introductory section) may have identified her as at risk of, or suffering from, depression and self-harming ideation.

Case 12.4

Reactive depression and suicide in the context of shame associated with pregnancy out of wedlock occurred in a teenager from a traditional family. She was unlikely to tell her family how she was feeling but may have been identified as depressed and/or suicidal if she had had routine antenatal psychosocial screening. However, this was unlikely due to the hidden nature of her pregnancy.

Case 12.5

This was a woman with chronic drug (?opiate) abuse and past depression; unless patient accepted treatment for drug abuse, suicide was likely to occur. Preventability therefore low.

Case 12.6

As noted in the comment, the late involvement and lack of continuity of psychiatric services, inadequate antidepressant dose and availability of firearms in someone who was severely depressed and had been expressing suicidal ideation all contributed to this woman's death. Inadequate antidepressant dosage in pregnancy is often seen, as clinicians tend to use minimum dosage to reduce fetal exposure. However, where a woman is severely depressed, the optimum, not the minimum, dosage should be used (Austin & Mitchell 1998a). One might even have considered ECT if there was inadequate response to medication. Such options needed to be considered in this woman who had been probably severely depressed throughout pregnancy. Again antenatal psychosocial screening and monitoring through the maternity hospital (described in Austin 2003) may have improved the quality of psychiatric care she received.

Case 12.7

The main issue in this case needed to be serious consideration of psychiatric admission postpartum assuming she was/remained psychotic and/or suicidal. Failing admission, tight coordination of psychiatric follow-up (i.e. weekly to thrice weekly psychiatric outpatient reviews; involving acute mental care team; constant review of need for admission/scheduling) was required; with a full discussion with family of their role in ensuring follow-up occurred. A review by a liaison psychiatrist prior to discharge may have led to a better outcome, in particular informing her family of the need for assertive follow up.

Case 12.8

In this case, there was a history of severe past episode of postnatal depression, but there were no details available about this woman's past or current psychiatric treatment. As noted by Oates (2003), the risk of recurrence with severe postnatal depression is very high. This should have been a consideration in bringing this woman to the attention of mental health services during her pregnancy. Antenatal psychosocial screening (via her GP or the antenatal clinic; Austin 2003) would have identified a need for psychiatric follow-up throughout her pregnancy. This would have allowed monitoring of mood and formulation of a plan for immediate recommencement of antidepressant postpartum (Austin & Mitchell 1998b) or as required in pregnancy. This woman was clearly requiring psychiatric monitoring but not apparently receiving it.

Summary

An overview of cases suggests that routine antenatal psychosocial screening and subsequent monitoring may have brought these women to the attention of psychiatric services earlier or in a more sustained way. We also know however that while women will be identified, many do not follow through with treatment. It is especially important in those cases to engage the assistance of family members to try and improve compliance, and safety. Premature cessation of medication is an added problem for women who are concerned with the baby's safety.

Best practice

While there is no way of predicting antenatally who will become depressed postnatally (Austin & Lumley 2003), a number of researchers across Australia (Austin 2004; Buist et al. 2002; Matthey et al. 2004) are now focussing on the benefits of detecting high-risk women and those suffering significant psychological morbidity, in pregnancy. Thus, a number of centres are now using the Edinburgh Depression Scale at the booking-in visit to assess for current symptoms of depression and anxiety and thoughts of self-harm. As part of more extensive antenatal psychosocial screening and early intervention programs, two Sydney maternity hospitals (Austin 2003; Matthey et al. 2004) are additionally using antenatal risk questionnaires to evaluate a woman's psychosocial risk by assessing for past psychiatric history; quality of key relationships and supports; recent stressors; past and current history of abuse; quality of parenting when growing up; substance abuse; and self-esteem and personality style. These programs have been well received by women and staff (Matthey et al. 2004) but can only be conducted where there are adequate psychosocial and psychiatric services to deal with the higher detection rates that potentially arise with universal psychosocial screening.

Such services need to comprise ready access to a perinatal mental health clinic, antenatal social workers and a mental health crisis team. For women requiring a more preventive/early intervention model, antenatal group interventions may be beneficial in reducing anxiety and depression scores and improving self-esteem antenatally (Austin et al. 2004) and reducing early postnatal psychological distress (Matthey et al. 2004).

While psychosocial screening programs are increasingly seen as important, they do not ensure that all symptomatic or high-risk women will be identified; nor once identified is there any guarantee that the woman will attend her referral, comply with or respond to

treatment. Clinically, we know that it is often the women who most need the help who are least likely to attend. Thus not all psychiatric-related maternal deaths can be prevented.

No guidelines or position statements published by RANZCP were found concerning issues surrounding the management of depression during pregnancy. There are however other initiatives currently taking place. Later in 2004 the NSW Centre for Mental Health will release guidelines for antenatal psychosocial screening for use across the state (NSW DOH 2004). It has also developed an antenatal risk questionnaire which is to be used with the Edinburgh Depression Scale and is currently being linked to the Midwives Database Questionnaire. This is to be piloted in the latter half of 2004. In addition the NSW Families First Program has introduced universal psychosocial screening in the first few weeks postpartum; completion of this venture will take place across New South Wales in 2005. Guidelines (due in 2006) for perinatal psychosocial screening are being prepared in the UK by the National Institute for Clinical Excellence.

There is a Cochrane review currently in progress examining the validity of antenatal screening for pregnant women. While the NSW Department of Health is recommending universal antenatal psychosocial screening across the state, results from the Cochrane review are awaited before any definitive recommendations can be made. When screening is implemented, it must be accompanied by adequate services for these women.

While the focus of the best practice section in this chapter has been on New South Wales, there are initiatives in other states and territories addressing similar concerns re maternal morbidity and mortality from psychiatric causes.

This chapter was reviewed and clinical commentary provided by Associate Professor Marie-Paule Austin.

13 Other indirect causes of maternal death

Introduction and definition

Indirect maternal deaths have traditionally been divided into deaths from cardiac disease, deaths from psychiatric causes and 'other' indirect deaths. In the 'other' category, the most common causes of death are deaths due to cerebrovascular disease, deaths due to infection, and deaths due to other conditions such as asthma, epilepsy and diabetes.

Epidemiology

Of the 90 maternal deaths in the 1997–99 cohort, 28 (31%) were indirect deaths. Of the 28 indirect deaths, seven were due to cardiac disease, eight due to psychiatric causes and 13 deaths, which were due to other causes, form the basis of this chapter. Of the 13 'other' indirect causes of death, four deaths were associated with infection, two deaths were associated with asthma and two deaths were due to a sub arachnoid haemorrhage. The remaining women died from Crohn's disease, retroperitoneal haemorrhage, hypovolaemic shock, pulmonary hypertension, and ruptured dissection of thoracic aorta (Table 13.1).

The women were aged between 18 and 42 years with gestational ages between 18 and 41 weeks. Among seven deliveries (two spontaneous vaginal, three emergency Caesarean section, one perimortem Caesarean section and one vacuum extraction), there were five liveborn infants.

Illustrative cases

Case 13.3

A 34 year old woman para 4 at 32 weeks gestation living in a remote community was admitted to the local medical centre with fever, restlessness and hyperventilation. While arrangements were being made for her transfer, she collapsed and died.

Cause of death: Septicaemia
Contributing causes of death: Myocarditis, pyelonephritis and perinephric abscess
Classification: Indirect

Clinical comment and best practice

These 13 cases present a wide range of clinical scenarios without a common theme. In all of these cases, there were severe pre-existing co-morbidities, sometimes under-recognised. Several of the case reports received from State Committees indicated opportunities for improvements in care, including early referral for specialist consultation in women with pre-existing heart disease or hypertension. The gravid uterus hinders early recognition of intra and retroperitoneal haemorrhage which is sometimes misdiagnosed as placental abruption, leading to delays in adequate management.

The four deaths from infection are a reminder that early and systematic investigation of non-specific symptoms in pregnant women is warranted in order to exclude sepsis.

Table 13.1: Other indirect causes of death, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
13.1	32	Sub arachnoid haemorrhage	Essential hypertension	27	—	Inadequate treatment for hypertension
13.2	32	Sub arachnoid haemorrhage	Essential hypertension, chronic renal impairment, ruptured cerebral artery aneurysm	35	Emergency Caesarean	Severe hypertension in two prior pregnancies
13.3	34	Septicaemia	Myocarditis, bronchopneumonia, pyelonephritis	32	Undelivered	Remote Australian area, difficulties in evacuation
13.4	26	Hypoxic encephalopathy	Acute asthma	18	—	Smoking
13.5	42	Ruptured dissection of thoracic aorta	—	Term	Vacuum extraction	—
13.6	37	Crohn's disease	Sepsis	24	Spontaneous vaginal	—
13.7	28	Septicaemia (source unknown)	Coagulopathy	37	Undelivered	—
13.8	34	Septicaemia (pneumococcal)	—	37	Spontaneous vaginal	—
13.9	30	Retroperitoneal haemorrhage	Trauma	32	Emergency Caesarean	—
13.10	37	Asthma	Ischaemic heart disease, smoking	12	—	—
13.11	18	Pneumonia	Asthma	31	Emergency Caesarean	—
13.12	25	Hypovolemic shock	Blood loss, ruptured splenic artery aneurysm	41	Undelivered	–
13.13	37	Pulmonary hypertension	Alcoholic liver disease	28	Perimortem Caesarean	–

This chapter was reviewed and clinical commentary provided by Associate Professor James King and Wendy Pollock.

Section D Incidental maternal deaths

14 Incidental maternal deaths summary

Incidental maternal deaths

There has been a decline in the incidental maternal mortality ratio. It was 3.7 deaths per 100,000 confinements in 1997–99, a decrease from 4.4 in the previous triennium (Table 14.1).

Table 14.1: Incidental maternal mortality ratios, 1973–99

Triennium	Total confinements	Incidental maternal deaths	Maternal mortality ratio*
1973–75	726,690	45	6.2
1976–78	678,098	19	2.8
1979–81	682,880	10	1.5
1982–84	713,985	27	3.5
1985–87	726,642	24	3.3
1988–90	754,468	26	3.4
1991–93	769,253	36	4.7
1994–96	767,448	34	4.4
1997–99	758,030	28	3.7

*per 100,000 confinements.

Incidental causes of maternal death

There were 28 incidental maternal deaths in the triennium. This is a decrease from the previous triennium, which had 34 incidental maternal deaths. The main causes of incidental death were deaths involving vehicles (N=7), drug-related and violent deaths (N=7), and deaths due to infection (N=6), pre-existing cancers (N=4), sub arachnoid haemorrhage (N=2), intracerebral haemorrhage (N=1) and epilepsy (N=1) (Table 14.2).

Table 14.2: Incidental causes of maternal death, 1997–99

Incidental causes of death	Number	Total
Deaths involving vehicles		**7**
Motor vehicle accident	5	
Pedestrian	1	
Helicopter crash	1	
Drug-related and violent deaths		**7**
Drug overdose	5	
Homicide	2	
Deaths due to infection		**6**
Pneumonia	1	
Hepatic failure	1	
Para influenza viral infection	1	
Sepsis	1	
Meningococcal septicaemia	1	
Cardiogenic shock	1	
Pre-existing cancers		**4**
Glioma	1	
Acute myeloid leukaemia	1	
Ovarian cancer	1	
Metastatic melanoma	1	
Other incidental causes		**4**
Sub arachnoid haemorrhage	2	
Epilepsy	1	
Intracerebral haemorrhage	1	
Total	**28**	**28**

Birth outcomes

Of the 28 incidental maternal deaths, 68% of infants were undelivered (N=19), 18% were liveborn (N=5), and 11% were stillborn (N=3). There was one death after a spontaneous abortion. Of the infants that were undelivered, five were at a gestational age of 28 weeks or more.

Table 14.3: Incidental maternal deaths by gestational age and birth outcomes, 1997–99

Gestational age	Livebirth	Undelivered	Stillbirth	Spontaneous abortion/ ectopic pregnancy	Total
<20 weeks	—	12	—	1	13
20–27 weeks	—	2	—	—	2
28–36 weeks	2	5	3	—	10
>=37 weeks	3	—	—	—	3
Total	**5**	**19**	**3**	**1**	**28**

Parity by age group

For the incidental maternal deaths in this triennium, 36% (N=10) were primiparous, 25% (N=7) were multiparous and 4% (N=1) were grand multiparous women. Parity was missing for 36% (N=10) of women.

Table 14.4: Incidental maternal deaths—parity by age group, 1997–99

	Parity				
Age group	0	1–3	>=4	Missing	Total
15–19	5	—	—	2	7
20–24	2	—	—	3	5
25–29	2	4	—	2	8
30–34	1	2	—	2	5
35–39	—	1	—	1	2
40–44	—	—	1	—	1
Total	**10**	**7**	**1**	**10**	**28**

15 Incidental causes of maternal death

Introduction

Incidental maternal deaths are deaths 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. These deaths are not included when calculating the maternal mortality ratio according to WHO definitions. However, there has been increasing interest in examining these maternal deaths that do not initially appear to be related to the pregnancy, but on closer examination may well be directly or indirectly associated with the pregnancy or its complications. An example of this would be death due to domestic violence, where the precipitation of the violent behaviour may be directly associated with the pregnancy. NACMM will continue to maximise efforts to obtain comprehensive ascertainment of these deaths and to scrutinise them to ensure correct classification.

Epidemiology

There were 28 deaths in the 1997–99 triennium which were classified as incidental maternal deaths compared with 34 in the 1994–96 triennium reflecting the change in classification of psychiatric cases from incidental to indirect. Five categories predominate in these deaths. They are deaths involving vehicles, deaths due to pre-existing cancers, deaths due to homicide, drug-related deaths and deaths due to infection.

Deaths involving vehicles

There were five maternal deaths due to unintentional injuries where the women were involved in motor vehicle accidents (Table 15.1). There was one other death where the pregnant woman was a pedestrian and another where she was a passenger in a helicopter. Alcohol and cannabis were contributing factors in three of the motor vehicle accidents. Of the five deaths involving motor vehicles, three had confirmed information that the deceased was not wearing a seatbelt and it is likely that the other two were also not wearing seatbelts.

Table 15.1: Incidental maternal deaths—vehicle accidents

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
15.1	17	Motor vehicle accident	—	36	Perimortem Caesarean	—
15.2	33	Motor vehicle accident	—	15	—	Not wearing seat belt, alcohol
15.3	18	Motor vehicle accident	—	36	Undelivered	Not wearing seat belt
15.4	33	Motor vehicle accident - pedestrian	—	18	—	—
15.5	24	Helicopter crash	Drowning	15	—	—
15.6	25	Motor vehicle accident	—	27	—	Not wearing seat belt
15.7	24	Motor vehicle accident	—	28	—	Alcohol

Violent deaths

There were two deaths due to homicide in this triennium both as a result of domestic violence (Table 15.2). One was an 18 year old woman, 18 weeks pregnant with a past history of intravenous drug use. There were concerns for her regarding domestic violence issues noted but at booking in she had denied this. The second death due to homicide occurred in a 25 year old woman nine weeks pregnant following a domestic dispute. In the previous triennium 1994–96, there were six deaths due to homicide.

Table 15.2: Incidental maternal deaths—drug-related and violent deaths

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
15.12	28	Drug overdose	—	29	—	—
15.13	22	Drug overdose	—	30	—	Narcotic addict, prior suicide attempt
15.14	33	Drug overdose	Depression	10	—	Known heroin user
15.15	19	Drug overdose	—	12	—	Known heroin user
15.16	24	Drug overdose	—	20	—	Known heroin user
15.17	18	Homicide	—	18	—	Domestic violence
15.18	25	Homicide	—	9	—	—

Drug-related deaths

There were five deaths due to drug overdose (Table 15.2). Four were due to heroin overdose in known heroin users and the fifth was due to an overdose of morphine. These women were aged between 18 and 33 and were between 10 and 30 weeks gestation. In the previous triennium, there were four drug-related deaths.

Deaths due to infection

There were six cases of incidental maternal death due to infection in the triennium 1997–99 (Table 15.3). In the previous triennium, there were two incidental deaths due to infection. The principal causes of death for the six women were influenza viral infection, hepatic failure due to hepatitis B infection, meningococcal septicaemia, E. coli sepsis, pneumonia and acute viral myocarditis. The women were aged between 18 and 35 years of age. There were three deliveries (two emergency Caesarean section and one perimortem Caesarean section), resulting in three stillborn infants.

Table 15.3: Incidental maternal deaths—deaths due to infection

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
15.19	35	Pneumonia	Alcohol abuse, Hepatitis C	18	Spontaneous abortion	No antenatal care
15.20	28	Hepatic failure	Hepatitis B	28	Emergency Caesarean	No antenatal care
15.21	18	Para influenza viral infection	—	14	—	—
15.22	18	E. coli sepsis	Disseminated intravascular coagulation	33	Emergency Caesarean	—
15.23	30	Meningococcal septicaemia	—	36	Perimortem Caesarean	—
15.24	19	Cardiogenic shock	Acute viral myocarditis	12	—	—

Pre-existing cancers

Four maternal deaths were due to pre-existing cancers (Table 15.4). The women were aged between 22 and 32 years of age. The cancers were acute myeloid leukaemia, glioma, ovarian cancer and metastatic melanoma. Three of these women delivered live infants by elective Caesarean section.

Table 15.4: Incidental maternal deaths—pre-existing cancers

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
15.8	26	Glioma	Sepsis	Died 15 days postpartum	Elective Caesarean	Livebirth
15.9	22	Acute myeloid leukaemia	—	19	—	—
15.10	27	Ovarian cancer	—	Died 11 days postpartum	Elective Caesarean	Livebirth
15.11	32	Metastatic melanoma	Septicaemia	Died 30 days postpartum	Elective Caesarean	Livebirth

Other deaths

There were four other incidental deaths in women aged between 27 and 42 years (Table 15.5). Two deaths were due to sub arachnoid haemorrhage, one death due to epilepsy and one due to an intracerebral haemorrhage. Two of these women delivered, one by an emergency Caesarean section and the other by perimortem Caesarean section resulting in two liveborn infants.

Table 15.5: Incidental maternal deaths—deaths due to other causes

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factors
15.25	27	Sub arachnoid haemorrhage	Ruptured middle cerebral artery, bronchopneumonia	30	Emergency Caesarean	Known drug user, Hepatitis C infection
15.26	42	Sub arachnoid haemorrhage	Cerebrovascular aneurysm	19	—	—
15.27	35	Epilepsy	Pulmonary oedema, coronary artery atheroma	8	—	—
15.28	28	Intracerebral haemorrhage	—	39	Perimortem Caesarean	—

Clinical comment and best practice

It is legislated throughout Australia that seatbelts be worn by all car passengers, including pregnant women. Individual state and territory transport authorities publish brochures with diagrams demonstrating the correct way to wear a seatbelt in pregnancy. Brochures are also available in languages other than English and for Aboriginal and Torres Strait Islander women. The correct position to wear a seatbelt is for the lap strap to be sitting over the thighs, across the pelvis and below the unborn child. The sash strap is to be placed above the stomach and between the breasts (ASTB 2004). Antenatal education should incorporate this important and highly relevant information as early in the pregnancy as possible, preferably at first contact with the care provider.

Many of the women who died from incidental causes received initial care in general acute care services. It would appear that there is room for improvement in early involvement of obstetric specialists in the management of pregnant women with 'non-obstetric' conditions including infection.

This chapter was reviewed by and clinical commentary provided by Associate Professor James King and Ms Wendy Pollock.

Section E Other key areas

16 Maternal mortality in Aboriginal and Torres Strait Islander women

Introduction and definition

Ever since Indigenous status has been recorded in Australian maternal mortality reports, the mortality ratios for Aboriginal and Torres Strait Islander women have been disproportionately high. The Aboriginal and Torres Strait Islander population demonstrates health outcome disadvantage for every public health parameter and maternal mortality reflects this also.

An Aboriginal or Torres Strait Islander woman is a woman who identifies as Aboriginal and/or Torres Strait Islander and is accepted as such by the community with which she is associated.

Ascertainment of Indigenous status

Indigenous status is a key demographic variable in maternal mortality surveys. However, the rate of identification of Indigenous status (ascertainment) continues to be suboptimal. Indigenous status was reported for 75 (83%) of the 90 maternal deaths in the current triennium. In the previous triennium, Indigenous status was known for 83 (83%) of the 100 maternal deaths (Table 16.1). Of those 83 deaths where Indigenous status was known, eight were Aboriginal and Torres Strait Islander, accounting for 9.6% of the deaths. In 1991–93, there were nine Aboriginal and Torres Strait Islander maternal deaths, accounting for 11.5% of the 78 deaths where Indigenous status was known.

Incomplete recording of Indigenous status remains a universal problem. Ascertainment of Indigenous status among maternal deaths peaked at 92% in 1991–93 but continues to be poorly reported (Table 16.1). This is inexplicable as the circumstances surrounding maternal deaths are extensively examined by State and Territory Maternal Mortality Committees, as well as at postmortem, and by the State and Territory Coroners. A priority for all future reporting should be to ensure that Indigenous status is identified and reported for all maternal deaths.

Table 16.1: Ascertainment of Indigenous status for maternal deaths, 1970–99

Triennium	% Ascertainment
1970–72	—
1973–75	—
1976–78	50
1979–81	48
1982–84	51
1985–87	84
1988–90	91
1991–93	92
1994–96	83
1997–99	83

Indigenous maternal mortality ratios

Information identifying Indigenous status has been available since 1970 but only for cases classified as direct maternal deaths. Information identifying Indigenous status for indirect and incidental deaths has been collected only since 1991. It has therefore been possible to calculate MMR for Aboriginal and Torres Strait Islander women only since 1991. Previously as with MMR for all women, the calculation included all maternal deaths. The MMR published for Aboriginal and Torres Strait Islander women for 1994–96 was 34.8 deaths per 100,000 confinements. This figure included incidental deaths. It has now been recalculated excluding incidental deaths with the resultant MMR being 17.4 for 1994–96 and 23.5 for 1997–99. All future reporting of calculated MMR will include direct and indirect deaths only.

The MMR for Aboriginal and Torres Strait Islander women was 23.2 per 100,000 confinements (1991–93), 17.4 per 100,000 confinements (1994–96) and 23.5 per 100,000 confinements (1997–99). The MMR have remained on average three times higher than the MMR for non-Indigenous women over the past three triennia 1991-1999 (Table 16.2). The threefold higher MMR reflect the overall all cause mortality rates for Aboriginal and Torres Strait Islander women of the same age groups, which are on average three to six times higher than non-Indigenous rates (AIHW 2002). These rates must be interpreted cautiously due to the incomplete recording of Indigenous status.

Aboriginal and Torres Strait Islander mothers comprise only 3.1% of the total confinements in Australia. Because of this very small proportion, the significantly higher Indigenous MMR remains insulated from the overall Australian MMR. As a result of incomplete ascertainment of Indigenous status, the Indigenous MMRs are likely to be underestimations of the true ratios. The higher MMR noted for this triennium provides no assurance that maternal mortality ratios for this population are improving.

Table 16.2: Indigenous maternal mortality ratios, 1991–99

Triennium	Direct deaths	Indirect deaths	Total Indigenous confinements	Indigenous maternal mortality ratio*	Non-Indigenous maternal mortality ratio*
1991–93	1	4	21,539	23.2	5.9
1994–96	3	1	22,996	17.4	8.3
1997–99	1	5	25,530	23.5	7.2

*calculated using direct and indirect deaths only.
Per 100,000 confinements.

Epidemiology

There were seven maternal deaths of Aboriginal and Torres Strait Islander women in this triennium, one direct maternal death, five indirect maternal deaths and one incidental death (Table 16.3). These deaths accounted for 9.3% of the 75 deaths where Indigenous status was known.

The seven Aboriginal and Torres Strait Islander women who died were aged between 18 and 37 years. The direct maternal death was due to renal failure. The five indirect maternal deaths were due to septicaemia, pulmonary hypertension, asthma, pneumonia and infective endocarditis. The incidental cause of death was a motor vehicle accident. All four of the women who delivered gave birth to liveborn infants.

Amid an Australian setting of falling fertility and rising maternal age, Aboriginal and Torres Strait Islander women continue to have their first and subsequent babies at significantly younger ages than non-Indigenous mothers. The average age of Aboriginal and Torres Strait Islander mothers in Australia in 2000 was 24.7 years compared to 29.0 years for non-Indigenous mothers. Aboriginal and Torres Strait Islander women have a higher fertility rate of 2.2 compared to 1.7 for non-Indigenous women (ABS 2002). These population characteristics coupled with more general health risk factors such as higher smoking rates and incidence of sexually transmitted infections increase the risks for Aboriginal and Torres Strait Islander women during childbirth.

Aboriginal and Torres Strait Islander women are 1.4 times more likely than non-Indigenous women to visit hospital for pregnancy and childbirth-related issues, experiencing higher rates of perinatal mortality and adverse maternal outcomes including death. In addition, Aboriginal and Torres Strait Islander people have significantly lower life expectancy and experience lower levels of access to health services than the general population; and are nearly twice as likely to live outside urban centres (ABS 2001).

Table 16.3: Maternal causes of death among Aboriginal and Torres Strait Islander women, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of delivery	Additional factor	Classification
13.3	34	Septicaemia	Myocarditis, broncho-pneumonia, pyelonephritis	32	Undelivered	Remote Australia	Indirect
13.13	37	Pulmonary hypertension	Alcoholic liver disease	28	Perimortem Caesarean	—	Indirect
13.10	37	Asthma	Ischaemic heart disease, smoking	12	—	—	Indirect
13.11	18	Pneumonia	Septicaemia, respiratory and multi-organ failure, DIC	31	Emergency Caesarean	—	Indirect
11.3	18	Infective endocarditis	Intravenous drug user	29	Elective Caesarean	—	Indirect
6.6	33	Renal failure	Pre-eclampsia	30	Emergency Caesarean	Puerperal cardiomyopathy, diabetes mellitus	Direct
15.7	24	Motor vehicle accident	—	28	—	Alcohol excess of driver	Incidental

Illustrative cases

Case 13.10

A 37 year old woman (parity unrecorded) at approximately 12 weeks gestation, with a previous history of acute severe recurrent asthma, cardiomyopathy and heavy smoking, presented at the emergency department of a remote district hospital with an acute episode of asthma. Treatment included oxygen, bronchodilators and corticosteroids and, within a few hours of admission, intubation and ventilation. Her aerial transfer was arranged with the

Royal Flying Doctor Service; however, her condition did not stabilise sufficiently to enable transfer. She subsequently suffered a cardiac arrest and died.

Cause of death: Asthma
Contributing cause of death: Ischaemic heart disease, smoking
Classification: Indirect

Case 13.11

An 18 year old woman para 0 presented for care at a general practitioner (GP) at 16 weeks gestation with a urinary tract infection. Ten weeks later, she attended a tertiary level obstetric hospital antenatal clinic with urinary frequency and dysuria, but no growth was obtained on culture of the urine. She was discharged back to the care of her GP, who treated her for a mild microcytic anaemia. At 30 weeks gestation she attended her GP with a history of 'flu-like' symptoms for ten days. She also complained of lower chest pain, aggravated by coughing and breathing. She was febrile and was noted to have tachycardia and shallow breathing, and was referred to hospital with possible pneumonia. She was observed in hospital where she was neither febrile nor breathless. She was given intravenous fluids and analgesics and discharged with the latter. She was asked to make an appointment with an obstetric service and attend there if pain persisted. She attended the tertiary level obstetric hospital again three days later with chest pain, breathlessness and right shoulder pain. She was found to be cyanosed with clinical and radiological signs of pneumonia. As there were some signs suggestive of fetal distress, urgent delivery was felt necessary; as the cervix was 2–3cm dilated and the head was high, an emergency Caesarean section was performed. The mother was treated with antibiotics and inotropic agents and retrieved to a hospital with adult intensive care facilities, but died ten days later.

Cause of death: Pneumonia
Contributing cause of death: Septicaemia, respiratory and multi-organ failure, and DIC
Classification: Indirect

Clinical comment

Multiple medical co-morbidities and remoteness from 'normal' medical /hospital care, which is assumed by most Australians to be available in the event of severe illness, are features often seen in association with Aboriginal and Torres Strait Islander maternal deaths. Five of the seven cases had pre-existing severe co-morbidities, reflecting the overall reduced health status of the Aboriginal and Torres Strait Islander population.

The reality is that women who live in remote Australia are not always able to be evacuated to major hospital care in life-threatening situations. Aboriginal and Torres Strait Islander women make up a large proportion of women living remote from high-level medical/hospital care and are, therefore, more likely to live in situations such that they may come to harm when evacuation is not possible.

Caution should be applied in the diagnosis and management of possible fetal distress at pre-term gestations when the mother is acutely ill. Delivery by Caesarean section in the fetal interest should only be undertaken after adequate cardiopulmonary stabilisation. Unless delivery of the fetus is required to facilitate resuscitation and ventilation, Caesarean section is best avoided in the setting of many acute maternal illnesses.

This chapter was reviewed and clinical commentary provided by Dr Michael Humphrey.

17 Deaths associated with Caesarean section

Introduction and definition

The percentage of births in Australia delivered by Caesarean section continues to rise and has increased from 17% of all deliveries in 1988 to 29% in 2002-03 (Lancaster & Pedisich 1993; AIHW 2004a).

This chapter includes information on the 34 women in the maternal mortality cohort who delivered by Caesarean section. This includes deaths classified as direct, indirect and incidental. From the information provided in the tables, it can be seen that the association with Caesarean section is either likely to be causal (e.g. post operative pulmonary thromboembolism) or unlikely to be causal, being part of the management of an obstetric emergency (e.g. haemorrhage from amniotic fluid embolism). Several Caesarean sections were undertaken for fetal retrieval in moribund women or in order to facilitate resuscitation and ventilation of the woman. In order to establish any causal associations between Caesarean section and maternal death, more detailed information will be required from the State and Territory Committees.

Epidemiology

Of the 90 maternal deaths included in this triennium, 50 women delivered infants prior to their death. Of these 50 women, 34 (68%) delivered by Caesarean section. Of these 34, there were 15 direct deaths, ten indirect and nine incidental deaths. The characteristics of these deaths are displayed in Tables 17.1, 17.2 and 17.3.

Table 17.1: Direct maternal deaths and Caesarean section, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of Caesarean section	Additional factors
3.8	34	Postpartum haemorrhage	Adherent placenta, twin pregnancy	25	Elective	First twin delivered spontaneous vaginally
4.1	36	Amniotic fluid embolism	—	42	Perimortem	Induced
4.2	31	Amniotic fluid embolism	—	39	Emergency	Induced
4.6	29	Amniotic fluid embolism	Disseminated intravascular coagulation	41	Emergency	Induced
4.7	36	Amniotic fluid embolism	Disseminated intravascular coagulation	38	Elective	No labour
5.1	36	Pulmonary thromboembolism	DVT	38	Elective	Prior immobilisation
5.6	29	Pulmonary thromboembolism	DVT	41	Emergency	—
6.1	42	Ventricular fibrillation	Gestational hypertension	38	Elective	Obesity
6.3	30	Cerebral haemorrhage	Pre-eclampsia	34	Elective	—
6.4	22	Unascertained	Pre-eclampsia	36	Emergency	—
6.5	35	Cerebral infarction	Sagittal sinus thrombosis, pre-eclampsia	29	Emergency	Severe pre-eclampsia in previous pregnancy
6.6	33	Renal failure	Pre-eclampsia	30	Emergency	Puerperal cardiomyopathy, diabetes mellitus
8.1	35	Hypoxia	Failed intubation	41	Emergency	—
8.2	23	Anaphylactic reaction of unknown aetiology	—	41	Elective	—
9.1	42	Puerperal cardiomyopathy	—	35	Emergency	—

Table 17.2: Indirect maternal deaths and Caesarean section, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of Caesarean section	Additional factors
11.1	31	Cardiac arrhythmia	Cardiac conduction defect	21	Perimortem	—
11.3	18	Infective endocarditis	Intravenous drug user	29	Elective	—
11.4	27	Aortic valve disease	—	31	Perimortem	—
12.6	28	Suicide by gunshot wound	Depression	39	Perimortem	History of depression
12.7	35	Suicide by hanging	Depression	Death at 32 days partum	Elective	History of depression
12.8	34	Drug overdose	Postnatal depression	Death at 29 days postpartum	Elective	Previous severe postnatal depression
13.2	32	Sub arachnoid haemorrhage	Essential hypertension, chronic renal impairment, ruptured cerebral artery aneurysm	35	Emergency	Severe hypertension in two prior pregnancies
13.9	30	Retroperitoneal haemorrhage	Trauma	32	Emergency	—
13.11	18	Pneumonia	Asthma	31	Emergency	—
13.13	37	Pulmonary hypertension	Alcoholic liver disease	28	Perimortem	—

Table 17.3: Incidental maternal deaths and Caesarean section, 1997–99

Case	Age	Principal cause of death	Contributing cause of death	Gestational age	Type of Caesarean section	Additional factors
15.1	17	Motor vehicle accident	—	36	Perimortem	—
15.8	26	Glioma	Sepsis	Died 15 days postpartum	Elective	—
15.10	27	Ovarian cancer	—	Died 11 days postpartum	Elective	—
15.11	32	Metastatic melanoma	Septicaemia	Died 30 days postpartum	Elective	—
15.20	28	Hepatic failure	Hepatitis B	28	Emergency	No antenatal care
15.22	18	E. coli sepsis	Disseminated intravascular coagulation	33	Emergency	—
15.23	30	Meningococcal septicaemia	—	36	Perimortem	—
15.25	27	Sub arachnoid haemorrhage	Ruptured middle cerebral artery, bronchopneumonia	30	Emergency	Known drug user, Hepatitis C infection
15.28	28	Intracerebral haemorrhage	—	39	Perimortem	—

Estimated case fatality rates and relative risks

There were 27 direct maternal deaths, who delivered infants (Table 17.4). Using delivery data from 1997–99, the direct maternal death rate for all deliveries in Australia was 3.6 per 100,000 deliveries. For indirect deaths, it was 1.7 deaths per 100,000 deliveries (Table 17.5) and for incidental deaths, it was 1.2 deaths per 100,000 deliveries.

Using spontaneous vaginal deliveries as the referent group, for direct deaths the relative risk of dying after an assisted or instrumental vaginal delivery was 2.8, and for Caesarean section delivery, 5.6. For indirect deaths, the relative risk of dying after an assisted or instrumental vaginal delivery was 2.8, and for Caesarean section delivery, 9.5. For incidental deaths, there were only Caesarean section deliveries, thus relative risks could not be calculated.

These calculated rates are observational. Inferences can therefore not be made that spontaneous vaginal deliveries are safer than Caesarean deliveries. The extra deaths from Caesarean sections are likely to be due to acute obstetric emergencies for which the Caesarean section is undertaken or for pre-existing conditions which increase the risk of subsequent mortality.

In future reporting, these categories need to be more closely examined and reported to enable a more meaningful discussion of the maternal death rates among Caesarean section deliveries.

Table 17.4: Direct maternal death rates by delivery type, 1997–99

Type of delivery	Total deliveries	Delivered direct deaths	Death rate per 100,000 deliveries	Relative risk	95% CI
All deliveries	758,030	27	3.6	—	—
Spontaneous vaginal	506,697	8	1.6	1.0	—
Assisted or instrumental vaginal	90,194	4	4.4	2.8	0.8 – 9.3
Caesarean section*	159,201	14	8.8	5.6	2.3 – 13.2

*excluding perimortem Caesarean section deliveries.

Table 17.5: Indirect maternal death rates by delivery type, 1997–99

Type of delivery	Total deliveries	Delivered indirect deaths	Death rate per 100,000 deliveries	Relative risk	95% CI
All deliveries	758,030	13	1.7	—	—
Spontaneous vaginal	506,697	2	0.4	1.0	—
Assisted or instrumental vaginal	90,194	1	1.1	2.8	0.2 – 30.9
Caesarean section*	159,201	6	3.8	9.5	1.9 – 47.1

*excluding perimortem Caesarean section deliveries.

Clinical comment

With the possible exceptions of one case of haemorrhage, two anaesthetic-related deaths and two cases of postoperative thromboembolism, complications of Caesarean section were infrequent causes of maternal death. Nevertheless, with the frequency of deaths from thromboembolic complications following Caesarean section in this and other reports, strong consideration should be given to a review of whether the RCOG guidelines for prophylaxis should be adopted in Australia. Neither of the two cases in this chapter received prophylactic management.

Best practice

Recommendations of prophylaxis against thromboembolism in Caesarean section were published in the UK maternal deaths report *Why Mothers Die 1997–99* (NICE 2001). These recommendations were based on the RCOG Working Party report on prophylaxis against thromboembolism and have recently been revised (RCOG 2004). There are no such guidelines in Australia. Issues surrounding thromboprophylaxis were discussed earlier (in Chapter 5 of this report), specifically the Obstetric Medicine Group of Australasia's position statement 'Anticoagulation in pregnancy and the puerperium' (OMGA 2001).

This chapter was reviewed and clinical commentary provided by Professor Michael Bennett and Associate Professor Michael Paech.

18 Epidemiology of maternal deaths in Australia 1973–99

Introduction

In 1964, 95 women were reported as dying from pregnancy-related causes in Australia; 35 years later in 1999 this had declined to 37 women. Maternal deaths in Australia have been reported triennially since 1964. Data from the first four reports have not been included in this analysis due to difficulties in analysing the data into categories. This chapter will present data for the 27-year period 1973–99.

Maternal mortality ratios

For the period 1973–99, 646 deaths were classified as being causally related to pregnancy, including 397 (61.5%) direct deaths and 249 (38.5%) indirect deaths. The overall maternal mortality ratio for the period was 9.8 deaths per 100,000 confinements. The ratio has declined from 12.7 in 1973–75 to a low of 6.2 in 1991–93 (Figure 18.1).

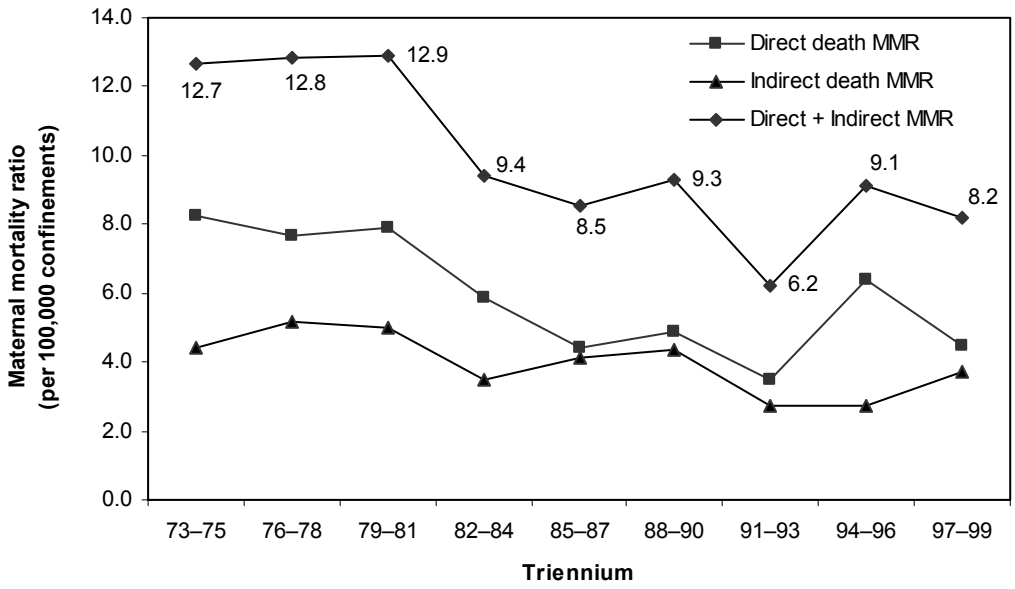

Figure 18.1: Australian maternal mortality ratios, 1973–99

Age-specific maternal mortality ratios

For the period 1973–99, the age-specific mortality ratios were highest for women aged 40–44 years followed by women aged 35–39 years. The most significant decrease was observed in the 40–44 year ratio after the 1979–81 triennium (Figure 18.2). For the three

triennia 1973-1981, the number of deaths of women in the 40-44 year age group was high. After 1982, the numbers of deaths of women in this age group fell dramatically and have remained at the same low level. The maternal mortality ratios for women aged 15–19 years and women aged 20–34 years did not differ significantly across the nine triennia and consequently were combined to form the referent 15–34 year age group. These age-specific maternal mortality ratios are based on confinement data presented in Table 18.1. For clarity, percentages have been used to demonstrate the changing age distribution of confinements over the nine triennia.

Table 18.1: Total confinements by age by triennium, 1973–99

Age group	1973–75	1976–78	1979–81	1982–84	1985–87	1988–90	1991–93	1994–96	1997–99
	%	%	%	%	%	%	%	%	%
15–19	11	9	8	7	6	6	5	5	5
20–24	33	32	29	28	24	21	20	18	17
25–29	35	37	37	38	39	38	35	32	33
30–34	14	16	19	21	23	26	29	30	30
35–39	5	4	5	6	7	8	10	12	13
40–44	1	1	1	1	1	1	1	2	2
Total*	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

*Including age 'not stated' category.

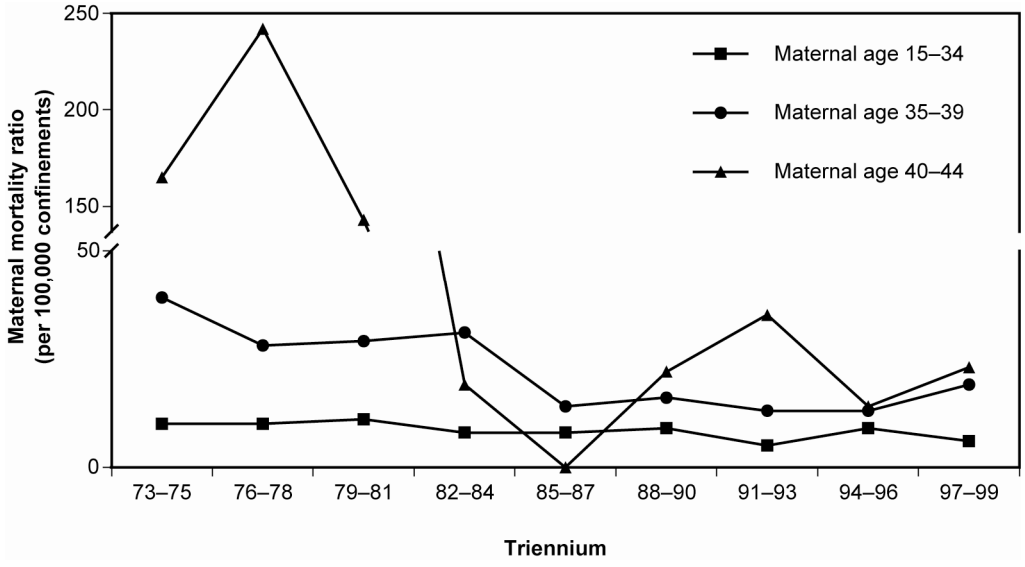

Figure 18.2: Age-specific maternal mortality ratios, 1973–99

Leading causes of maternal death

The leading causes of all 646 reported maternal deaths were cardiovascular disease (15.3%), deaths due to haemorrhage (11.8%), pulmonary thromboembolism (11.3%), deaths due to hypertensive disorders of pregnancy (9.9%) and amniotic fluid embolism (7.4%).

Direct maternal deaths

The leading principal causes of direct deaths have remained unchanged during the period 1973–99, with pulmonary embolism accounting for nearly one in five direct deaths. Deaths due to haemorrhage accounted for 19.5% of direct deaths, amniotic fluid embolism accounted for 12.3%, deaths due to ectopic pregnancy (7.4%), and deaths due to infection (6.7%). The cause-specific pregnancy-related mortality ratios decreased between 1973–84 and 1985–99 for deaths due to ruptured uterus and anaesthetic complications, but increased for deaths due to pre-eclampsia and pregnancy-induced hypertension.

Indirect maternal deaths

Indirect deaths were dominated by cardiovascular disease, accounting for an average of 40% of deaths per triennium. The major subcategories of these deaths included peripartum cardiomyopathy (18%), primary pulmonary hypertension (15%), aortic rupture (11%: five confirmed cases of Marfan's syndrome), myocardial infarction (7%) and rheumatic heart disease (4%). Other indirect causes include psychiatric disorders (8%), sub arachnoid haemorrhage (7%), and deaths due to infection (6% pneumonia, 5% septicaemia).

Discussion

The most significant decline in mortality over the period has been in women aged ≥40 years. Australian census data from the period show a marked decline in both parity and average number of children born to women aged 40–44 years. In 1976, women aged 40–44 years had on average 3.2 children compared to 2.2 in 1996. The proportion of grand multiparous women declined from 34.6% in 1976 to 13.1% in 1996 (ABS 1992, ABS unpublished data 1996). A comparison of data from the *Report on Maternal Deaths in Australia 1970–72* and the 1994–96 report showed that women aged >40 years with ≥4 children had a much higher risk of death during the period 1964–72 than all women aged >40 years in 1994–96, irrespective of parity (AIHW 2001; NHMRC 1976).

The predominant cause of death for all women during the period 1973–99 was embolism. The decline in anaesthetic- and uterine-ruptured-related deaths between 1973–84 and 1985–99 occurred despite the increase in operative deliveries, inductions and Caesarean sections seen over the period. Caesarean section rates increased from 4.8% in Western Australia in 1975, to nationally reported rates of 21.9% in 1999 (Lancaster & Pedisich 1993; Nassar & Sullivan 2001). The decline in anaesthetic-related deaths may reflect improved obstetric management, changes in anaesthetic practice and greater accessibility to trained anaesthetists.

The number of maternal deaths due to hypertensive disorders is possibly due to more frequent diagnosis and women with pre-existing disease electing to have children. As the proportion of women with pre-existing medical conditions having children continues to rise, so have the risks of complications from indirect maternal causes (DOH 1998; Grimes 1994). Cardiovascular disease remains the leading cause of indirect deaths in Australia and the United Kingdom, accounting for up to a fifth of maternal deaths in some triennia. Cardiovascular disease is the only cause of death where pregnant women have been found to have an increased risk of death when compared with non-pregnant women (Turner et al. 2002a). In both the UK and Australia, indirect cardiac deaths are more prevalent than deaths from haemorrhage, genital sepsis or abortion (NICE 2001). Peripartum cardiomyopathy has

replaced rheumatic heart disease and valvular disease as the leading cause of cardiovascular death in pregnancy and the puerperium.

Ascertainment of maternal deaths has been cited as a problem in a number of international studies (Atrash et al. 1995; Hoyert et al. 2000; King & Flenady 1999; NICE 2001; WHO 1991) with improvements in ascertainment hindering the interpretation of changing mortality ratios over time. A survey of obstetricians in hospitals in Queensland, Australia, revealed under-reporting of 34% of deaths for the period 1994–97 (King & Flenady 1999). It is of concern that this occurred at the same time as an increase in the Australian MMR observed in the 1994–96 triennium. A similar increase in deaths was found in the UK following a number of initiatives to improve ascertainment and address inconsistencies in the classification of deaths (DOH 1998).

Accurate classification of maternal deaths is required to clearly identify as much as possible whether the pregnancy was a primary or contributing cause or an incidental factor in relation to the death. Because international maternal mortality ratios are calculated on direct and indirect deaths only, differing classification practices have a significant impact upon the overall ratios published by each country. Differences relating to the classification of deaths are evident with a number of cases of anaesthetic-related deaths and hypertensive disorders of pregnancy classified as indirect rather than direct deaths.

Although incidental deaths were not presented in this chapter, it is important to note that there is growing evidence in the literature that some violent deaths (e.g. suicide and homicide) are under reported in maternal mortality. There are also changing practices in classification of these deaths, which were discussed in Chapter 12.

This chapter is based on a journal article written by E Sullivan, J Ford, G Chambers and E Slaytor and accepted for publication in the Australian and New Zealand Journal of Obstetrics and Gynaecology.

19 Trends in reproductive health and maternity care in Australia, 1991–2000

Introduction

The World Health Organization defines reproductive health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, in all matters relating to the reproductive system and to its functions and processes' (WHO 1999).

This chapter will focus on the reproductive trends of women aged 15–44 years and will examine the patterns of reproductive health over the ten-year period 1991–2000.

Total births and fertility rates

The number of births in Australia declined by 3% over the period 1991–2000 from 257,247 in 1991 to 249,636 in 2000. The fertility rate correspondingly dropped from 1.86 to 1.76 births per woman (ABS 2002) (Table 19.1).

Age-specific fertility rates

The trend in decline of fertility in younger women is contrasted with a relative increase in fertility of women aged 30–44 years over the period 1991–2000 (Table 19.1). The most marked change in rate occurred in the 40–44 age group which increased from 5.5 to 8.7 births per 1,000 women (a 60% increase) over the decade. In women aged 20–24 years, the fertility rate dropped by 25% from 75.0 to 59.2 births per 1,000 women.

Table 19.1: Age-specific fertility rates, 1991–2000*

	Age group (years)							Total fertility
Year	<20	20–24	25–29	30–34	35–39	40–44	>=45	rate**
1991	22.1	75.0	132.0	100.2	36.0	5.5	0.2	1.855
1992	22.0	74.9	132.3	104.6	38.3	6.1	0.3	1.893
1993	20.9	71.3	129.8	105.4	38.9	6.3	0.2	1.864
1994	20.7	69.7	125.8	105.0	41.1	6.7	0.3	1.846
1995	20.4	67.1	121.7	106.0	42.3	7.2	0.3	1.825
1996	20.1	65.2	117.1	105.7	43.7	7.5	0.3	1.797
1997	19.8	62.8	113.7	106.5	44.8	7.5	0.3	1.777
1998	18.9	61.4	111.4	107.0	45.5	8.0	0.3	1.762
1999	18.5	60.8	108.6	108.0	46.8	8.5	0.3	1.757
2000	17.7	59.2	107.9	109.5	48.7	8.7	0.4	1.760

*Births per 1,000 women
**Births per woman
Source: ABS Australian Bureau of Statistics: Births 3301.0 2002

Maternal age and parity

The average age of women having children increased over the ten-year period (Table 19.2).

Between 1991 and 2000, the proportion of women aged 20–24 years having their first child was essentially unchanged. Whereas for women aged 25 years and older there had been a marked increase in the proportion of women having their first baby in 2000. For women aged 30–34 years the proportion of women having their first child increased from 26.2% in 1991 to 33.2% in 2000.

A multiparous mother is defined as a woman who has had between one and three children. The most marked change was observed in multiparous mothers aged 30–34 years. In 1991, 68.3% of women in this age group were multiparous, compared with 62.6% in 2000.

Grand multiparous mothers have had four or more children. In 1991, 12.5% of women aged 35 years and older were mothers to four or more children compared to 8.8% in 2000. The opposite trend was observed in women aged 25–34 years, where in 1991 4.0% were mothers to four or more children compared to 3.4% in 2000.

Mode of delivery

The method of birth changed over the ten-year period. In 1991, 68.4% of all confinements were spontaneous vaginal deliveries, compared with 64.9% in 2000. Forceps deliveries decreased from 10.0% to 5.1% of all deliveries, while vacuum extraction births rose from 2.5% to 6.1% of all births. Vaginal breech deliveries decreased from 1.1% to 0.6% of all deliveries.

Caesarean section deliveries

The most notable change in method of birth was the increase in the proportion of all deliveries by Caesarean section, which overall increased from 18.0% in 1991 to 23.3% in 2000. With regard to the type of Caesarean section, Caesarean section without labour increased from 9.6% to 12.3% and Caesarean section with labour increased from 8.4% to 11.0%. Similar changing trends in method of birth have been observed in the UK, where the overall rate of Caesarean section increased from 15% in 1994–95 to 21.3% in 2000 (NICE 2001).

Caesarean section by maternal age

There is also a trend of increasing Caesarean section with older maternal age. In 1991, 45.6% of Caesarean section deliveries were in women aged 30 years and older, compared with 57.9% in 2000.

In 1991, 48.5% of Caesarean sections without labour were in mothers aged younger than 30 years, compared with 36.2% in 2000. In women aged 35 years and older, the increase was more pronounced, rising from 17.5% to 27.6%.

In 1991, 60.8% of Caesarean sections with labour were in mothers aged younger than 30 years, compared with 48.4% in 2000. In women aged 35 years and over, the increase was from 11.7% to 19.3%.

Onset of labour

With regard to the onset of labour by confinements, the categories are 'spontaneous', 'induced' or 'no labour'. The proportion of confinements with spontaneous onset of labour

decreased from 70.4% to 61.5% between 1991 and 2000. The proportion of confinements with induced labours increased from 19.5% to 25.6% over the period while those with no labour increased from 9.9% to 12.9%.

Postnatal length of stay

The average length of postnatal hospital stay following delivery of an infant decreased from 5.2 days in 1991 to 3.7 days in 2000. For women delivering by Caesarean section, the average length of stay decreased by 36% from 7.0 to 5.1 days and for spontaneous vaginal deliveries, the length of stay decreased by 48% from 4.6 to 3.1 days.

Other reproductive indicators

Rates of infertility

Infertility is defined in Australia as women of reproductive age (15–44 years) at risk of pregnancy who report trying unsuccessfully for a pregnancy for one year or more (Ford et al. 2003). There has been no national survey of the prevalence of infertility in Australia, but it is generally assumed to be similar to that in other developed countries.

Number of induced abortions

Induced abortion involves the termination of pregnancy by medical or surgical means. It is subject to different legal requirements and interpretations in the different states and territories, and there are variations in the extent to which statistics are collected. There are no comprehensive and reliable national data on induced abortions. Only South Australia and Western Australian legislation require notification of all induced abortions. The abortion rate in South Australia for 1999 was 17.8 per 1,000 women aged 15–44 years. The highest rate was 33.7 per 1,000 women aged 20–24 years (SAACR 2000). The induced abortion rate in 1999 for Western Australia was 19.7 per 1,000 women aged 15–44 years. The highest rate was 32.0 per 1,000 women aged 20–29 years (personal communication, Health Department of Western Australia).

Assisted reproductive technology

Since 1979, Assisted Reproductive Technology (ART) has been used in Australia to assist couples becoming pregnant. The main ART procedures include in-vitro fertilisation (IVF), intra-cytoplasmic sperm injection (ICSI), and gamete intra-fallopian transfer (GIFT). The number of births following ART increased from 2,237 births in 1992 which accounted for less than 1.0% of total births in Australia (Lancaster et al. 1995) to 4,801 in 2000, accounting for 1.9% of all Australian births (Hurst & Lancaster 2001).

Table 19.2: Reproductive trends, 1991–2000

Reproductive feature	1991	2000
Maternal Age	**Mean age all births**	
Non–Indigenous mothers	27.9 years	29.3 years
Aboriginal and Torres Strait Islander mothers	23.5 years	24.7 years
Maternal Age and Primiparity	**Percentage of confinements**	
<20 years	82.6%	81.9%
20–24 years	55.8%	54.4%
25–29 years	40.4%	44.9%
30–34 years	26.2%	33.2%
35–39 years	20.0%	25.1%
40–44 years	17.5%	22.5%
Mode of delivery	**Percentage of confinements**	
Spontaneous vaginal	68.4%	64.9%
Forceps	10.0%	5.1%
Vacuum extraction	2.5%	6.1%
Vaginal breech	1.1%	0.6%
Caesarean section	18.0%	23.3%
No labour	9.6%	12.3%
With labour	8.4%	11.1%
Onset of labour	**Percentage of confinements**	
Spontaneous	70.4%	61.5%
Induced	19.5%	25.6%
No labour	9.9%	12.9%
Postnatal length of stay	**Mean number of days**	
All deliveries	5.2 days	3.7 days
Spontaneous vaginal delivery	4.6 days	3.1 days
Caesarean section	7.0 days	5.1 days

Source: Perinatal data collection, AIHW National Perinatal Statistics Unit.

Summary

There was a gradual but persistent change in the reproductive picture of Australian women over the ten-year period 1991–2000. Women who are electing to have children are getting older, having fewer children and are increasingly likely to have an operative or assisted delivery. This ageing of the *productive* reproductive cohort is not being uniformly seen across all subpopulations of women in Australia. Statistics on Aboriginal and Torres Strait Islander women presented here show mothers are on average nearly five years younger than non-Indigenous women. The reproductive picture of Australian women is incomplete as there are no national data available on early pregnancy loss, including the number of termination of pregnancies taking place in Australia.

20 International comparisons

Introduction

Maternal mortality statistics historically have been used as an indicator of the reproductive health of women in a country. WHO estimates that each year about half a million women between the ages of 15 and 49 years die of complications of pregnancy and childbirth. Over half of these women are from Africa (53%), while the rest are from Asia (42%) and Latin America (4%). Less than 1% of maternal deaths occurring world wide are in developed countries (Goodrum 2001). During the 20th century risks to women associated with childbirth in developed countries have been dramatically reduced as a result of many factors (Turner et al. 2002a). These include technological advancements in obstetrical care and greater access to health services. Although the maternal mortality ratio (MMR) has reduced dramatically over the past 50 years, women continue to experience preventable pregnancy-related deaths with certain groups of women being at greater risk of death (Berg et al. 1996).

The changing risk profile of women becoming pregnant may account for some of the maternal deaths. Many women are delaying child-bearing, leading to an older cohort of women being pregnant with an increased risk of maternal death (Callaghan & Berg 2003; Hoyert et al. 2000; Nassar et al. 2000; Wildman et al. 2004). Furthermore, with advances in technology an increasing number of women who previously were unable to have children because of infertility or complex medical problems are now having children (Walters et al. 2002). There is strong evidence that the magnitude of maternal mortality is seriously underestimated in developed countries (Atrash et al. 1995).

In order to put Australia in an international context, this review was undertaken to examine the maternal mortality surveillance systems of several other nations. A number of different approaches to maternal mortality surveillance were examined.

Methodology

A literature review was undertaken to identify several maternal mortality reporting systems. A detailed examination of each system from seven different countries was undertaken. The criteria for selecting these countries were that the systems be comparable, the reports available in English, and the countries have similar demographic profiles and be from different continents. The countries chosen were Australia, USA, Canada, UK, France, South Korea and South Africa.

The scope of each collection was determined as were the different characteristics of each system. We were interested in determining how many of the different systems were able to make recommendations and/or guidelines to improve clinical care based on their case investigations. The different reporting periods, types of maternal death and classification issues were also examined.

Results

Reporting of maternal deaths

Of the seven countries, five produced separate maternal mortality reports. The Australian, UK and South African reports are published triennially (AIHW 2001; NICE 2001; Pattinson 1999). The reports from South Korea were undertaken as special surveys and not part of an ongoing process of publishing reports (Han 2002). The report from France was based on information gathered by the national committee of experts regarding maternal deaths in 1996–97 (French report 2001). Neither USA nor Canada publishes separate maternal death reports. The USA publishes maternal mortality data in the *Morbidity and Mortality Weekly Report*, produced by the Centers for Disease Control and Prevention (CDC 2003). Canadian maternal mortality data are published in *Chronic Diseases in Canada*, available on the Health Canada web site (Turner et al. 2002a, 2002b).

Ascertainment of maternal deaths

Confidential enquiries

Confidential enquiries are conducted in the UK, South Africa, France and Australia. A confidential enquiry is carried out by a committee of experts and investigates all aspects of the circumstances surrounding a maternal death. Where necessary, additional information about the deaths is gathered to facilitate this process. Notification method is different in all four countries. In the UK, the notification of maternal deaths is made by a health professional directly involved in the death. In South Africa, the facility where the death occurred completes the maternal death notification form. In Australia, the deaths are reported from a number of sources: the health department, hospitals, medical practitioners, midwives, coroner's office, Registrar of Births, Deaths and Marriages, and review of the perinatal and hospital morbidity collections. In France, deaths to be investigated by the confidential enquiry are notified by the SC8 division in INSERM, where the certifying doctor is contacted and invited to participate in the enquiry process. France uses its confidential enquiry data independently of its routinely and permanently collected mortality data.

Vital statistics

Maternal death data are provided by the national vital statistical office in the USA, Canada and South Korea and are supplemented by death certificates. In addition, the death certificates for women of reproductive age are linked to certificates of reportable pregnancy outcomes such as livebirth, stillbirth or fetal death that occurred within the preceding year, indicating the mother was pregnant when she died. Pregnancy tick boxes are present on death certificates in the USA, Australia, Canada, France, South Africa and the UK.

Data validation

While all countries ensure that their maternal death cohort is as accurate as possible, two countries have specific data validation methods for this purpose. In the UK, a specific computer program is used to validate data. This program codes the cause of death and underlying causes of death automatically. As a result, the Office of National Statistics has been able to undertake a more extensive search of death data to identify all conditions listed which may suggest a maternal death (NICE 2001). In Australia, the Australian Bureau of Statistics data and National Hospital Morbidity Database are being used for validation.

Classification

All seven countries used the ICD-10 definition to classify maternal deaths. There was uniformity in reporting of deaths during pregnancy and up to 42 days after delivery, in all the countries.

Late maternal deaths

Late maternal deaths are deaths due to direct or indirect causes that occur between 43 and 365 days after termination of a pregnancy. The UK, USA and Canada report late maternal deaths. Australia will collect late maternal deaths systematically from 2000.

Denominators

For calculating the maternal mortality ratio, the WHO definition has livebirths as its denominator. Inconsistencies in the denominators used were observed. The UK uses maternities, Australia uses confinements, USA, Canada, France and Korea use livebirths. In South Africa, as the number of deliveries is not known, an estimated livebirths figure is used.

Maternal mortality ratio

All countries except the USA use the maternal mortality ratio to report national maternal death data. The USA uses the pregnancy-related mortality ratio (PRMR), which is calculated using pregnancy-related deaths (direct and indirect deaths), which are all pregnancy-related deaths of women up until one year after pregnancy (CDC 2003). This therefore includes late maternal deaths in its calculation. Among the seven countries included in this study, the maternal mortality ratio ranged from 5.1 (Canada 1988–92) to 150 (South Africa 1998) maternal deaths per 100,000 livebirths. For Australia, the MMR was 8.2 per 100,000 confinements (1997–99), France was 9.6 per 100,000 livebirths (1996–97), the UK was 11.4 per 100,000 maternities (1997–99), South Korea 15.2 per 100,000 livebirths (1999–2000) and USA reported a PRMR of 11.8 per 100,000 livebirths (1991–99).

Standardised instrument

Among the four countries that conduct confidential enquiries, three have a standard instrument for death review–UK, France and South Africa. In Australia, while there is a National Maternal Death Reporting Form, which facilitates data entry at the national level, there is no standardised instrument at the state and territory levels where each death is investigated.

Policy implications

One of the primary functions of the UK report is to make recommendations concerning the improvement of clinical care and service provision, including local audit, to purchasers of obstetric services and professionals involved in caring for pregnant women.

In France, the national committee of experts from the confidential enquiry makes recommendations concerning prevention of maternal deaths after an examination of all the cases including any avoidable factors that may have been present.

In Australia, one of the purposes of the National Advisory Committee on Maternal Mortality is to identify patterns of suboptimal care and avoidable factors and, where possible, make recommendations concerning improvements to maternity care practices and services in Australia.

Canada and the USA do not publish reports specific to maternal mortality. As a consequence, there are no published policy statements or indications of guidelines specifically relating to their maternal mortality collections.

In the two special surveys undertaken for South Korea, there were no reported policy implications for their collection. However, the initiative behind the surveys was to correct the estimated maternal mortality ratio, which had been reported as being 130 deaths per 100,000 population, compared with the North Korean rate of 70 deaths. Using internationally derived statistical methods, the surveys were able to accurately calculate and report the official MMR for South Korea. These surveys were undertaken specifically to correct the rates, which was successful. There are no future maternal death surveys planned; however, death data are still collected.

Leading causes of maternal mortality

There has been a shift in the leading causes of maternal mortality in developed countries. In the past, deaths due to haemorrhage, infection and pre-eclampsia dominated. More recently, the leading causes have changed (in the UK, USA, Canada, France, South Korea and Australia) and are now predominately embolism, haemorrhage and gestational hypertension. There is also an increase in the deaths attributable to cardiomyopathy and other medical conditions (CDC 2003). It has been suggested that this reflects improved ascertainment of pregnancy-related deaths due to data linkage between death certificates of women and live and stillbirths occurring within one year of the mother's death (CDC 2003). The increasing number of deaths caused by other medical conditions might also be affected by the age distribution of the women giving birth. Women are becoming pregnant at older ages increasing their risk of being pregnant with chronic medical conditions (Berg et al. 1996, 2003; Parsons & Harper 1999). In addition, they are at a higher risk for adverse reproductive health outcomes (Berg et al. 2003).

In South Africa, the most common causes of maternal death in 1998 were complications of hypertension in pregnancy (23.2%), AIDS (14.5%), obstetric haemorrhage (13.3%), and non-pregnancy-related sepsis (excluding AIDS) (8.5%). The proportion of deaths caused by non-pregnancy-related infections, including AIDS, increased dramatically from 23% in 1998 to 31% in 1999–2001. Deaths resulting from AIDS were probably significantly under-reported and it is the commonest cause of maternal death at all levels of care in South Africa. HIV testing is not done for all pregnant mothers (Pattinson 1999).

Table 20.1: International comparisons of maternal mortality reporting

Country	Type of ascertainment	MMR per 100,000 denominator[a]	Denominator used	Death certificate pregnancy tick box	Standardised instrument to investigate deaths	Late maternal deaths reported
Australia	Confidential enquiry	8.2	Confinements	YES	NO	YES
UK	Confidential enquiry	11.4	Maternities	YES	YES	YES
USA	Vital statistics	11.8[b]	Livebirths	YES	Not applicable	YES
Canada	Vital statistics	5.1	Livebirths	YES	Not applicable	YES
South Korea	Vital statistics	15.2	Livebirths	NO	Not applicable	NO
South Africa	Confidential enquiry	150	Estimated livebirths	YES	YES	NO
France	Confidential enquiry	9.6	Livebirths	YES	YES	NO

(a) Based on the most recent published data.
(b) Pregnancy- related mortality ratio, calculated using direct and indirect deaths up until one year after pregnancy.

Discussion

Maternal mortality is an internationally used indicator of the overall effectiveness of obstetric health and of the general health care system. Additional case-finding techniques were used by many countries to enhance their reporting systems. Whenever additional strategies are used for data verification, extra cases are identified thus elevating the reported maternal mortality ratios (Atrash et al. 1995; Bouvier-Colle et al. 1991). After data validation in France, extra cases were found which increased the MMR from 9.7 to 21.9 (Bouvier-Colle et al. 1991). Under-reporting of maternal mortality during 1987–90 in the USA was shown by comparing two different data sources; the rate was greater using data from the National Pregnancy Mortality Surveillance System than from the National Vital Statistics System (Hoyert et al. 2000). A record linkage study undertaken in Georgia (USA) found an increase of 30% in the pregnancy-related maternal mortality ratio during 1990–92 (CDC 1995).

Identifying maternal deaths using vital record linkage can improve ascertainment. The USA, and Canada are using data provided by the national vital statistics system in addition to having linkage of death certificates of women of childbearing age with livebirth and stillbirth certificates recorded within one year of woman's death. This has increased the ascertainment (Atrash et al. 1995). South Korea also uses the same method and in addition, in a special survey done, the deaths were matched with maternity benefit data of health insurance (Han 2002). In the USA and South Korea, hospital discharge records are used to further enhance the surveillance and identify a few deaths missed from other sources and also provide supplementary data on medical diagnosis and procedures (Buescher et al. 2002; Han 2002). However, any data linkage studies cannot ascertain deaths that occur in early pregnancy, such as those associated with induced or spontaneous abortion or ectopic pregnancy, because of pregnancies less than 20 weeks not being registered as a birth.

Classification of deaths as maternal deaths is based on the information contained on the death certificate. Reasons for under-reporting of maternal deaths have included improper completion of certificates and errors in coding the underlying cause of death (Turner et al. 2002b). In most countries, the timing of death is not stated on the death certificate. It appears

that differences in practices both in completing death certificates and in interpretation of rules used for coding information about causes of deaths have direct consequences on maternal mortality rates (Salanave et al. 1999).

All countries are using the ICD-10 definitions of maternal mortality, but not all are reporting late maternal deaths. According to CDC reports, 11% of maternal deaths in the USA occur after 42 days but less than one year following termination of pregnancy (CDC 2003). Reporting mortality only up to 42 days underestimates the level of maternal mortality. In a prospective cohort study undertaken in South Africa, 194 maternal deaths were identified following termination of a registered pregnancy. Of the 194 deaths, 82 occurred during the first 42 days after delivery/miscarriage. A further 50 women (26%) died between 43 and 365 days post-pregnancy (Hoj et al. 2003) and were classified as late maternal deaths. The UK, USA and Canada are reporting late maternal deaths. Australia will be collecting and reporting late maternal deaths from the 2000–02 triennium.

Definitions are shifting from a narrow definition of maternal mortality—deaths with specific pregnancy-related causes that occur during pregnancy or within 42 days of the end of pregnancy (ICD-9)—to a broader classification of pregnancy-related mortality (ICD-10), deaths that were caused or aggravated by pregnancy, occurred during pregnancy or within 365 days of the end of pregnancy. It remains to be seen whether the change from ICD-9 to ICD-10 will have an impact on maternal mortality ratio reporting internationally.

Conclusion

The seven international countries examined in this chapter all use a combination of different methodologies to ensure that maternal death ascertainment is as accurate as possible. While there are clearly differences in maternal mortality between countries according to health and obstetric reasons, differences must in part be attributed to the different ascertainment methods.

Examining each maternal death on a case by case basis as is undertaken in confidential enquiries is the most extensive method for investigating maternal deaths. The use of data linkage and comparing other data sources can increase the number of deaths found in a country. Active surveillance is needed in all countries using all methods available to overcome under-reporting and to accurately estimate the number of maternal deaths for each country.

This chapter was prepared by Dr Gunapoopathy Ponnampalam.

21 Data collection and classification issues

Role of AIHW National Advisory Committee on Maternal Mortality

The role of the National Advisory Committee on Maternal Mortality (NACMM) was to oversee the compilation of all reported deaths into a national report. As with the previous triennium, the Committee sought and gained ethics approval from the AIHW Ethics Committee and the University of New South Wales Human Ethics Committee for the review of the deaths and production of the report. All Committee members signed confidentiality undertakings as defined in section 29(1) of the AIHW Act 1987 prior to any access to the data.

The NACMM requested maternal death data from all the states and territories for the period 1997–99. All states and territories provided data by September 2003 to the Committee. Data were stored in a secure environment at the National Perinatal Statistics Unit, University of New South Wales, under AIHW guidelines. The data received from the states and territories were variable in detail and quality.

Regional-level data were not made available to the Committee and a decision was made by the Committee not to categorise data by state and territory. Due to the very small number of deaths and the sensitive nature of the report, all efforts were taken to minimise the identifiability of the cases. The Committee considered that spontaneous recognition may occur but that this small risk did not warrant the use of pertubation in the report. Furthermore, the Committee felt strongly that the integrity and utility of the report would be irreparably damaged by pertubation. It should be noted that all deaths occurred 5–7 years prior to the compilation of the report.

Following a meeting of the NACMM in June 2003, a subcommittee was formed in order to review each cause of death and classification for the purpose of consistency of national reporting. The Maternal Mortality Review Working Group (MMRWG) met three times to review all 90 maternal deaths. There was some inconsistency in classification of deaths between the states and territories; in about 5% of cases, classification was changed. These changes primarily related to psychiatric deaths and were discussed in Chapter 12.

The Advisory Committee also reviewed the format of the existing report, and decided to strengthen the epidemiology section and international comparisons on maternal deaths. Under the terms of reference, the report aims to identify patterns of suboptimal care and avoidable factors and, where possible, make recommendations concerning improvements to maternity care practices and services in Australia and make references to relevant evidence-based clinical guidelines where appropriate.

State and Territory Maternal Mortality Committees

This is the twelfth triennial report on maternal deaths in Australia. It covers the years 1997, 1998 and 1999. Each state and territory has an expert committee that reviews all maternal deaths (Appendix 3). The composition of these Committees usually comprises some or all of the following experts—obstetricians, obstetric physicians, midwives, pathologists, general practitioners, epidemiologists, and Aboriginal and Torres Strait Islander and consumer representatives. Each State and Territory Committee has developed different ways to maximise the maternal death notifications; this may include notifications from health departments, hospitals, attending practitioners, coroner's office, Registrar of Births, Deaths and Marriages and review of the perinatal and hospital morbidity collections (Appendix 4). Each death is then comprehensively reviewed. The sources of information reviewed include any hospital admissions, autopsy, toxicology, police and coroners' reports, and other ancillary information. The information collected by the states and territories is of variable quality and timeliness. Type of information collected may include usual residence and place death occurred, date of death, age at death, parity, gestational age at death, country of birth, date of delivery or abortion, number of days postpartum, Aboriginal or Torres Strait Islander status, baby outcome, relevant medical history, interventions/procedures, admission to ICU/CCU, blood transfusion, mechanical ventilation and anaesthesia, terminal event, postmortem conducted, coronial inquest, pathology results, toxicology findings, principal and underlying cause of deaths, classification of death, any avoidable factors and those present at the terminal event. This information is consolidated into a narrative as a case summary.

The State and Territory Maternal Mortality Committees review confidential reports on each maternal death that has occurred within their jurisdiction. The Committees consider each death individually and determine the cause of death where possible. Some of the committees also review the deaths for the presence of any avoidable factors. The State and Territory Maternal Mortality Committees also classify each maternal death as direct, indirect or incidental. A number of the State and Territory Committees publish annually the findings of their maternal death review in state reports. This national report collates the findings made available by the State and Territory Committees.

Case summaries

The case summaries presented in this report are summarised from antenatal records, hospital notes, postmortem reports and coroner's reports. They are de-identified as far as possible, whilst retaining information relevant to the understanding of the causal pathway which resulted in a maternal death. Case summaries are standardised to include age, parity, gestational age at death, relevant medical history, causes of death, and classification as direct, indirect and incidental. In several instances, cases have been already published in the individual state and territory reports. In these situations, the summaries are reproduced from these reports.

Each case summary has been assigned a unique identification number which relates to the primary chapter of inclusion, for ease of reference. The illustrative cases for each chapter were chosen by the MMRWG. All case summaries of incidental deaths have been included in a single chapter and have not been cross-referenced with other chapters (as have direct and indirect deaths).

Validation of maternal deaths, 1997–99

Following receipt of maternal death data from the states and territories, two additional data systems were manually reviewed to validate the data and to determine the ascertainment of maternal deaths.

AIHW National Death Index

Data from the AIHW National Death Index (NDI) (based on ABS mortality data) were reviewed for underlying cause of death for women aged 11–54 years, by age, state of residence and cause of death. All data received from the NDI were de-identified. Confidential death data provided to the NPSU by the states and territories in some cases, did not have date of birth or date of death. This limited checking or validation with the death data. Where a new death was identified in the NDI data, the relevant state or territory was notified to review and investigate the possible maternal death.

Death data from the NDI were specifically requested for deaths registered in 1997–2000 for all women aged 15–54 with a maternal death flag, a pregnancy-related diagnosis code or an F53 code—mental disorders in the puerperium.

A further nine deaths were identified from NDI data. Four of these deaths were late maternal deaths, and one was a maternal death and is now included in this report. Four cases were unable to be identified by State and Territory Committees as maternal mortality cases and until proven otherwise are considered misclassifications.

National Hospital Morbidity Database

The National Hospital Morbidity Database (NHMD) holds data Australia-wide from all hospital separations. The parameters used to search these databases were women aged 11–54 years with an ICD-9 and ICD-10 diagnosis code related to pregnancy, and a hospital discharge status of death. This would identify all women who were admitted to hospital and died whilst in hospital. For the 1994–96 maternal death cohort, the NHMD was used in a two way approach for validation: known cases were validated in the NHMD as well as potentially new cases identified and followed up. There were many problems with this approach, the most significant being inconsistencies with data from the NHMD which resulted in many unnecessary investigations. The other issue was that a large proportion of maternal death data provided to the NPSU, due to individual state/territory requirements, had not included date of birth or date of death.

For the current triennium, the NHMD has been used to validate maternal deaths in only one way: we have validated the 63 deaths that occurred in hospital rather than attempt to search for potentially missing cases. In the triennium 1997–99, the international classification of diseases changed from the 9th version to the 10th version. Validation was complicated by this change. For all the women known to have died in hospital identified from the National Maternal Mortality Database, (N=63), eight were pronounced dead on arrival and would therefore not have a hospital separation. Three records did not provide maternal date of birth, which made validation impossible. Of the remaining 52 cases, 40 (77%) were validated with the NHMD. It is difficult to explain why not all of the cases were able to be identified using the hospital separation data. In several instances, data received from states and territories indicated that the woman died in hospital. If this death was not identified in the NHMD, it was assumed that the death occurred prior to arriving at hospital and would therefore not be a hospital admission. There is the 'grey' area in between concerning individual hospital admission practices, where depending on the amount and extent of

resuscitation, the patient may or may not be admitted. This may explain some of the ten cases not validated with the NHMD.

Death certificates

Australia now has pregnancy tick-box questions on all state and territory death certificates. This is a change from the last triennium. There are still discrepancies, however, between the exact questions asked. Most of the states and territories ask two questions: 'Was the deceased pregnant within 6 weeks of death?' and 'Was the deceased pregnant between 6 weeks and 12 months of death?' Two state/territory certificates ask one question only: 'Was the deceased pregnant within three months before death?'.

At present, state and territory confidential enquiries into maternal deaths are conducted using death certificate data whose primary source is the Registrar of Births, Deaths and Marriages. This information in some states is received via the Australian Bureau of Statistics (ABS) where it is coded according to the International Classification of Diseases. For their data, the ABS relies upon completion of medical certificates of cause of death. In the 1997–99 triennium, for a maternal death to be noted, a pregnancy code had to be assigned to the cause of death. This assumes:

- that pregnancy was related to the underlying cause of death (not any of the other multiple causes which may have been present). Until 1997 only the underlying cause of death was recorded in the ABS database. Thus for incidental deaths, where there is no obvious link between the death and the pregnancy, a question of ascertainment is raised. A maternal death 'flag' was introduced in 1994 to address this issue;
- that coding was accurately completed. Direct causes of death are likely to be coded correctly, however indirect causes such as cerebrovascular disorders are coded differently in relation to pregnancy, than in the rest of the population. If mention of pregnancy status is not obvious on the death certificate, such a condition could be miscoded; and
- that data entry was accurate. There is significantly more room for error in the entering of a numeric code of up to 4 digits, than where a yes/no response is involved. Extensive edits of the database reduce this possibility.

Standardised reporting

A standardised reporting form was introduced in the 1997–99 triennium (Appendix 5) which was expected to streamline reporting to the NPSU. This form has standardised the reporting of cases to the NPSU, but it was not used by all states and territories. It is hoped that all states and territories will comply with using the form for reporting of deaths in the 2000–02 triennium. Key indicators such as Indigenous status, weight, country of birth and avoidable factors were not collected uniformly across Australia. Extensive data cleaning and follow-up was undertaken at the NPSU to increase the ascertainment of certain key variables. This process resulted in the ascertainment percentages for Indigenous status rising from 61% to 83% and for country of birth from 67% to 89%. The maternal age and date of birth of one case were missing, but found after enquiries to the appropriate state/territory committee. It is hoped that the 2000–02 data will not require such follow-up to complete essential primary data fields for the maternal mortality database.

Update of maternal deaths, 1994–96

There were a further six deaths which occurred in the 1994–96 triennium, but which were not included in the cohort for that report due to late reporting to the NPSU. All six were late deaths. Three were classified as direct, one as indirect and two as incidental. Late deaths can only be included as maternal deaths if they fall into the category of direct or indirect. Therefore four extra deaths may be added to the 1994–96 cohort. The women died from cardiomyopathy (two deaths), pulmonary embolism and septicaemia.

Assessment of avoidable factors

There is no agreed national definition for an avoidable death nor an objective instrument to review them. The accepted definition for an avoidable death is of 'some departure from the accepted standard of satisfactory care by the woman, practitioner or institution' which may have contributed to the death.

For 1997–99, a standardised maternal death reporting form was introduced to streamline reporting of deaths to the NPSU. It was hoped that this form would ameliorate the reporting of avoidable factors as determined by each State and Territory Committee.

The amount of information given to the NPSU on the reporting form varied depending upon the privacy concerns of individual states and territories and the degree of rigour used in examining the deaths. In some states where the deaths are examined, the Committee assigns a finding of avoidability, based on collective expert opinion. Due to the lack of standardisation of review and assignment of avoidability, it is prudent to present only general results on avoidability.

In the 1997–99 report avoidability was assessed to some extent by seven of the eight states and territories. The process for assessing avoidability was not standardised across the jurisdictions and in some states it was only indicated in a general sense if an 'avoidable factor' was present, with no assignment of the category of avoidability. In an attempt to standardise avoidability, five categories were created on the National Maternal Death Reporting Form. These are personal/family, logistical systems, facilities, health personnel and model of care.

It is important to note that these data are variable and must be interpreted cautiously. It is not suggested in cases in which avoidable factors are considered to be present that death could certainly have been prevented, but that the presence of an avoidable factor is regarded as an indication that the risk of death could have been lessened. This information is critical to ongoing efforts to ensure safe motherhood.

In the UK, the Confidential Enquiry in Maternal Deaths (CEMD) uses a method deemed to be the gold standard of a comprehensive investigation assessment tool. This allows for a scientific and evidence-based clinical review of each death and all surrounding issues. Reports from the CEMD have underpinned obstetric practice in the UK for nearly 50 years, with key objectives to make recommendations concerning the improvement of clinical care and service provision, including local audit, to purchasers of obstetric services and professionals involved in caring for pregnant women. In participating in the UK enquiry, the professionals concerned with each death are asked to reflect on any clinical or other lessons that have been learned, either personally or as a part of the wider institution, and what action may have followed as a result. As a result of this process, the UK report includes extensive analysis and details of each death and any factor that may have been thought to have been involved in the death.

A proposal to design and implement an Australia-wide instrument to investigate maternal deaths is currently being considered by the NACMM and is discussed in Chapter 22.

22 Recommendations for future reporting

A. Late maternal deaths reporting

The WHO maternal definition of a maternal death is 'the death of a woman while pregnant or within 42 days of termination of pregnancy'. It is becoming increasingly clear that the 42 day cut-off period is no longer appropriate. For this reason, several developed countries have begun to collect 'late maternal deaths'—deaths occurring in women between 43 and 365 days after termination of pregnancy. The origin of the 42-day cut-off period is unclear and has been suggested to be associated with historical, religious and cultural practices (Hoj et al. 2003).

The latest revision of the WHO International Classification of Diseases (ICD-10) has introduced a new category, 'late maternal deaths', defined as:

> The death of a woman from direct or indirect obstetric causes more than 42 days but less than one year after termination of pregnancy.

These late maternal deaths are increasingly being collected internationally in accordance with the new WHO ICD-10 classification. These deaths are particularly relevant to developed countries like Australia where advances in clinical care and medical technology may result in a delay of an inevitable death post the traditional 42-day period, and where deaths related to psychiatric illness and unintentional injuries are increasingly being ascertained. It is anticipated that the process of reporting and investigating late maternal deaths may take some time to become established in the current maternal mortality surveillance systems. It is hoped that from 2004 reporting and investigating of late maternal deaths will be adopted by all State and Territory Committees.

B. Standardisation of confidential maternal death enquiries

The UK, South Africa and France have national standardised instruments that facilitate their confidential maternal death enquiries. While the National Maternal Death Reporting Form has ameliorated the process whereby the states and territories provide data to the NPSU for inclusion in this report, there is no nationally agreed instrument for investigation of maternal deaths at the state and territory level.

A proposal is currently being prepared to design such a standardised instrument for Australia. It would greatly improve the data quality and consistency of reporting across Australia and would enable a more in-depth analysis of all the deaths based on a comprehensive scientific and evidence-based clinical review. An extensive consultative process will be undertaken regarding this instrument and items for inclusion. External funding will be sought for this project to be undertaken in conjunction with the AIHW National Advisory Committee on Maternal Mortality, the State and Territory Maternal Mortality Committees, and the state and territory coroners. Depending on funding for this project, it is anticipated that the instrument would be ready for implementation by all states and territories prior to the 2006–08 triennium.

C. Progress of preparation for the next triennium 2000–02

Data requests were made to all states and territories for collection of the 2000–02 maternal death forms in April 2003 and again in March 2004. At the time of finalising this report (June 2004), six of the eight states and territories have provided NPSU data with maternal death data. These data have been entered into the National Maternal Mortality Database awaiting a complete national collection for the 2000–02 triennium. Preparation for the 2000–02 maternal mortality report will commence as soon as all data have been received by the NPSU.

D. National Coroners Information System

The National Coroners Information System (NCIS) is a national Internet-based data storage and retrieval system for coronial cases in Australia. It provides an efficient and effective research tool to authorised users in the fields of death and injury surveillance and public health and safety. For the next triennium, the NCIS will be used for validation of maternal deaths in Australia. It is anticipated that it will be an extremely useful tool for future reporting to enhance data accuracy and completeness.

Section F Appendices

Appendix 1: Membership of the AIHW National Advisory Committee on Maternal Mortality

Representative	Organisation/specialty
Professor William Walters (Chair 1999–2004)	State Mortality Committee NSW
Associate Professor James King (Chair 2004 –)	State Mortality Committee VIC
Professor Michael Bennett	State Mortality Committee NSW
Dr Shelby Jarrell	State Mortality Committee TAS
Professor David Ellwood	Territory Mortality Committee ACT
Dr Paul Devenish-Meares	State Mortality Committee QLD
Professor Jeffrey Robinson	State Mortality Committee SA
Associate Professor Barry Walters	State Mortality Committee WA
Ms Margaret Stewart	Territory Mortality Committee NT
Dr Elizabeth Sullivan	AIHW National Perinatal Statistics Unit
Professor Lesley Barclay	Australian Council for Safety and Quality in Health Care
Professor David Henderson-Smart	National Health and Medical Research Council
Associate Professor Michael Paech	Australian & New Zealand College of Anaesthetists
Professor Michael Peek (Deputy Chair)	Royal Australian & New Zealand College of Obstetricians and Gynaecologists
Associate Professor Marie-Paule Austin	Royal Australian & New Zealand College of Psychiatrists
Dr Susan Arbuckle	Royal College of Pathologists of Australasia
Dr William Hague	Obstetric medicine physician
Ms Merryl Green	Maternity Alliance
Associate Professor Deborah Black	School of Public Health & Community Medicine, UNSW
Ms Wendy Pollock	Australian College of Midwives

Appendix 2: Membership of AIHW National Advisory Committee Working Group

Maternal Mortality Review Working Group

Associate Professor James King (Chair)
Dr Elizabeth Sullivan (Co-chair)
Professor Michael Bennett
Associate Professor Barry Walters
Ms Wendy Pollock

Appendix 3: Membership of the State and Territory Maternal Mortality Committees 1997–99

The composition and titles of the State and Territory Maternal Mortality Committees for the period 1997–99 were as follows:

New South Wales Maternal and Perinatal Committee

(Committee for 1998)

Dr Susan Arbuckle
Dr David Barclay
Ms Claire Bell
Professor Michael Bennett
Dr Andrew Berry
Dr Andrew Child
Dr John Daniels
Professor David Henderson-Smart
Dr John Hobbs
Dr Ian Hoult
Ms Linda Jones
Dr Penelope Knowlden
Ms Judith Meppem
Dr Des Mulcahy
Dr Elisabeth Murphy
Dr Louise Newman
Ms Margy Pym
Dr John Smoleniec
Dr Lee Taylor
Professor Brian Trudinger
Professor William Walters

Victorian Consultative Council on Obstetric and Paediatric Mortality and Morbidity, Maternal Mortality Subcommittee

Professor NA Beischer (Chair 1997–99)
Dr DW Fortune
Dr D Johnson
Dr PM Renou
Mr IC Ross
Mrs S Murray
Professor RJ Pepperell
Dr AE Altman

Queensland Council on Obstetric and Paediatric Morbidity and Mortality, Maternal Mortality and Morbidity Subcommittee

Dr Ifor Thomas (Chair 1997)
Dr Jeremy Oats (Chair 1998–99)
Ms Marie Barton

Ms Vicki Flenady
Dr Karen Lust
Dr Dianne Payton
Dr Ian Stephens
Dr James King
Dr Donald Cave
Professor Michael Humphrey
Dr Roy Hemsley

South Australian Maternal, Perinatal and Infant Mortality Committee, Maternal Subcommittee

Professor J Robinson (Chair)
Dr Brian Duffy
Dr William Hague
Dr James Harvey
Dr T Yee Khong
Dr John Biggins (1997)
Dr George Kokar (1998–99)
Associate Professor A MacLennan
Ms Leslie White (1997)
Ms Elizabeth Wood (1998–99)
Dr Annabelle Chan (Medical Secretary)

Maternal Mortality Committee of Western Australia

PERMANENT:

Professor Constantine A Michael (Chair)
Deputy Dr Mark McKenna (Obstetrician), Faculty of Medicine and Dentistry, University of Western Australia nomination
Dr Peter Hugo (Obstetrician) Royal Australian and New Zealand College of Obstetricians & Gynaecologists (WA State Committee) nomination
Dr Tim Jeffery (Obstetrician) Commissioner of Health nomination

PROVISIONAL:

Dr Katrina Alexander, Australian Medical Association (WA Branch) nomination (metro)
Dr Michael Dale Jones, Australian Medical Association (WA Branch) nomination (metro)
Dr David Mildenhall, Australian Medical Association (WA Branch) nomination (rural)
Dr Robin Joseph Enfield Kirk, Australian Medical Association (WA Branch) nomination (rural)
Ms Julie Watson, Australian Nursing Federation (WA Branch) nomination
Mr Terry Jongen, Australian Nursing Federation (WA Branch) nomination.

Tasmanian Maternal Mortality and Morbidity Committee

The Committee did not meet during the 1997–99 triennium, although there was one maternal death reported.

Northern Territory Maternal and Child Health Committee

The Committee met once in the 1997–99 triennium. The chair of the committee was Dr Shirley Hendy.

Australian Capital Territory Maternal, Perinatal, Infant Mortality and Morbidity Committee

The data for ACT maternal deaths 1997–99 were collected and provided to the NPSU by the ACT Maternal Perinatal Information Network. The Committee was formed in 1998 and meets three or four time per year.

Professor David Ellwood, Associate Dean, Clinical School, The Canberra Hospital (TCH)
Dr Alison Kent, Neonatologist, Centre for Newborn Care, The Canberra Hospital
Dr Jane Thompson, Coordinator, Clinical Health Improvement Program (CHIP), Women's & Children's Health, TCH
Dr Sue Packer, Community Paediatrician, Child at Risk Assessment Unit, TCH Staff Specialist Obstetrics and Gynaecology, Maternity Unit, TCH
Ms Elizabeth Sharpe replaces Ms Rosemary Kennedy, Director of Nursing Women's & Children's Health, Maternity Unit, TCH
Ms Katrine Scott-Findlay, Director of Nursing, Women's & Children's Health, Maternity Unit, TCH
Ms Sue Minter, Associate Director of Nursing, Maternity, Medical & Mental Health, Calvary Public and Private Hospitals
Ms Stephanie Ham, Clinical Nurse Consultant, Delivery Suite, John James Memorial Hospital
Mr Ian Bull, Manager, Data Management Unit, ACT Health
Ms Mary Kirk, Director of Nursing, Queen Elizabeth II Family Centre, ACT Health
Ms Denise Lamb replaces Ms Giovanna Richmond, Director, Child, Youth, and Women's Health Program, ACT Community Care
Mr Geoff Bagnall, Consumer Representative, Health Care Consumers
Ms Emma Baldock, Homebirth Midwife
Mrs Maureen Bourne, Data Manager, Population Health Research Centre, ACT Health
Ms Karen Lees, Population Health Research Centre, ACT Health

Appendix 4: Method of enquiry

State and Territory Maternal Mortality Committees

State and Territory Committees collect maternal deaths data through a variety of formal and informal channels. Sources of data include direct information from hospitals; postmortem and coroners' reports; midwives' reports; medical practitioners' reports; clinical case notes; newspaper reports; and by informal communication between clinicians. All states and territories have Maternal Mortality Committees, which either meet on a regular basis, or meet to discuss cases as they arise.

Each state or territory has a slightly different data collection methodology.

In *New South Wales*, the Director General of Health has instructed all hospitals to notify maternal deaths to the NSW Maternal and Perinatal Committee. Information is also obtained from the Registry of Births, Deaths and Marriages via the Australian Bureau of Statistics and there is an arrangement with the Coroner's office to provide reports for all maternal deaths.

In the *Northern Territory*, information regarding maternal deaths comes from the Midwives' Data Collection, monthly medical superintendent reports and the Coroner's office. Hospital co-morbidity is also checked.

In *South Australia*, hospitals provide data through the completion of incident report forms. The Coroner's office asks doctors to notify maternal deaths. Midwives complete a supplementary birth record data form for all births that are $\geq$20 weeks gestation or birth-weight >400g. Other data sources include pathologists and the attending practitioner.

In *Queensland*, all deaths, including maternal deaths, are reported via the Registrar General's Office to the Australian Bureau of Statistics, where deaths are coded. A quarterly report is provided via the Queensland Government Statistician's office to the Council Secretariat. In addition, coroners autopsy reports of maternal deaths are received from the State Centre for Forensic Pathology. Information about maternal deaths is also received via informal mechanisms.

In *Victoria*, as in other states, there is no mandatory requirement to notify maternal deaths data. A variety of sources are used to notify the Victorian Committee including death certificates from the Registrar of Births, Deaths and Marriages; midwives' reports; the Coroners office; and newspaper reports. Case histories are built up from postmortem reports, police reports and confidential medical reports.

In *Western Australia*, maternal deaths are notified by the attending practitioner and death certificates sent to the Department of Health WA. Case histories are then gathered from hospitals, medical practitioner clinical case notes, and from coronial and postmortem reports.

The small populations of *Tasmania* and the *Australian Capital Territory* increase the likelihood that detailed information is easily retrieved from hospitals, the Coroners office and attending practitioners.

AIHW National Perinatal Statistics Unit

The AIHW NPSU requests and collates all maternal death data sent by the states and territories. This data collection is facilitated by the National Maternal Death Reporting Form (Appendix 5). All de-identified data are entered into the National Maternal Mortality Database prior to analysis for this report.

Confidentiality

Strict confidentiality is observed at all stages. Maternal death data sent by the states and territories are de-identified prior to receipt by the NPSU. On arrival at the NPSU, data are again checked for de-identification prior to entry into the password-protected National Maternal Mortality Database. After preparation of the report, the anonymous maternal death forms and any related documentation are destroyed.

Appendix 5: National Maternal Death Reporting Form

CONFIDENTIAL

NATIONAL MATERNAL DEATH REPORTING FORM

1. This standardized reporting form is for the use of State and Territory Maternal Mortality Committees and hospitals (where indicated) in the review of all deaths in women while either pregnant or within 365 days of a pregnancy being delivered or terminated, irrespective of the duration and the site of the pregnancy, including abortions and ectopic pregnancies. Cases where the pregnancy was unlikely to contribute significantly to the death are also included.
2. All data will be treated confidentially and is covered under the protection of the AIHW Act.
3. This form was developed in conjunction with the National and State and Territory Maternal Mortality Committees. Some components have been developed from the Guidelines for completing the maternal death notification form (Second edition, 1999), Department of Health, South Africa.
4. Please return forms and direct enquiries to Dr Elizabeth Sullivan, Director, AIHW National Perinatal Statistics Unit, Level 2, McNevin Dixon Building, Randwick Hospital Campus, Avoca St, Randwick NSW 2031. Please telephone Elizabeth Sullivan on (02) 9382 1014 with any queries.

AIHW

For office use only: AIHW NPSU case number ☐☐☐☐☐☐☐

Details of deceased	
State/Country (of usual residence) **Postcode** (of usual residence) ☐☐☐☐	**State in which death occurred**
Date of death ☐☐/☐☐/☐☐☐☐	**State case number** ☐☐☐☐☐☐☐
Maternal date of birth ☐☐/☐☐/☐☐☐☐	**Maternal country of birth**
Torres Strait Islander or Aboriginal status ☐ Torres Strait Islander ☐ Aboriginal ☐ Both ☐ Non Indigenous ☐ Not specified	
Maternal age at death ☐☐☐	**Maternal weight at time of death**
Date of delivery/ abortion (if applicable) ☐☐/☐☐/☐☐☐☐	**If death occurred antepartum; gestational age at death** ☐☐ (weeks)
Plurality ☐ Single ☐ Multiple If multiple, no.	**If death occurred postpartum; number of days postpartum at death** ☐☐☐ (days)
Parity (*excluding* current pregnancy if delivered at or beyond 20 weeks gestation): ☐☐	**Did the mother smoke at all during pregnancy?** ☐ Yes ☐ No ☐ Unknown
Was this pregnancy the result of assisted reproductive technology? ☐ Yes ☐ No ☐ Unknown If yes, please specify	
Place of death	
Setting of death : ☐ Home ☐ Hospital ☐ Birth Centre ☐ Other (please specify)	**If hospital, was it:** ☐ The hospital in which she was booked to delivery ☐ Un-booked admission ☐ An emergency transfer from elsewhere ☐ Other (please specify) ..... **Hospital level** .....
Date of last hospital admission (if applicable): ☐☐/☐☐/☐☐☐☐	**Date of last hospital discharge** (if applicable): ☐☐/☐☐/☐☐☐☐

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Delivery and neonatal information

Type of labour: ☐ Spontaneous ☐ Augmented ☐ Induced ☐ No labour ☐ No specified

Type of delivery:

- ☐ Spontaneous vaginal
- ☐ Elective Caesarean section
- ☐ Forceps
- ☐ Vaginal breech
- ☐ Vacuum extraction
- ☐ Emergency Caesarean section
- ☐ Caesarean section for fetal retrieval in a recently dead or moribund mother
- ☐ Caesarean section (unspecified)
- ☐ Unspecified
- ☐ Other (please specify) ……

Number of previous Caesarean section deliveries: ……

Was the previous birth by Caesarean section? ☐ Yes ☐ No ☐ Unknown

Baby outcome (if applicable)
☐ Livebirth ☐ Stillbirth ☐ Neonatal death Birth weight: …… (gms)

Maternal medical conditions

Pre-existing conditions

- ☐ Diabetes mellitus
- ☐ Essential hypertension
- ☐ Cardiac disease
- ☐ Epilepsy
- ☐ Mental Illness
- ☐ Other

Comments on pre-existing conditions:

Pregnancy related conditions
☐ Gestational diabetes ☐ Hypertensive disorder of pregnancy ☐ Ectopic pregnancy ☐ Other

Comments on pregnancy related conditions:

Interventions (tick appropriate boxes)

Early pregnancy		Antenatal		Intrapartum		Postpartum		Other	
Evacuation		Transfusion		Instrument Del.		Evacuation		Gen. Anaes.	
Laparotomy		Version		Symphysiotomy		Laparotomy		Epidural	
Hysterectomy				Caesarean		Hysterectomy		Spinal Anaes.	
Transfusion				Hysterectomy		Transfusion		Local Anaes.	
				Transfusion		Manual removal		ICU/CCU	
						Return to OT		Ventilation	

Other interventions: ……
Comments on interventions:

Anaesthesia: (related to terminal event)
☐ No ☐ Yes …… ……(please specify)

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Birth attendant:
☐ Obstetrician ☐ Registrar/RMO ☐ Other Doctor ☐ Anaesthetist
☐ Midwife ☐ GP ☐ Other birth attendant .....

Cause of death – as specified by State or Territory Maternal Mortality Committee

Primary (underlying) cause of death:

Contributing (antecedent) causes of death:

Terminal event (description):

Classification of death
☐ Direct ☐ Indirect ☐ Incidental

Classification of death (into ICD-10 categories*)
☐ Pregnancy-related death – 0 to 42 days (any cause; O95 or other pregnancy, childbirth, puerperium code)
☐ Late maternal death – 42 to 365 days (direct or indirect; O96))
☐ Death from sequelae of direct causes – post 365 days (direct; O97)
☐ Other – incidental death occurring 42-365 days post-pregnancy or termination

Cause of Death – as specified on Medical Death Certificate

Direct cause of death (disease or condition directly leading to death)
.....

Antecedent causes of death:
Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last

(1) .....

(2) .....

(3) .....

Post-mortem information

Post-mortem conducted:	**Coronial inquest:**
☐ Yes ☐ No	☐ Yes ☐ No

Macroscopic/ microscopic findings: (please attach relevant documentation)

Toxicology findings: (please attach relevant documentation)

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Avoidable factors as determined by State/Territory Maternal Mortality Committee

Avoidable factors ☐ Yes, avoidable factors present ☐ No, death was inevitable

System	Examples	✔
Personal/family	Delay in woman seeking help	
	Refusal of treatment or admission	
	Insufficient antenatal care	
Logistical systems	Lack of transport from home to health care facility	
	Lack of transport between health care facilities	
	Communication breakdown between health services	
Facilities	Lack of facilities, equipment or consumables	
	Lack/ delay in access to health services due to rural location	
Health personnel	Lack of human resources (e.g. lack of available staff)	
	Lack of antenatal care providers	
	Lack of expertise, training or education	
	Lack of access to interpreter services	
Model of care	Inappropriate early discharge	

Comments on avoidable factors:

Case summary:
(or please attach discharge summary, autopsy report and other relevant information)

Reported in State report: ☐ Yes ☐ No

If yes, which State or Territory:

……

Name of person completing form:

……

Signature: ……

Phone No. ……

Date: ☐☐/☐☐/☐☐☐☐

Please return forms to Dr Elizabeth Sullivan, Director, AIHW National Perinatal Statistics Unit, Level 2, McNevin Dixon Building, Randwick Hospital Campus, Avoca St, Randwick NSW 2031.

Appendix 6: Statistical methods and classifications

Maternal mortality ratio

The maternal mortality ratio (MMR) is used internationally to compare maternal mortality between countries. Australia has in the past included incidental deaths in calculating the MMR. In order to be consistent with international practice, this will no longer be the case. The formula for calculating the MMR is thus:

$$\frac{\text{Total direct and indirect maternal deaths}}{\text{Total confinements}} \times 100{,}000$$

Confinements are the number of pregnancies of 20 weeks gestation or more resulting in a livebirth or a stillbirth. A livebirth is defined as a liveborn infant weighing at least 400g, or if the weight is not known, born after at least 20 weeks gestation. A stillbirth is defined as a stillborn infant weighing at least 400g, or if the weight is not known, born after at least 20 weeks gestation. A stillborn infant is one that does not breathe or show any other sign of life after birth.

In line with recent international conventions (WHO, 1999), this report uses the term 'maternal mortality ratio' instead of 'maternal mortality rate'. The most appropriate denominator for estimating maternal mortality ratios is the number of women at risk, that is, the number of pregnant or recently pregnant women in a specific time period. However, this is not determinable, the unknown component being the number of pregnancies ending before 20 weeks gestation. WHO defines the maternal mortality ratio as the number of maternal deaths related to the number of livebirths, as this denominator is available in most countries.

Age-specific and age-standardised rates

Age-specific rates

Age-specific mortality rates are calculated by dividing the number of deaths occurring in each specified age group by the corresponding population at risk in the same age group in a specified time period, expressed as a rate per 100,000 confinements. These rates are used to compare differences in maternal mortality between age groups.

Age-standardised rates

Incidence and mortality rates are often adjusted to enable comparisons between populations that have different or changing age structures. This effectively removes the influence of age structure on the summary rate, described as the age-standardised rate. There are two different methods used to age adjust. In this report we have used direct standardisation in which average triennium age-specific maternal mortality rates are multiplied by each constant age-specific population (the Australian 2001 Female Population Standard) and divided by 100,000. The expected number of cases in each age group is derived in this way, summed and divided by the total standard population and multiplied by 100,000 to give the age-standardised rate. Age-standardised and age-specific mortality rates are similarly

derived except that the denominator population is the age-specific population of the standard population.

Table A6.1: The Australian 2001 female population standard

Age group	Total females
0–4	624,858
5–9	657,874
10–14	660,094
15–19	**662,077**
20–24	**641,636**
25–29	**706,171**
30–34	**739,696**
35–39	**750,770**
40–44	**744,821**
45–49	683,539
50–54	648,237
55–59	495,911
60–64	408,042
65–69	346,923
70–74	334,826
75–79	292,000
80–84	201,800
85+	183,313
Total all ages	*9,782,588*
Total 15–44	**4,245,171**

Appendix 7: Late maternal deaths

The latest revision of the WHO International Classification of Diseases (ICD-10) has introduced a new category, 'late maternal death', defined as:

> The death of a woman from direct or indirect obstetric causes more than 42 days but less than one year after termination of pregnancy.

Maternal deaths that occur beyond the 42 days after delivery are often not captured by routine surveillance systems (Hoj et al. 2003). The latest revision the WHO International Classification of Diseases (ICD-10) has introduced a new category, 'late maternal deaths', that comprises deaths that occur between 43 and 365 days after delivery (WHO 1993). Several international data linkage studies have revealed that a significant number of maternal deaths are missed by routine surveillance (CDC 2003; Gissler et al. 1996; Horon & Cheng 2001; NICE 2001; Turner et al. 2002b). In particular, late maternal deaths due to suicide and homicide are significantly under-reported because they frequently occur after the woman has left the hospital setting. Researchers at the Confidential Enquiry in Maternal Deaths in the UK found an additional 250 late maternal deaths, including 40 additional deaths from suicide or violent causes, between 1996 and 1999 through a pilot data linkage study (NICE 2001). Similarly, Finnish researchers found 73 suicides associated with pregnancy from a register linkage study of maternal deaths between 1987 and 1994 (Gissler et al. 1996). A Canadian data linkage study identified a significant under-reporting of maternal deaths from all causes, with 60% of the deaths identified occurring between 43 and 365 days of delivery (Turner et al. 2002b). The Centers for Disease Control (CDC) in the United States found that 11% of deaths that occurred between 1991 and 1999, excluding suicides, injury or violent deaths, were late maternal deaths (CDC 2003). Other subpopulation data linkage studies have identified a disturbingly high incidence of homicides in late deaths associated with pregnancy, which were not captured by routine methods (Horon & Cheng 2001).

Late maternal death data have been requested to be collected as part of routine surveillance from 2000–02. A number of late maternal deaths identified by State and Territory committees during the 1997–99 triennium are reported here. The number of late maternal deaths is restricted to those which have been notified to the NPSU, and are not an indication of the prevalence of these deaths. Of the five deaths that occurred between 43 and 365 days and notified to the NPSU, four were classified as incidental deaths, which are therefore excluded from this appendix. A further four late maternal deaths were identified through ABS death data during data validation processes for this report. All five valid late maternal deaths are presented in Table A7.1.

For the 2000–02 triennial report, these deaths will be included in a separate chapter in the main body of the report.

Table A7.1: Late maternal deaths, 1997–99

Case no.	Age	Principal cause of death	Days postpartum at death	Classification
1	19	Hanging	63	Indirect
2	37	Peripartum cardiomyopathy	43	Direct
3	29	Premature separation of placenta	60	Direct
4	31	Ruptured uterus secondary to amniotic fluid embolism	122	Direct
5	44	Cardiac arrest secondary to thrombosis and embolism	53	Direct

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