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Maternal deaths in Australia

2008–2012

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Authoritative information and statistics to promote better health and wellbeing

MATERNAL DEATHS SERIES
Number 5

Maternal deaths in Australia

2008–2012

Australian Institute of Health and Welfare
Canberra
Cat. no. PER 70

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This publication is part of the Australian Institute of Health and Welfare's Maternal deaths series. A complete list of the Institute's publications is available from the Institute's website <www.aihw.gov.au>.

ISSN 1449-8863
ISBN 978-1-74249-742-6 (PDF)
ISBN 978-1-74249-743-3 (Print)

Suggested citation

AIHW: Humphrey MD, Bonello MR, Chughtai A, Macaldowie A, Harris K & Chambers GM 2015. Maternal deaths in Australia 2008–2012. Maternal deaths series no. 5. Cat. no. PER 70. Canberra: AIHW.

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Published by the Australian Institute of Health and Welfare

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Contents

Acknowledgments

The authors of this report were Professor Michael Humphrey, Dr Michelle Bonello, Dr Abrar Chughtai, Mr Alan Macaldowie, Dr Katie Harris and Dr Georgina Chambers at the National Perinatal Epidemiology and Statistics Unit (NPESU).

The report has been made possible by the contribution of members of the medical and midwifery profession, state and territory data managers and staff at the Australian Institute of Health and Welfare (AIHW).

The NPESU is a formally affiliated institution of the University of New South Wales (UNSW), School of Women's and Children's Health, Faculty of Medicine. The NPESU is a collaborating centre of the AIHW.

This report is the result of the hard work, generosity of time and commitment by the members of the National Maternal Mortality Advisory Committee (NMMAC) that provided peer oversight.

The support of the State and Territory Maternal Mortality Committees (STMMC) that undertake confidential review of maternal deaths, and the state and territory data managers and staff, who compile the cases, have been invaluable. We acknowledge the continuing close cooperative relationship with the New Zealand Perinatal and Maternal Mortality Review Committee.

We would like to thank the members of the National Maternity Data Development Advisory Group who provided advice throughout the development of this report.

We acknowledge funding from the Australian Government Department of Health for the National Maternity Data Development Project.

Abbreviations

ABS	Australian Bureau of Statistics
AFE	amniotic fluid embolism
AHMC	Australian Health Ministers' Conference
AIHW	Australian Institute of Health and Welfare
AMOSS	Australasian Maternity Outcomes Surveillance System
ANZICS	Australian and New Zealand Intensive Care Society
BMI	body mass index
CDC	Centers for Disease Control and Prevention
CI	confidence interval
CPR	cardiopulmonary resuscitation
CS-MMR	cause-specific maternal mortality ratio
GAS	group A beta haemolytic streptococcus
hCG	human chorionic gonadotropin
HELLP syndrome	Complication of pre-eclampsia characterised by haemolysis, elevated liver enzymes and low platelet count
ICD-10	WHO International Statistical Classification of Diseases and Related Health Problems, 10th revision
IVF	in vitro fertilisation
MDGs	Millennium Development Goals
mmHg	millimetres of mercury
MMR	maternal mortality ratio
NMDDP	National Maternity Data Development Project
NMDR	National Maternal Death Reporting
NMDRDS	National Maternal Death Report Data Set
NMMAC	National Maternal Mortality Advisory Committee
NPESU	National Perinatal Epidemiology and Statistics Unit
PGF2α	prostaglandin F2 alpha
PMMRC	Perinatal and Maternal Mortality Review Committee
PPH	postpartum haemorrhage

RANZCOG	Royal Australian and New Zealand College of Obstetricians and Gynaecologists
RANZCP	Royal Australian and New Zealand College of Psychiatrists
RCA	root cause analysis
RCOG	Royal College of Obstetricians and Gynaecologists
RHD	rheumatic heart disease
SOMANZ	Society of Obstetric Medicine of Australia and New Zealand
STMMC	State and Territory Maternal Mortality Committees
UK	United Kingdom
UKOSS	United Kingdom Obstetric Surveillance System
UNSW	University of New South Wales
VTE	venous thromboembolism
WHO	World Health Organization

Symbols

–	nil or rounded to zero
. .	not applicable
n.a.	not available
n.p.	not publishable because of small numbers, confidentiality or other concerns about the quality of the data

Summary

Maternal deaths in Australia 2008–2012 provides a summary of statistics on maternal mortality in Australia to inform safety and quality of maternity care in Australia, and provides good practice guidance from members of the National Maternal Mortality Advisory Committee (NMMAC).

In 2008–2012, there were 105 maternal deaths in Australia that occurred within 42 days of the end of pregnancy, representing a maternal mortality ratio (MMR) of 7.1 deaths per 100,000 women who gave birth in Australia. The number of maternal deaths increased each year from 2008 to 2012. It is uncertain whether this is an actual increase or reflects improvements in case ascertainment.

There were 49 maternal deaths directly related to the pregnancy in 2008–2012. Fifty-three deaths were indirect maternal deaths, due to non-pregnancy related conditions aggravated by the pregnancy or its management. Three maternal deaths could not be classified as direct or indirect deaths.

The women who died were aged between 17 and 50. Women aged 40 and over, women who are obese with a body mass index (BMI) of 30 or more, and women of Aboriginal and Torres Strait Islander origin, were among those at increased risk of maternal death.

Maternal mortality in Australia has been reported since the 1964–1966 triennium. The direct MMR in the 1964–1966 triennium (30.3 deaths per 100,000 women who gave birth) was 10.4 times higher than the direct MMR in the 2009–2011 triennium (2.9 deaths per 100,000 women who gave birth). The total MMR has fallen from 12.7 deaths per 100,000 women who gave birth in 1973–1975 to 7.2 deaths per 100,000 women who gave birth in 2009–2011.

Key causes of maternal death in Australia in 2008–2012

- The leading causes of direct maternal death were obstetric haemorrhage (11), thromboembolism (10) and hypertensive disorders (9) and, when combined, these accounted for more than 61% of all direct maternal deaths.
- The leading cause of indirect maternal death was cardiovascular disease (15).
- There were 16 deaths due to psychosocial causes, including 12 due to suicide.
- Five of the direct deaths due to obstetric haemorrhage were related to the presence of pathological placentation (placenta accreta and/or percreta), and 5 were due to postpartum haemorrhage.
- Five non-obstetric haemorrhage deaths resulted from rupture of a splenic artery aneurysm and 5 were due to intracranial haemorrhage.

Aboriginal and Torres Strait Islander maternal mortality

Maternal mortality for Aboriginal and Torres Strait Islander women is double that of other Australian women, with an Aboriginal and Torres Strait Islander MMR of 13.8 deaths per 100,000 women who gave birth compared with 6.6 deaths per 100,000 for other Australian women who gave birth. Although the differential between the MMRs is decreasing, caution should be exercised in drawing conclusions due to the small numbers being analysed. Cardiovascular conditions, sepsis and psychosocial conditions were the leading causes of maternal deaths among Aboriginal and Torres Strait Islander women.

1 Introduction

1.1 Background to the report

Although maternal death and pregnancy-related morbidity are rare in Australia, the review of maternal deaths remains an important measure of maternity services and obstetric care. This is the sixteenth report published on maternal deaths in Australia. The purpose of the report is to identify trends in maternal mortality and to develop an evidence base for maternal deaths that can be used to inform maternity services policy and practice. Since Australia initiated the practice of reporting and subsequently published data on maternal mortality for the triennium 1964–1966, maternal deaths have decreased by nearly two-thirds.

The World Health Organization (WHO) estimates that worldwide 287,000 women die each year from complications of pregnancy and childbirth (WHO 2014). Australia is a signatory to the United Nations Millennium Development Goals (MDGs), which form an agreed international blueprint aimed at reducing poverty, hunger and disease by the target date of 2015. The fifth MDG is 'Improve maternal health', and is stated as 'Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio' (UN 2010). The maternal mortality ratio has dropped by 45% between 1990 and 2013, from 380 to 210 deaths per 100,000 live births <http://www.who.int/mediacentre/factsheets/fs348/en/>.

The National Maternity Services Plan

In 2008, a national review of maternity services was carried out in Australia, led by the Commonwealth Chief Nurse and Midwifery Officer. The findings were presented in 2009 in *Improving maternity services in Australia: the report of the Maternity Services Review* (Commonwealth of Australia 2009). The report aimed to identify key gaps in maternity care and to inform development of the first National Maternity Services Plan (AHMC 2011).

The National Maternity Services Plan (the Plan) was launched in February 2011 and sets out a 5-year vision for maternity care that provides a strategic national framework to guide policy and program development across Australia (AHMC 2011).

The purpose of the Plan is to maintain Australia's high standard of maternity care while seeking to improve access to services and choice in care, which includes increasing and supporting the maternity workforce, strengthening infrastructure and building the evidence base of what works well in Australia. In particular, the Plan's priority areas are to: meet the needs of women and their families living in rural and remote areas; improve birth outcomes for Aboriginal and Torres Strait Islander people; and meet the requirements of women who are vulnerable due to medical or other risk factors. The Plan targets primary maternity services during the antenatal, intrapartum and 6-week postnatal period for both women and babies (AHMC 2011). In 2011, the incumbent federal government provided funding for the National Maternity Data Development Project (NMDDP).

National Maternity Data Development Project

The NMDDP was set up in response to Recommendation 1 of the Plan. The primary aims of the NMDDP are to develop a nationally consistent and comprehensive maternal and perinatal mortality and morbidity data collection in Australia. High-quality and nationally consistent data are required to assess the safety and outcomes of current and emerging

models of maternity care in Australia and will enable the monitoring of disparities in health outcomes for population subgroups compared with the general population. The project is managed by the NMDDP Advisory Group. A report on Stage 1 of the NMDDP was published in 2014 (see <http://www.aihw.gov.au/publication-detail/?id=60129547184>).

National Maternal Mortality Advisory Committee

The NMMAC was convened to provide guidance and national relevance to the development of the national *Maternal deaths in Australia* reports (the current members are listed in Appendix A), and is a subcommittee of the NMDDP Advisory Group. The NMMAC provides expert advice on the development of *Maternal deaths in Australia* reports, including strategic advice, facilitation of data supply and provision of clinical commentary, and good practice guidance.

1.2 Purpose of this report

The National Maternity Services Plan Priority Action 2.1 recommends that a national maternal mortality review process be established and that national maternal mortality reports are produced (AHMC 2011). This report reviews 5 years of maternal deaths, from 2008 to 2012, and is a 'rolling' quinquennial report, building from the *Maternal deaths in Australia 2006–2010* report.

Detailed examination and reporting of maternal deaths improves performance in all sectors of maternity care by advancing maternity care practices and informing policy. Internationally, measuring maternal mortality enables comparisons of maternal health outcomes across countries, and may be seen as an indicator of society's health-care services.

Where possible, comparisons are made with data contained in the most recent maternal mortality reports from New Zealand (PMMRC 2014) and United Kingdom (Knight et al. 2014) data. Relevant studies by Australasian Maternity Outcomes Surveillance System (AMOSS) and UK Obstetric Surveillance System (UKOSS), where published, are also referenced.

1.3 Aims of this report

- Provide an overview of maternal mortality from collated information on maternal deaths in Australia that occurred during the period 1 January 2008 to 31 December 2012.
- Provide an evidence base to inform policy development.
- Provide a platform to assist practitioners to reduce maternal mortality and counsel high-risk women who are considering pregnancy.
- Provide guidance regarding women who may be at higher than normal risk of death or severe morbidity and who may require additional care efforts in relation to those identified risk factors.
- Inform national processes for classification of maternal deaths, providing a basis for consensus in the review of maternal deaths by state and territory maternal mortality committees (STMMCs), and nationally.

1.4 Structure of this report

Chapter 1 provides the background, including the policy context.

Chapter 2 provides the definitions and classifications used in the report, and the methodology and data used in measuring maternal mortality.

Chapter 3 provides an overview of maternal deaths in Australia from 2008 to 2012.

Chapter 4 provides detailed information on causes of direct and indirect maternal deaths.

Chapter 5 provides detailed information on maternal deaths of Aboriginal and Torres Strait Islander women.

Chapter 6 provides information on incidental maternal deaths.

The report includes illustrative case vignettes and good-practice guidance points to make the report more accessible to clinicians working in maternity services. The aim of these sections is to provide educational opportunities for teaching and learning and practice improvement.

2 Definitions, classification and methods

2.1 Definitions and classifications

Australia applies the standard international definition of 'maternal death'. The WHO *International statistical classification of diseases and related health problems, 10th revision* (ICD-10), defines maternal death as 'the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes' (WHO 1992). Maternal deaths are subdivided into 2 categories: direct and indirect deaths (Table 2.1). These categories divide the maternal deaths into those that result directly from complications of pregnancy or its management (direct), and those that are due to pre-existing or inter-current disease but where disease progression was influenced by pregnancy (indirect). Deaths considered to be unrelated to pregnancy are classified as 'incidental'.

Table 2.1: Definitions of maternal death categories

Type of death	Definition
Direct maternal deaths[(a)]	Those resulting 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
Indirect maternal deaths[(a)]	Those resulting from previous existing diseases or diseases that developed during pregnancy, and which were not due to a direct obstetric cause, but were aggravated by the physiologic effects of pregnancy
Incidental maternal deaths	Deaths from unrelated causes that happen to occur in pregnancy or the puerperium
Maternal death, not further classified	Deaths considered to be related to the pregnancy or its management, but could not be further classified as either 'direct' or 'indirect'
Unclassified death	Maternal death from unspecified or undetermined cause occurring during pregnancy, labour and delivery, or the puerperium

(a) Definitions are from the *International statistical classification of diseases and related health problems*, 10th revision, volume 2, section 5.8.1.

The category 'Maternal death, not further classified' was applied where pregnancy was considered to have contributed to the death, but where the jurisdictional maternal mortality committee found that the death could not be classified as a direct or indirect maternal death.

Deaths that were not classified by state or territory and were provided with insufficient information to assess cause of death were considered 'unclassifiable'.

Though there is increasing interest in the examination of 'Late maternal deaths' in a number of jurisdictions (Knight et al. 2014; QMPQC 2013), they are not examined in this report. Late maternal deaths are deaths that occur between 43 days and 365 days after pregnancy ends and result from obstetric complications of the pregnant state or previous existing diseases or diseases that developed during pregnancy.

The cause of death used in this maternal mortality report is that determined by the STMMC after consideration of all available information. Autopsy, coronial and other information is frequently available after the health-care facility admission and discharge coding process is completed, and hence the cause of death allocated by the STMMC may not be the same as the initial discharge ICD-10 coding.

Classification of deaths related to psychosocial morbidity

In 2011 and 2012, the World Health Organization (WHO) recommended classifying all maternal suicide deaths as direct maternal deaths (Pattinson et al. 2009; WHO 2012).

In Australia, the process of classification has been dependent on whether there is a known history of psychiatric illness. Jurisdictional maternal mortality committees (STMMC) have usually classified a death where there was previous psychiatric illness that was known to health-care professionals as an indirect death unless a new mental health illness arose for the first time during the pregnancy, in which case it would be classified as a direct death. Maternal deaths associated with external events, such as homicide, substance abuse and events of undetermined intent, would be classified as either an indirect or incidental death, depending on the presenting circumstances.

However, in 2012 the NMMAC considered the classification of psychosocial maternal deaths and took advice from the Royal Australian and New Zealand College of Psychiatrists (RANZCP) and from within its expert membership. RANZCP's view is that it is difficult to determine the onset of psychosocial issues and, if a significant psychiatric issue arises during pregnancy or postpartum, it is still a psychiatric issue and therefore it should always be classified as an indirect cause if maternal death occurs.

The NMMAC came to the conclusion that puerperal psychosis, which is related to a dramatic change in hormone levels during pregnancy, is extremely rare and is the only mental health condition known to be directly related to pregnancy. Hence, maternal deaths related to the development of a puerperal psychosis are the only psychosocial maternal deaths that are directly related to the pregnancy. Maternal deaths related to underlying psychiatric illness are only indirectly related to the physiological effects of pregnancy. It was further agreed to classify relevant external causes of maternal death (such as substance misuse, homicide in the setting of domestic violence and events of undetermined intent) to 'indirect' causes of death. Homicide occurring in a setting other than a psychosocial setting such as domestic violence is classified as 'incidental' death.

Note: Because this decision was made by the NMMAC at the end of 2012, some of the deaths in this report were classified by the relevant STMMC using previous classification conventions. Therefore, categorisation of psychosocial deaths into direct, indirect and incidental may not be consistent within this report and with previous reporting periods.

2.2 Measuring maternal mortality

A maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (WHO 1992).

The incidence of maternal death is expressed as the maternal mortality ratio (MMR), which is calculated using direct and indirect deaths combined, and excludes incidental deaths.

The WHO definition specifies that the number of live births or the total number of births (live births plus fetal deaths) can be used as the denominator, and where both denominators are available, both calculations are made (WHO 1992). Although the most appropriate denominator for estimating maternal mortality would be the number of women at risk (that is, the number of pregnant or recently pregnant women), this number is not available in Australia because the number of pregnancies ending before 20 weeks gestation is unknown.

In Australia, accurate population data are available for the number of women who gave birth to at least 1 baby (either a live birth or a stillbirth) of 20 weeks completed gestation or more or birthweight of 400 grams or more; this is the denominator number used when calculating the MMR in this report.

Calculation of maternal mortality ratio (MMR)

$$\text{MMR} = \frac{\text{Number of direct and indirect maternal deaths}^{(a)}}{\text{Number of women who gave birth}^{(a)}} \times 100{,}000$$

(a) For a defined place and time.

Australian maternal death reports prior to the 1997–1999 triennium included incidental deaths in the definition and MMR calculations. Caution must therefore be taken when comparing MMRs from triennia prior to 1997–1999 with MMRs from the 1997–1999 triennium onwards. Refer to Table 3.2 for comparable rates that separate out the components of direct, indirect and incidental deaths for these years.

2.3 Data for 2008–2012 maternal deaths

Primary data collection and review regarding maternal deaths in Australia is undertaken by the state and territory health departments, with initial notification including significant input from the relevant Registrars of Births, Deaths and Marriages, and Coroners. Data from these jurisdictions are subsequently provided to AIHW NPESU for collation into a National Maternal Death Report Data Set and reviewed by the NMMAC.

State and territory maternal mortality committees

A confidential enquiry into the maternal deaths that occurred in 2008–2012 was undertaken by 7 STMMCs. The Northern Territory did not convene a committee during this time period. The confidential enquiry process seeks to identify and understand the individual circumstances surrounding each death with a view to improving future maternity care and maternal and perinatal outcomes. The committees operate under legal privilege and are provided with clinical information and the results of autopsy investigations where available. This enables the STMMC to agree on the causes of each death and assign the death to a maternal death category. The organisational and governance arrangements for STMMCs vary between jurisdictions (details of each jurisdiction's maternal death data collection process is outlined in Appendix B).

Reporting maternal deaths in 2008–2012

The methodology used for this report is similar to previous reports. It includes epidemiological data on maternal deaths, the use of illustrative vignettes known as 'case summaries', clinical commentary and references to published guidelines for further education on specific clinical management where available and relevant.

Maternal mortality in Australia has been reported nationally since 1964. Reports were triennial until the 2003–2005 triennium. Procedural difficulties led to a hiatus of 5 years, and a 'catch-up' process was commenced with a quinquennial 2006–2010 report (AIHW et al.

2014). This 2008–2012 rolling quinquennial report continues the 'catch-up' process. Caution is advised when comparing overlapping time periods.

Minimal information related to the assessment of avoidable factors or preventability surrounding the deaths is included in this report. This was a decision of the NMMAC and was made due to the absence of a nationally consistent approach to assessment of preventability of deaths and the retrospective nature of the data collection. This information is not readily available or routinely collected in all jurisdictions.

Data elements, such as maternal place of residence (and hence remoteness of residence), could not be presented with the necessary degree of accuracy for this report due to differing legislative frameworks governing the ability of STMMCs and health departments to share information regarding maternal deaths and their jurisdictional review. Formal mechanisms, including legislative changes, are needed for more effective data sharing between jurisdictional maternal mortality registration authorities and maternal mortality data collection and review committees.

Case vignettes

Case vignettes or summaries have been incorporated to provide opportunities for teaching and learning and practice improvement, as in previous reports. Care has been taken to remove or change information that could potentially identify any individual. A decision was made by the NMMAC to not identify Aboriginal and Torres Strait Islander status in the case summaries and to not have any case summaries in the chapter on Aboriginal and Torres Strait Islander women. Perturbation, where a number of cases may have been combined, was used in the case summaries to prevent identification.

3 Maternal deaths in Australia in 2008–2012

Information about the deaths of 135 women that occurred during pregnancy or up to 42 days postpartum in Australia for the period 2008–2012 was provided to the AIHW NPESU. Following review by jurisdictional and national committees, 105 (78.0%) were classified as being directly or indirectly related to pregnancy, 27 were classified as incidental to the pregnancy, and 3 were unclassified deaths.

Figure 3.1 and Table 3.1 show the distribution of maternal deaths between 2008 and 2012. Forty-nine of the 135 deaths (36.3%) were directly related to obstetric complications of the pregnancy and occurred while the woman was pregnant or within 42 days of the termination of the pregnancy. Fifty-three deaths (39.3%) were classified as indirect maternal deaths and were considered to be due to non-pregnancy related conditions that were aggravated by the pregnancy or its management. Three maternal deaths (2.2%) were considered to be related to the pregnancy or its management, but could not be further classified as either direct or indirect.

Twenty-seven of the remaining 30 deaths, or 20.0% of all reported maternal deaths, were considered to be incidental to the pregnancy or its management. Of the remaining 3 (2.2%) deaths, there was insufficient information to classify them and they were categorised as unclassified deaths of women during pregnancy and the puerperium. No further information is presented about unclassified deaths in this report. Incidental and unclassified deaths are not included in the calculation of MMRs.

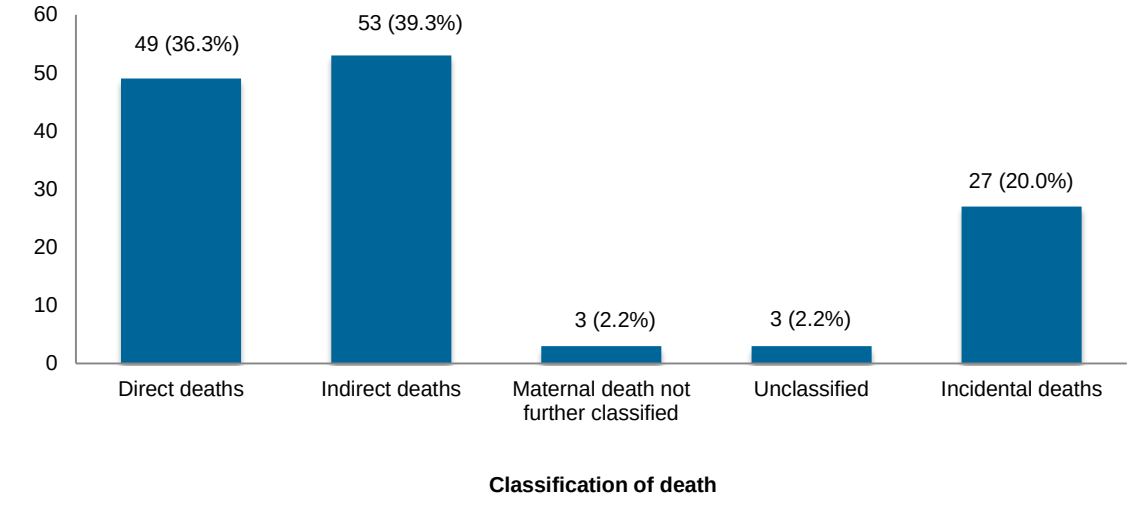


Figure 3.1: Maternal deaths by classification and incidental deaths, Australia, 2008–2012

3.1 Maternal mortality ratio

There were 105 maternal deaths between 2008 and 2012. The maternal mortality ratio (MMR) is a proportion that uses the number of direct, indirect and maternal deaths not further classified in the numerator and the number of women who gave birth in Australia to babies of at least 400 grams birthweight or at least 20 weeks gestation as the denominator. It is calculated over a defined time period. The MMR for the period 2008–2012 is 7.1 per 100,000 women who gave birth (Table 3.1).

Table 3.1: Maternal mortality ratio, Australia, 2008–2012

Year[a]	Direct deaths	Indirect deaths	Maternal deaths not further classified	Unclassified deaths[b]	Incidental deaths[c]	Total deaths	Number of women who gave birth	Maternal mortality ratio[d]
2008	6	7	0	0	8	21	292,156	4.4
2009	6	12	0	2	6	26	294,540	6.1
2010	9	10	1	1	5	26	294,814	6.8
2011	11	14	1	0	4	30	297,126	8.8
2012	17	10	1	0	4	32	307,474	9.1
Total	**49**	**53**	**3**	**3**	**27**	**135**	**1,486,110**	**7.1**

(a) 2008–2012 is a 5-year period; 3-year reporting periods were used up to the end of the 2003–2005 triennium.

(b) Insufficient information was available to classify 3 deaths; these deaths are not included in the MMR calculations.

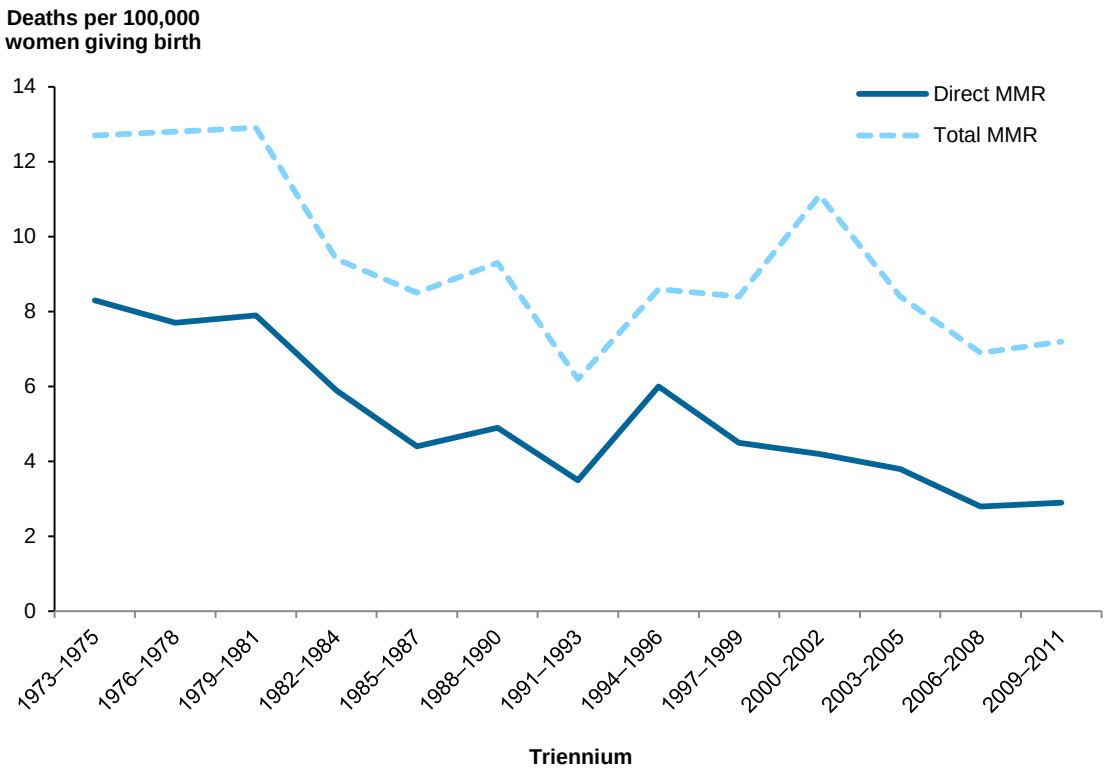
(c) These deaths are not included in the MMR calculations.

(d) Per 100,000 women who gave birth. Includes direct deaths, indirect deaths and deaths not further classified.

The MMR for 2008–2012 is similar to the most recently reported MMR for the period 2006–2010 (6.8 per 100,000 women who gave birth) and the 2003–2005 triennium (8.4 per 100,000 women who gave birth), and lower than the MMR of 11.1 per 100,000 women who gave birth reported for the 2000–2002 triennium.

Triennial maternal mortality ratio

For ease of international comparison, triennial historical comparisons are presented in Figure 3.2 and Table 3.2 from 1973 to 2011. Prior to the 1973–1975 triennium, definitional differences were such that only the direct MMR can be compared. There has been a statistically significant ($p < 0.05$) decline in total MMR between 1973–1975 and 2009–2011, and the fluctuations in the MMR over the period reflect the variability in rare death reporting.



Note: 1964–1966, 1967–1969 and 1970–1972 triennia are not included in this figure due to definitional differences in use for those periods.

Figure 3.2: Maternal mortality ratios by triennium, Australia, 1973–2011

Table 3.2: Maternal mortality ratios by triennium, Australia, 1973–2011

Years	Direct deaths[a]	Associated deaths		Number of women who gave birth	Direct maternal mortality ratio[b]	Maternal mortality ratio[c]
1964–1966	202		73	667,649	30.3	Not calculated
1967–1969	166		71	713,064	23.3	Not calculated
1970–1972	150		94	790,818	19.0	Not calculated
		Indirect deaths	Incidental deaths			
1973–1975	60	32	45	726,690	8.3	12.7
1976–1978	52	35	19	678,098	7.7	12.8
1979–1981	54	34	9	682,880	7.9	12.9
1982–1984	42	25	27	713,985	5.9	9.4
1985–1987	32	30	24	726,642	4.4	8.5
1988–1990	37	33	26	754,468	4.9	9.3
1991–1993	27	22	36	769,253	3.5	6.2
1994–1996	46	20	34	767,448	6.0	8.6
1997–1999	34	30	28	758,030	4.5	8.4
2000–2002	32	52	3	753,901	4.2	11.1
2003–2005	29	36	13	773,248	3.8	8.4
2006–2008	24	35	15	859,088	2.8	6.9
2009–2011	26	36	18[d]	886,480	2.9	7.2[e]

(a) Data in this table from periods prior to 2006–2010 are based on historical reports and occasionally do not align with subsequent tables in the report for the 1973–75 and 1991–1993 triennia.

(b) Maternal mortality ratio calculated from direct maternal deaths only, per 100,000 women who gave birth.

(c) Maternal mortality ratio calculated from direct and indirect maternal deaths, per 100,000 women who gave birth. Due to definitional differences, this cannot be calculated for the 1964–1966, 1967–1969 and 1970–1972 triennia. Therefore, these triennia cannot be compared with those that follow.

(d) Includes 3 unclassified deaths.

(e) Includes 2 maternal deaths not further classified as either direct or indirect.

Note: Table does not include 2012 data because triennium data are incomplete.

3.2 State and territory maternal mortality ratios

The MMR varied by state and territory of death (Table 3.3), ranging from 3.3 deaths per 100,000 women who gave birth in Tasmania to 25.8 deaths per 100,000 women who gave birth in the Northern Territory: the least populous jurisdiction in Australia. The variation between the states' MMRs may reflect case identification within each jurisdiction, and the NMMAC believes that uniform mandatory reporting of all maternal deaths would be warranted. The small number of deaths indicates that caution should be used when interpreting the state and territory MMRs.

Table 3.3: Maternal deaths by type of death, state and territory of usual residence, 2008–2012

State and territory	Number of women who gave birth	Direct deaths[(a)]	Indirect deaths[(a)]	Direct and indirect deaths	Maternal death not further classified	Maternal mortality ratio[(b)]
NSW and ACT[(c)]	507,519	14	15	29	1	5.9
Vic	366,083	13	17	30	0	8.2
Qld	306,129	13	12	25	1	8.5
WA	156,979	0	5	5	1	3.8
SA	99,319	5	1	6	0	6.0
Tas	30,732	n.p.	n.p.	1	0	3.3
NT	19,349	n.p.	n.p.	5	0	25.8
Total[(d)]	**1,486,110**	**49**	**53**	**102**	**3**	**7.1**

(a) Numbers may differ from those published in state and territory reports due to possible differences in the classification of maternal deaths by the NMMAC and the STMMCs.

(b) Per 100,000 women who gave birth.

(c) Includes 4 women whose state of usual residence was NSW and who died in another state or territory.

(d) Includes 1 woman who died in Tasmania and whose state or territory of usual residence was unknown.

3.3 Causes of maternal deaths

There were 105 maternal deaths, 49 of which were direct maternal deaths, 53 were indirect maternal deaths and 3 were maternal deaths that could not be classified due to insufficient information being available. Overall, the leading causes of maternal death in Australia in this 5-year reporting period were cardiovascular disorders (16 deaths) and psychosocial deaths (16 deaths).

Of the 49 direct maternal deaths, the leading causes were obstetric haemorrhage and thromboembolism, which together accounted for almost 43% of all direct maternal deaths (Figure 3.3, Table 3.4). Amniotic fluid embolism is less prominent in this period than in previous periods; it was still the most prominent cause of direct maternal death in New Zealand and the United Kingdom for the period 2008–2012 (Knight et al. 2014; PMMRC 2014). Of concern is the continuing prominence of thromboembolic direct maternal deaths, despite the development of clear guidelines for thromboembolic prophylaxis in high-risk pregnancies (RCOG 2007, 2009a, 2009b).

There were 53 indirect maternal deaths in Australia between 2008 and 2012, with cardiovascular deaths and deaths related to psychosocial morbidity remaining the leading causes of indirect maternal death (Figure 3.3, Table 3.4). The prominence of cardiovascular deaths was in line with the leading causes of indirect maternal death in New Zealand and the United Kingdom, which were pre-existing medical conditions and cardiac disease, respectively, and reflects the increasing age of mothers and increasing levels of obesity and other risk factors. Of note was the unusually high number of non-obstetric haemorrhage deaths from rupture of a splenic artery aneurysm, which is discussed in 'Section 4.4 Non-obstetric haemorrhage' and 3 deaths related to the 2009 H1N1 influenza pandemic, which are discussed in 'Section 4.5 Sepsis' and were examined in detail in *Maternal deaths in Australia 2006–2010* (AIHW et al. 2014).

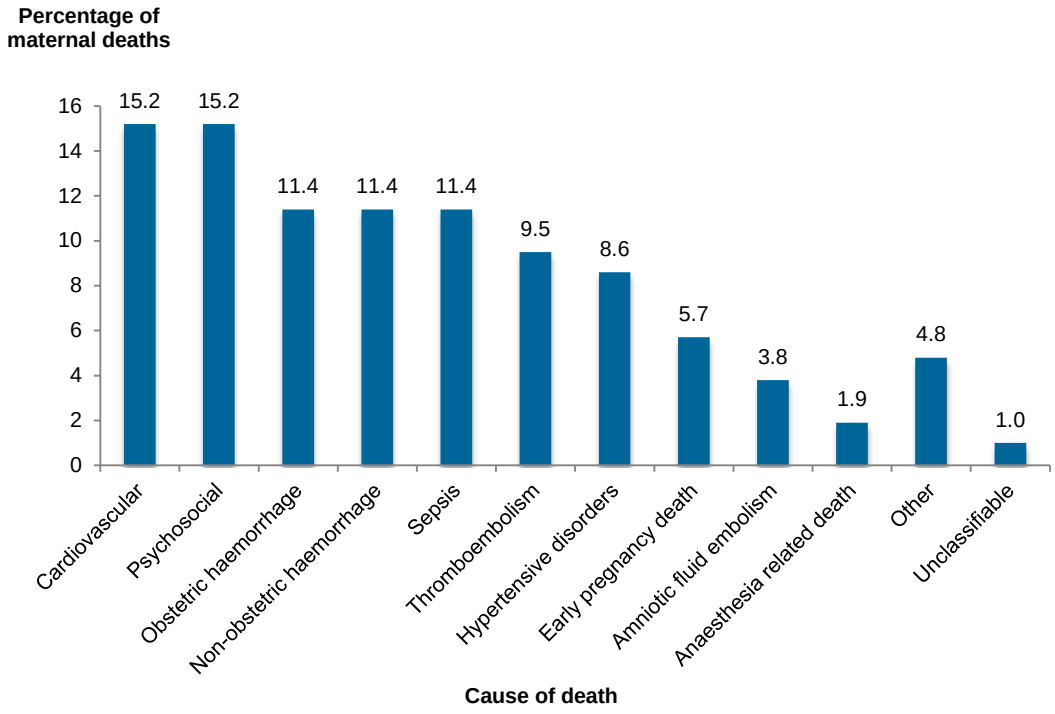


Figure 3.3: Causes of maternal deaths, per cent, Australia, 2008–2012

Table 3.4: Causes of maternal deaths, Australia, 2008–2012

Cause of death	Classification of deaths			Total	
	Direct	Indirect	Maternal death not further classified	Number	%
Cardiovascular	1	15	0	16	15.2
Psychosocial	1	14	1	16	15.2
Obstetric haemorrhage	11	1	0	12	11.4
Non-obstetric haemorrhage	3	9	0	12	11.4
Sepsis (including H1N1 influenza)	4	7	1	12	11.4
Thromboembolism	10	0	0	10	9.5
Hypertensive disorders	9	0	0	9	8.6
Early pregnancy death	5	1	0	6	5.7
Amniotic fluid embolism	4	0	0	4	3.8
Anaesthesia related death	1	1	0	2	1.9
Other	0	5	0	5	4.8
Unclassified	**0**	**0**	**1**	**1**	**1.0**
Total	**49**	**53**	**3**	**105**	**100.0**

3.4 Demographic and clinical characteristics

An understanding of the demographic and pregnancy characteristics of women who die is required to interpret the MMR accurately and plan services appropriately. Due to the distributed nature of data being contributed to the National Maternal Death Report Data Set, some demographic characteristics (e.g. postcode of normal residence, which would allow for a remoteness of residence statement) were not available for all women who died.

Maternal age

Table 3.5 shows maternal deaths between 2008 and 2012 by age group. The age of the women who died ranged from 17 to 50. The incidence of maternal death was higher at the extremes of reproductive age (Figure 3.4), with the lowest incidence of maternal death occurring between the ages of 25 and 34 (MMR 4.9 per 100,000 women who gave birth). Forty per cent (40%) of the maternal deaths occurred in the women who were aged 35 or over (MMR 12.4 per 100,000 women who gave birth).

Table 3.5: Maternal deaths by age group and percentage of women who gave birth by age group, Australia, 2008–2012

Age group (years)	Number of deaths[a]	Percentage of deaths	Number of women who gave birth	Percentage of total number of women who gave birth	MMR[b]
<20	5	4.8	57,346	3.9	8.7
20–24	14	13.3	208,903	14.1	6.7
25–29	23	21.9	408,346	27.5	5.6
30–34	20	19.0	471,743	31.7	4.2
35–39	29	27.6	277,115	18.6	10.5
≥40	13	12.4	60,785	4.1	21.4
Total[c]	**105**	**100.0**	**1,486,110**	**100.0**	**7.1**

(a) Direct, indirect and maternal deaths not further classified.

(b) Per 100,000 women who gave birth.

(c) Includes 1 woman of unknown age group.

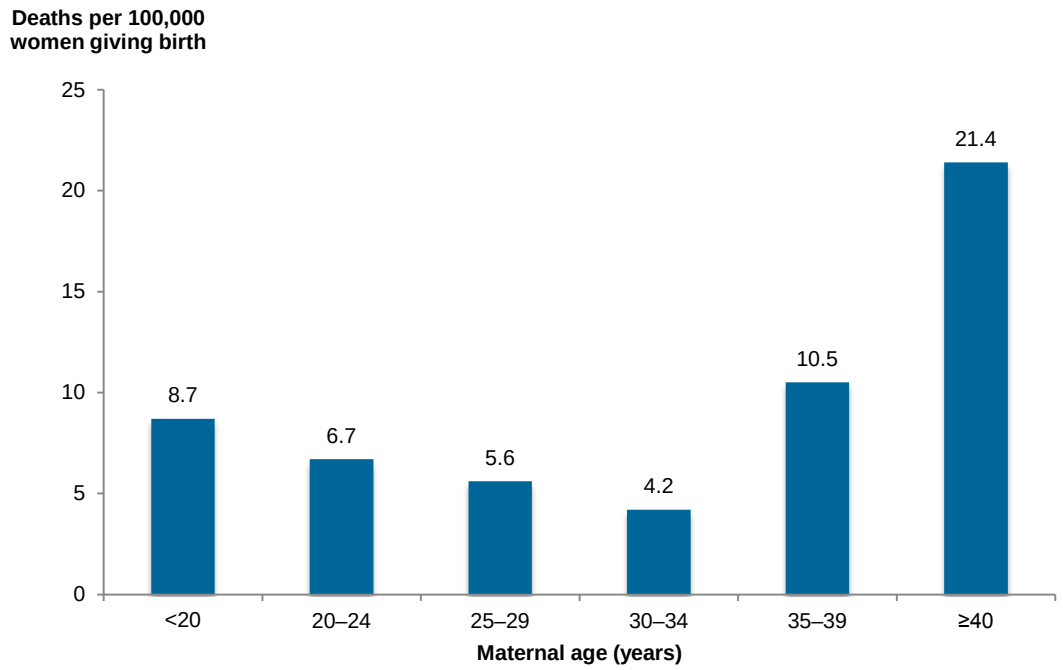


Figure 3.4: Maternal mortality ratio by maternal age group, Australia, 2008–2012

Age-standardised death rates for direct and indirect deaths between 2008 and 2012 are presented in tables 3.6 and 3.7. The numbers of deaths are small and reflect the variability of the rates over time by age groups. For direct maternal deaths, women aged 35 and older had the highest rates of maternal mortality in a number of the time periods, though this trend was not entirely uniform. For indirect deaths, however, there was no obvious trend.

For direct deaths, the overall age-standardised rate for maternal mortality has trended downwards over the triennia. For indirect deaths, the overall age-standardised rate for maternal mortality has fluctuated over the triennia.

Note that the age-standardised rates are expressed per 100,000 female population aged 15–44, in contrast to the crude MMRs that are expressed per 100,000 women who gave birth.

Table 3.6: Age-specific and age-standardised maternal mortality rates: direct maternal deaths, Australia, 1973–2011

Triennium	Direct deaths[a]	15–19 years	20–24 years	25–29 years	30–34 years	35–39 years	40–44 years	Age-standardised rate[b]
1973–1975	66	0.25	1.10	1.14	0.42	0.57	1.00	0.74
1976–1978	52	0.22	0.58	0.70	0.80	0.41	0.73	0.58
1979–1981	54	0.17	0.80	0.60	0.74	0.39	0.54	0.54
1982–1984	42	0.11	0.75	0.62	0.23	0.45	0.08	0.37
1985–1987	32	0.20	0.25	0.40	0.52	0.27	0.00	0.28
1988–1990	37	0.05	0.35	0.52	0.59	0.26	0.06	0.31
1991–1993	27	0.00	0.09	0.44	0.28	0.34	0.16	0.22
1994–1996	46	0.11	0.33	0.48	0.69	0.47	0.10	0.37
1997–1999	34	0.00	0.20	0.27	0.37	0.58	0.14	0.27
2000–2002	32	0.10	0.05	0.38	0.45	0.36	0.13[c]	0.25
2003–2005	29	0.10	0.15	1.00	0.22	0.40	0.13	0.34
2006–2008	24	0.10	0.14	0.19	0.18	0.34	0.13	0.18
2009–2011	26	0.00	0.21	0.21	0.18	0.17	0.34	0.19

(a) Data in this table from periods prior to 2006–2010 are based on historical reports and occasionally do not align.

(b) Directly age-standardised to the Australian female population aged 15–44 at 30 June 2001.

(c) Includes 1 woman aged over 44.

Notes

1. Rates expressed per 100,000 female population.
2. Table does not include 2012 data because triennium data are incomplete.

Table 3.7: Age-specific and age-standardised maternal mortality rates: indirect maternal deaths, Australia, 1973–2011

Triennium	Indirect deaths[a]	15–19 years	20–24 years	25–29 years	30–34 years	35–39 years	40–44 years	Age-standardised rate[b]
1973–1975	30	0.06	0.42	0.57	0.31	0.53	0.19	0.35
1976–1978	35	0.11	0.64	0.53	0.27	0.25	0.46	0.37
1979–1981	34	0.17	0.39	0.65	0.36	0.30	0.09	0.33
1982–1984	25	0.11	0.27	0.34	0.29	0.32	0.00	0.22
1985–1987	30	0.30	0.20	0.75	0.16	0.11	0.00	0.25
1988–1990	33	0.05	0.20	0.52	0.54	0.26	0.06	0.27
1991–1993	21	0.15	0.09	0.24	0.32	0.15	0.05	0.17
1994–1996	20	0.00	0.10	0.19	0.55	0.09	0.00	0.16
1997–1999	28[c]	0.16	0.05	0.41	0.37	0.27	0.05	0.22
2000–2002	52	0.15	0.26	0.75	0.90	0.22	0.13	0.41
2003–2005	36	0.15	0.24	0.34	0.48	0.31	0.13	0.28
2006–2008	35[d]	0.10	0.41	0.19	0.36	0.34	0.17	0.26
2009–2011	36	0.09	0.26	0.21	0.53	0.37	0.09	0.26

(a) Data in this table from periods prior to 2006–2010 are based on historical reports and occasionally do not align.

(b) Directly age-standardised to the Australian female population aged 15–44 at 30 June 2001.

(c) Data do not include 2 indirect deaths in the 1997–1999 triennium that were notified or amended after the 1997–1999 report was published.

(d) Includes 1 woman aged over 44.

Notes

1. Rates expressed per 100,000 female population.
2. Table does not include 2012 data because triennium data are incomplete.

Table 3.8 shows the maternal deaths by age and parity. During the period 2008–2012, 62 of the women (59%) who died had between 1 and 3 previous pregnancies resulting in a birth. Eight (8%) of the women who died were of higher parity.

Table 3.8: Maternal deaths by parity and age group, Australia, 2008–2012

Age group (years)	Parity (number)						
	0	1	2	3	≥4	Not stated	Total
<25	6	5	4	1	0	3	19
25–29	6	8	4	3	2	0	23
30–34	9	3	4	1	0	3	20
35–39	4	7	9	5	2	2	29
≥40	1	4	3	1	4	0	13
Total[(a)]	**27**	**27**	**24**	**11**	**8**	**8**	**105**

(a) Includes 1 woman of unknown age group.

Demographics of the women who died

Table 3.9 shows a number of demographic characteristics and the utilisation of antenatal care of the 105 women who died as a direct or indirect consequence of pregnancy. The table is stratified by the Indigenous status of the woman. Eight of the women were known to be Aboriginal and Torres Strait Islanders, 79 were known to be non-Indigenous and the Indigenous status of the woman was not known in 18 cases. Forty-two of the women (40%) who died were aged 35 or over. Sixteen of the women (16%) were overweight, with a BMI between 25 and 29.9, and 19 (19%) of the women were obese, with a BMI of 30.0 or more. Nineteen of the 61 women (31%) for whom smoking status was available, smoked during pregnancy, and 8 of the 32 women (25%) for whom alcohol status was known consumed alcohol during their pregnancy.

Overall, the data available to NMMAC regarding the characteristics of women was poor (e.g. alcohol consumption information was not available for 77% of the women) and it is difficult to draw valid conclusions about these possible risk factors for maternal death.

Table 3.9: Characteristics of women who had direct and indirect maternal deaths, Australia, 2008–2012

	Aboriginal and Torres Strait Islander women	Non-Indigenous women	Unknown status	Total
Maternal age				
Under 20	1	2	2	5
20–24	4	9	1	14
25–29	0	19	4	23
30–34	0	19	1	20
35–39	1	21	7	29
40 or over	2	9	2	13
Not stated	0	0	1	1
Total	**8**	**79**	**18**	**105**
Maternal BMI[(a)] at first antenatal visit				
Less than 18.5	0	1	0	1
18.5–24.9	2	12	0	14
25–29.9	1	12	3	16
30 or more	2	14	3	19
Not stated	3	40	12	55
Total	**8**	**79**	**18**	**105**
Smoking status during pregnancy				
Smoked	3	13	3	19
Did not smoke	1	35	6	42
Not stated	4	31	9	44
Total	**8**	**79**	**18**	**105**
Alcohol consumption status				
Alcohol consumed	2	4	2	8
Alcohol not consumed	1	19	4	24
Not stated	5	56	12	73
Total	**8**	**79**	**18**	**105**
Antenatal care				
0–2 antenatal visits	1	6	2	9
3–5 antenatal visits	5	33	9	47
Not stated	2	40	7	49
Total	**8**	**79**	**18**	**105**

(a) kg/m^2.

Note: Three maternal deaths were not able to be classified due to insufficient information being available.

Country of birth

Table 3.10 shows the country of birth for the women who died. The majority (71.5%) were born in Australia. Nine of the women not born in Australia (whose country of birth was known) were born in New Zealand and 12 were born in the Asia-Pacific region.

Table 3.10: Maternal deaths by country of birth, Australia, 2008–2012

	Total number of women who gave birth	Percentage of total number of women who gave birth	Number of maternal deaths	MMR
Australia	1,062,483	71.5	64	6.0
Other	415,274	27.9	26	6.3
Unknown	8,353	0.6	15	. .
Total	**1,486,110**	**100.0**	**105**	**7.1**

Mode of birth

Forty-three of the women (40.9%) who died had given birth by caesarean section, 20 (19.0%) had given birth by an unassisted normal vaginal birth and 8 (7.6%) had given birth by an assisted vaginal birth (forceps or vacuum assisted birth). The baby was unborn at the time of the woman's death in 15 cases (14.3%) and the birth method was not stated for 17 women (16.2%)(Table 3.11).

Table 3.11: Maternal deaths by type of death and mode of birth, Australia, 2008–2012

	Type of death			
Mode of birth	Direct	Indirect	Maternal death not further classified	Total
Unassisted normal vaginal birth	10	8	2	20
Assisted vaginal birth[(a)]	4	4	0	8
Caesarean section birth	22	21	0	43
Baby not born	4	10	1	15
Not stated	9	8	0	17
Total	**49**	**53**[(b)]	**3**	**105**

(a) Forceps or vacuum extraction-assisted vaginal births.

(b) Total includes 2 fetal retrievals.

Table 3.12 shows the urgency with which caesarean section was performed in the 43 women who died and who had a caesarean section birth. Eighteen of these caesarean sections (42%) were performed in response to an immediate threat to life of the mother or baby, while 15 (35%) were performed with no immediate threat to the life or health of the mother or baby. Three caesarean sections (7%) were perimortem operations. There was limited information available regarding the indication for a number of these caesarean sections.

Table 3.12: Maternal deaths by type of death and urgency of caesarean section, Australia, 2008–2012

	Type of death		
Urgency of caesarean section	**Direct**	**Indirect**	**Total**
Immediate threat to life of mother or baby	10	8	18
Maternal or fetal compromise with no immediate threat to life	6	4	10
No maternal or fetal compromise but needs early delivery	0	1	1
Delivery timed to suit woman or staff	3	1	4
Peri- or postmortem	0	3	3
Not stated	3	4	7
Total	**22**	**21**	**43**

Where women died

Sixty-nine of the women died in a hospital. Thirty-eight of these women died a direct death and 31 women died an indirect death or a death not further classified (Table 3.13). Sixty-two per cent of these women died in an intensive care or operating theatre setting, with a further 12% dying in an emergency department. There were no deaths in high-dependency or coronary care settings.

Table 3.13: In-hospital maternal deaths by location and setting of death in hospital and type of death, Australia, 2008–2012

	Number	Direct (%)	Indirect (%)	Maternal death not further classified (%)	Percentage of total hospital deaths (%)
Maternity setting	3	33.3	33.3	33.3	4.3
Intensive care unit	31	67.7	29.0	3.2	44.9
Emergency department	8	37.5	62.5	0.0	11.6
Mental health unit	2	0.0	100.0	0.0	2.9
Operating theatre	12	75.0	25.0	0.0	17.4
Other	4	25.0	75.0	0.0	5.8
Unknown	9	33.3	66.7	0.0	13.0
Total	**69**	**55.1**	**42.0**	**2.9**	**100.0**

Baby outcomes among maternal deaths

Birth outcomes on 78 (74.3%) cases were available. Where data were available, 21% of babies were stillborn (Table 3.14).

Table 3.14: Maternal deaths by baby outcome, Australia, 2008–2012

	Type of death			
	Direct	Indirect	Maternal death not further classified	Total
Live birth	31	30	1	62
Stillbirth	6	9	1	16
Not stated	12	14	1	27
Total	**49**	**53**	**3**	**105**

Incidence of autopsy

Three-quarters of the women who died (76%) were the subjects of autopsy (Table 3.15). The NMMAC strongly suggests that all maternal deaths should be reported to the relevant Coroner and autopsy should be advocated where the cause of death is not clearly known. There were several deaths where a presumptive diagnosis was not confirmed by autopsy. Presumptive diagnoses of cause of death may not be correct (e.g. amniotic fluid embolism versus pulmonary thromboembolism).

Table 3.15: Maternal deaths by performance of autopsy, Australia, 2008–2012

	Type of death			
	Direct	Indirect	Maternal death not further classified	Total
Autopsy performed	36	41	3	80
Autopsy not performed	13	8	0	21
Not stated	0	4	0	4
Total	**49**	**53**	**3**	**105**

Good practice guidance

- Autopsy should be advocated for all maternal deaths where the cause of death is not clearly known.

Source: NMMAC.

3.5 Avoidability

The presence or absence of avoidable factors was assessed in 80% of the 135 direct, indirect, unclassified and incidental maternal deaths (Table 3.16). This assessment was variably made by STMMC, root cause analyses (RCAs) and Coroners. Avoidability assessment was not available in 20% of deaths, due to legislation in some jurisdictions preventing provision of such information to the NMMAC and inactivity of individual STMMCs for some periods. Eighty-three per cent of the potentially avoidable factors were related to the provision of health care and 17% were related to the pregnant woman.

Table 3.16: Assessment of avoidability of maternal deaths, Australia, 2008–2012

Avoidability assessment	Avoidability detail	Total
Potentially avoidable factors identified	**Factors related to health-care provision**	
	Clinician operator error	3
	Delay in accessing specialist assistance	1
	Delayed diagnosis and transfer	7
	Delayed emergency response by staff	4
	Failure to follow recommended best practice	7
	Failure to maintain adequate airway and ventilation post-operatively	1
	Failure to recognise deteriorating patient condition	1
	Inadequate communication between health services	4
	Inadequate education and training of staff	1
	Inadequate mental health care in pregnancy	1
	Inadequate resuscitation	1
	Inadequate screening for appropriate risk factors	2
	Inadequate treatment and supervision of pre-eclampsia	1
	Inappropriate care setting for level of clinical risk	1
	Lack of an appropriate patient care plan	3[(a)]
	Factors related to the pregnant woman	
	Driver error and failure to wear seatbelt	1
	Failure to wear seatbelt	1
	Excessive stimulant use by the woman	1
	Inadequate maternal engagement with appropriate health care	4
	Patient refusal of blood products	1[(a)]
No avoidable factors identified	–	63
Avoidability not assessed	–	27
Total		**136**[(a)]

(a) Two factors present in 1 woman.

3.6 International comparisons

In 2014, the World Health Organization (WHO) estimated that globally there were 289,000 maternal deaths in 2013 (WHO 2014). The estimated global MMR in 2013 was 210 maternal deaths per 100,000 live births. The sub-Saharan Africa region alone accounted for 62% (179,000) of global deaths, followed by southern Asia at 24%. Almost one-third of all global maternal deaths occurred in India (50,000 deaths, 17%) and Nigeria (40,000 deaths, 14%). The rounded MMR of individual countries varied between 1,000 per 100,000 women who gave birth in Sierra Leone and 1 per 100,000 women who gave birth in Belarus and 2 per 100,000 women who gave birth in Israel.

Compared with the 5-year MMR of 7.1 deaths per 100,000 women who gave birth in Australia in 2008–2012, the 3-year rolling MMR reported from New Zealand in the years 2010–2012 was 14.7 per 100,000 maternities with a decline from 18.2 per 100,000 maternities in 2006–2008 (PMMRC 2012). The United Kingdom reported an MMR of 11.4 per 100,000 maternities in 2006–2008 (Cantwell et al. 2011) and 10.1 per 100,000 maternities in 2009–2011 (Knight et al. 2014). The MMR in the United States of America was reported to be 16.0 per 100,000 live births for the period 2006–2010 (Creanga et al. 2015), and has risen from 9.1 per 100,000 in 1987–1990 (CDC 2014). In comparing the MMR from individual countries, it is important to be aware of differences in ascertainment and application of definitions.

4 Direct and indirect maternal deaths

This chapter reviews direct and indirect maternal deaths by grouped causes of death, presented in order of frequency of the conditions that caused the death. For each of the grouped causes of death presented in this chapter, a standard set of information is provided. This includes an introduction to the topic, where available an introduction to morbidity data for the same condition, an overview of the information on the women who died along with incidence, demographic and morbidity information associated with the condition, and good practice guidance to highlight areas of clinical relevance that have been selected by relevant experts in the field of perinatal health.

The small number of deaths in a number of the sections limits the interpretation of the data, and caution should be used when interpreting these results.

4.1 Cardiovascular

Cardiovascular disease-related maternal mortality

Cardiovascular disease is the leading cause of death generally and the most common cause of death during pregnancy in industrialised countries. Pregnancy may unmask previously undiagnosed cardiovascular disease, due to the physiological changes that occur, including increased cardiac output related to increased blood volume and increased heart rate, and peripheral vasodilation with decreased systemic vascular resistance.

Improved diagnosis and management of congenital heart disease has increased the number of women with pre-existing congenital heart disease surviving into adulthood and embarking on pregnancies (Bowater & Thorne 2010; Simpson 2012). Women are giving birth at older ages, with 22.4% of women who gave birth in 2012 being over the age of 35, and 4.3% being over 40 (Hilder et al. 2014). Older mothers have higher rates of diabetes, hypertension, obesity, hyperlipidaemia and metabolic syndrome, concurrently adding to the population of pregnant women with acquired heart disease.

Rheumatic heart disease (RHD) is a rare condition with high morbidity and mortality. The increased cardiac demands of pregnancy are often accompanied by the appearance of cardiac symptoms in those with RHD, even if they have been well and without symptoms before pregnancy. Although cases of RHD have mostly disappeared in Australia, Aboriginal and Torres Strait Islander women have among the highest documented rates of RHD in the world (AIHW 2004). The AMOSS (2013) commenced a national study of RHD in pregnancy in 2012. This study aims to provide an evidence base to improve clinical care and associated maternal and perinatal outcomes for women with RHD in pregnancy.

Deaths from cardiac disease in 2008–2012

There were 16 indirect maternal deaths from cardiac-related causes between 2008 and 2012, making cardiovascular disease the most common cause of maternal death for this period (along with psychosocial deaths). The maternal mortality ratio (MMR) for cardiac-related deaths for 2008–2012 was 1.1 per 100,000 women who gave births, compared with 1.0 in 2006–2010 and 1.7 in 2003–2005 (Table 4.1).

The mortality rate for cardiovascular disease in Australia in 2008–2012 is of a similar order to the United Kingdom in 2010–2012 (MMR 2.25 cardiac deaths per 100,000 women who gave birth to 1 or more live or stillborn infants at 24 weeks or more gestation) (Knight et al. 2014).

Table 4.1: Maternal deaths from cardiovascular disease, Australia, 2000–2012

	Number	Maternal mortality ratio[(a)]
2000–2002	12	1.6
2003–2005	13	1.7
2006–2010[(b)]	15	1.0
2008–2012[(b)]	16	1.1

(a) Per 100,000 women who gave birth.

(b) 2008–2012 and 2006–2010 are 5-year periods; previously 3-year reporting periods were used.

Table 4.2 compares the causes of maternal deaths due to cardiovascular disease between 2008 and 2012 with the previous 3 reporting periods.

In 2008–2012, there were 4 deaths due to dissection of the aorta, 4 due to cardiomyopathy and 2 due to myocardial infarction. There were 2 deaths from other cardiac causes: 1 from acute bacterial endocarditis and 1 from Takayasu arteritis. There were 2 other deaths where the cause of death could not be determined, but a cardiac cause was likely.

Table 4.2: Maternal deaths due to cardiovascular disease by cause, Australia, 2000–2012

Cause of death	2000–2002	2003–2005	2006–2010[(a)]	2008–2012[(a)]
Myocardial infarction	2	. .	2	2
Atherosclerosis	1	. .	2	. .
Congenital heart disease	3	3	3	. .
Aortic dissection	2	3	3	4
Cardiac failure	2	1	1	1
Peripartum cardiomyopathy	1	1	. .	4
Primary pulmonary hypertension diagnosed at autopsy	. .	1	. .	. .
Hypertensive heart disease	. .	. .	. .	1
Takayasu arteritis	. .	. .	1	1
Endocarditis			1	1
Undetermined	. .	1	2	2
Total	**11**	**10**	**15**	**16**

(a) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Table 4.3 shows the cause of death, age group, parity and timing of death for the 16 women who died from cardiovascular causes. The gestational timing of the deaths ranged across all 3 trimesters of pregnancy, with more occurring in the third trimester and postpartum period. Eight of the 12 women were aged 30 or over. Of the 16 women who died, 1 died in early pregnancy, 2 died during the antepartum period, 3 died intrapartum and 10 died postpartum.

Table 4.3: Maternal deaths due to cardiovascular disease, Australia, 2008–2012

Cause of death	Maternal age group	Parity[a]	BMI[b]	Smoking status	Indigenous status	Timing of death
Myocardial infarction	35–39	N	33.4	Did not smoke	Non-Indigenous	Postpartum
Myocardial infarction	≥40	M	35.0	Did not smoke	Non-Indigenous	Antepartum
Aortic dissection	25–29	N	26.5	Did not smoke	Non-Indigenous	Intrapartum
Aortic dissection	30–34	N	26.5	Did not smoke	Non-Indigenous	Postpartum
Aortic dissection	35–39	N	34.0	Not stated	Non-Indigenous	Postpartum
Aortic dissection	30–34	N	17.0	Did not smoke	Non-Indigenous	Antepartum
Cardiomyopathy	30–34	M	42.8	Not stated	Non-Indigenous	Postpartum
Cardiomyopathy	20–24	M	32.9	Did not smoke	Indigenous	Postpartum
Cardiomyopathy	30–34	M	Not stated	Not stated	Non-Indigenous	Postpartum
Cardiomyopathy and congenital heart disease	25–29	M	Not stated	Not stated	Non-Indigenous	Postpartum
Hypertensive and arrhythmic heart disease	35–39	N	Not stated	Did not smoke	Non-Indigenous	Postpartum
Left ventricular failure of uncertain cause	30–34	N	Not stated	Did not smoke	Non-Indigenous	Intrapartum
Infective endocarditis	20–24	N	19.7	Smoked	Indigenous	Early pregnancy
Intracerebral haemorrhage	30–34	N	19.0	Did not smoke	Non-Indigenous	Postpartum
Undetermined	35–39	M	Not stated	Not stated	Non-Indigenous	Intrapartum
Undetermined	35–39	M	Not stated	Not stated	Non-Indigenous	Postpartum

(a) Parity is denoted by the following abbreviations: N = nullipara; M = multipara.

(b) BMI = body mass index.

The NMMAC noted that early multidisciplinary care, including cardiology referral, is recommended for pregnant women with cardiac disease. Limited details on the pregnancy for the women discussed here were available and it is not known whether they were referred for specialist care early in pregnancy.

For the 16 women who died of cardiovascular disease, comorbidities and lifestyle factors such as BMI, smoking status, hypertension and diabetes were not reported to the NPESU in a significant proportion of cases; therefore, such data are not able to be presented in this report.

Fifteen of the 16 women who died were referred to the Coroner and 14 had an autopsy. Autopsy allows clarification of the cause of death because numerous medical conditions may present with similar symptoms. There are also a number of cardiac diseases causing sudden cardiac death with a genetic basis that may have implications for family members.

Good practice guidance

- Autopsy should be advocated where the cause of a maternal death may be cardiac-related

Source: NMMAC.

Ischaemic heart disease

There were 2 deaths in late pregnancy due to myocardial infarction. Both the women were aged over 35 and were obese. One had the known risk factors for cardiovascular disease of hypertension and diabetes mellitus.

There was 1 death, which is reported in 'Section 4.5 Sepsis', where a known background of ischaemic heart disease contributed to the death of a woman with H1N1 influenza.

Aortic dissection

There were 4 deaths from aortic dissections in ruptured aortic aneurysms. One occurred in the second trimester of pregnancy, 1 early in the third trimester and the other 2 at term. The women who died were aged between 26 and 36.

Case summary

A primigravida at 37 weeks gestation had epigastric and chest discomfort, which she interpreted as gastro-oesophageal reflux and self-treated with antacids. Two days later she attended an emergency department with severe chest pain. During chest X-ray, she collapsed and was found to be pulseless. She did not survive despite cardiopulmonary resuscitation and perimortem caesarean section. Autopsy revealed a ruptured aortic dissection. There were no potentially avoidable factors found.

Cardiomyopathy

Four women died as a consequence of cardiomyopathy. All 4 women were non-Indigenous and aged under 35, and 2 were known to be significantly obese. Significant comorbidities were present in 3 of the women.

One woman had corrected tetralogy of Fallot. A health practitioner who did not regularly participate in antenatal care saw her for pregnancy care and, despite episodes of shortness of breath, there was no plan to refer her to a maternity service for care or to a cardiologist until she entered the third trimester of pregnancy.

Other deaths

There was 1 death from infective endocarditis complicating ischaemic heart disease and 1 from the sequelae of Takayasu arteritis. The 2 deaths from undetermined causes were sudden unexpected deaths. Both of these cases were reviewed by the Coroner and were

determined to be due to suspected 'cardiac causes', although the exact cause of death could not be determined.

Preconception assessment and counselling

Women with known heart disease should be properly assessed preconception. For those with congenital heart disease, discussions around pregnancy should be carried out at the onset of menarche and before pregnancy is planned. Counselling should be offered that includes discussion and advice on appropriate methods of contraception. It is unknown whether this occurred for the women whose deaths are presented in this chapter.

Summary

Cardiovascular disease represented 1 of the 2 largest causal groups of maternal deaths, along with psychosocial deaths, between 2008 and 2012 in Australia, and accounted for 15.2% of maternal deaths overall and 28.3% of indirect deaths. The risk of death due to cardiovascular disease is likely to rise with increases in cardiovascular risk factors including smoking, increasing maternal age, obesity, diabetes and hypertension. An increasing number of women with acquired cardiac disease, such as ischaemic heart disease, and with known congenital heart disease are embarking on pregnancies.

Clinicians caring for pregnant women need to be aware of the increasing burden of cardiovascular disease in Australia. Consideration needs to be given to pre-existing or new-onset heart disease in pregnant women who present with cardiovascular symptoms, and these patients should be referred for appropriate and timely cardiovascular investigation and management. This management may involve referral to a multidisciplinary tertiary hospital where there is expertise in the management of cardiac disease occurring in pregnancy (RANZCOG 2014a; RCOG 2011).

Good practice guidance

- Women with known cardiovascular disease should have access to pre-pregnancy counselling. This should ideally be offered at the onset of menarche and should include appropriate contraceptive advice.
- All women with high-risk pregnancies due to cardiovascular disease should be referred to appropriate multidisciplinary tertiary services that provide access to cardiac investigations and cardiologists and/or physicians with expertise in this area.
- Women with severe chest or abdominal pain must be investigated with appropriate thoracic or abdominal imaging.

Source: NMMAC.

4.2 Psychosocial

Severe psychosocial maternal mortality

Up to 9.0% of antenatal women and up to 16.0% of postnatal women in Australia are affected by depression (Beyondblue 2008). The *Clinical practice guidelines: Depression and related disorders – anxiety, bipolar disorder and puerperal psychosis – in the perinatal period* (Beyondblue 2011; Austin et al. 2011) aim to improve the prevention and early detection of antenatal and postpartum depression, and to provide better care, support and treatment for pregnant women, new mothers and their families.

A significant proportion of maternal deaths occur among women with a previous psychiatric history (Austin et al. 2007). Evidence suggests that substance misuse and domestic violence often complicate deaths related to psychiatric illness, and in a minority can be the primary cause (Austin et al. 2007; Oates 2003).

Classifying maternal deaths associated with psychosocial morbidity

In Australia, each maternal death undergoes a thorough process of review and investigation in the form of a confidential death enquiry. As part of this process, there is the opportunity to reliably examine the circumstances surrounding each death on an individual basis and determine previous psychosocial morbidity.

Since the 1997–1999 triennium, *Maternal Deaths in Australia* reports have classified deaths among women with a pre-existing psychiatric illness or psychiatric illness that developed during pregnancy and was not due to direct obstetric causes as indirect, and deaths deemed unrelated to the pregnancy due to 'external causes' as incidental.

As discussed in Chapter 2, the NMMAC modified the classification methodologies for psychosocial deaths in late 2012. Maternal suicides in the specific setting of first-recognised onset of pregnancy-related psychiatric morbidity in the current pregnancy are to be classified as direct deaths. All other maternal suicides and psychosocial deaths due to causes such as substance abuse and homicide in a domestic violence setting would be classified as indirect deaths.

Because this decision occurred at the end of the period covered by this report, most of the deaths were classified by the relevant STMMC using the previous classification methodologies.

Deaths from psychosocial causes in 2008–2012

For this report, the term 'psychosocial causes' describes deaths in which a psychiatric condition contributed to the cause of death, and encompasses the wider issues of domestic violence and substance misuse.

Psychosocial morbidity, along with cardiovascular disease, was a leading cause of maternal death in Australia. There were 16 maternal deaths from causes related to psychosocial morbidity between 2008 and 2012. The MMR due to psychosocial morbidity has remained stable, ranging from 0.9 deaths per 100,000 women who gave birth in 2006–2010 to 1.2 deaths per 100,000 women who gave birth in 2003–2005 and in 2000–2002. In 2008–2012, the MMR

due to psychosocial morbidity was 1.1 deaths per 100,000 women who gave birth (Table 4.4). Australian maternal death reports prior to 2006–2010 used the term 'psychiatric deaths'.

Prior to 1997, deaths from psychiatric causes, apart from puerperal psychosis, were classified as incidental deaths, so comparisons with triennia prior to 1997 must be undertaken with caution.

If the World Health Organization (WHO) recommendation that all maternal suicide deaths be classified as direct maternal deaths (Pattinson et al. 2009; WHO 2012) was used, 12 of the 16 psychosocial deaths would be classified as direct deaths (rather than 1 death as classified by the relevant STMMC). This would have the effect of increasing the direct MMR (all causes) for this period from 3.3 per 100,000 women who gave birth to 4.0 per 100,000 women who gave birth, and decreasing the indirect MMR from 3.6 per 100,000 women who gave birth to 2.8 per 100,000 women who gave birth. The total MMR would remain unchanged at 7.1 per 100,000 women who gave birth.

Table 4.4: Maternal deaths related to psychosocial morbidity, Australia, 2000–2012

Reporting period	Number	Maternal mortality ratio[(a)]
2000–2002	9	1.2
2003–2005	9	1.2
2006–2010[(a)]	13	0.9
2008–2012[(a)]	16	1.1

(a) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Of the 16 women who died from causes related to psychosocial morbidity between 2008 and 2012, 12 committed suicide, 2 were murdered, 1 was a known substance user who overdosed on illicit drugs with unknown intent and 1 had an adverse reaction to psychotropic medication (Table 4.5).

Table 4.5: Maternal deaths due to psychosocial morbidity by cause, Australia, 2000–2012

Cause of death	2000–2002	2003–2005	2006–2010[(a)]	2008–2012[(a)]
Suicide	7	4	9	12
Homicide	. .	3[(b)]	2	2
Overdose	1	2	2	1
Other	1	. .	. .	1
Total	**9**	**6**	**13**	**16**

(a) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

(b) Deaths due to homicide were previously reported in the 'other category' and not 'psychiatric deaths'.

Table 4.6 gives a summary of the women who died from causes associated with psychosocial morbidity in Australia between 2008 and 2010.

Of the 12 women who committed suicide, 6 committed suicide by hanging and 4 took a drug overdose. The method of suicide for 2 women was not stipulated. The women who died were aged between 18 and 40. Three of the women died while they were pregnant and 6 women died in the postnatal period. Two of the women who died in association with early pregnancy committed suicide after a termination of pregnancy; the indications for

termination of pregnancy are not known. Two of the 12 women who died by suicide were Aboriginal women.

Two women were murdered; the circumstances of these deaths are not stated. One woman was a known intravenous substance abuser and she died of multiple drug toxicity. One woman was given Diazepam for anxiety in an emergency setting and collapsed shortly afterwards.

Table 4.6: Maternal deaths due to psychosocial causes in Australia, 2008–2012

Cause of death	Timing of death	Indigenous status	Maternal age group	Prior mental health illness	Known mental health contact	Receiving mental health treatment perinatally
Suicide	Postpartum	Indigenous	20–24	Not stated	No	No
Suicide	Postpartum	Non-Indigenous	30–34	Known but not specified	Yes	Yes
Suicide	Antepartum	Non-Indigenous	20–24	Depression	No	No
Suicide	Postpartum	Non-Indigenous	25–29	Known but not specified	Yes	Yes
Suicide	Early pregnancy	Not stated	30–34	Not stated	No	No
Suicide	Early pregnancy	Non-Indigenous	30–34	Known but not specified	No	No
Suicide	Postpartum	Non-Indigenous	35–39	Anxiety and depression	No	No
Suicide	Early pregnancy	Not stated	20–24	Not stated	No	No
Suicide	Early pregnancy	Non-Indigenous	<20	Not stated	No	No
Suicide	Antepartum	Indigenous	<20	Anxiety and depression	Yes	Yes
Suicide	Postpartum	Non-Indigenous	25–29	Not stated	Not stated	Not stated
Suicide	Postpartum	Non-Indigenous	35–39	Not stated	Yes	Yes
Adverse medication reaction	Postpartum	Non-Indigenous	25–29	Anxiety and depression	Yes	Yes
Multiple drug toxicity	Antepartum	Not stated	<20	Depression	No	No
Homicide	Postpartum	Non-Indigenous	20–24	Not stated	No	No
Homicide	Postpartum	Indigenous	35–39	Not stated	Not stated	Not stated

Eight of the women who committed suicide were known to have a prior mental health illness. Austin et al. (2007) suggest 'that such deaths may have been avoided if there had been adequate monitoring of the women's mental health status'. Five of these 8 women had a known mental health contact and were receiving mental health treatment.

Case summary

A multiparous woman was known to have mental health issues during the antenatal period and was under the care of a mental health liaison service. She took an overdose of her psychotropic medication 2 weeks postpartum. Review of this death considered that there was inadequate mental health care during the pregnancy and postpartum follow-up after discharge from the maternity unit was inadequate.

Case summary

A young woman sought a termination of pregnancy via a private service provider sited a long distance from her home. A counsellor confirmed that she was making a clear decision to terminate her pregnancy, and that the underlying reason for this request was that she did not wish for children at that time in her life. Termination of pregnancy was performed on the grounds of 'psychosocial emotional wellbeing'. There was no agreed follow-up plan by any health-care provider. A relationship breakdown subsequently occurred and she committed suicide 3 weeks after the procedure. Review of this death concluded that there was inadequate attention paid to post-termination follow-up.

Summary

Psychosocial morbidity is a leading cause of maternal death in Australia. Except for maternal suicide following first recognised onset of pregnancy-related psychiatric morbidity (i.e. puerperal psychosis and postnatal depression), the NMMAC has classified maternal deaths due to psychosocial causes as indirect deaths. The high proportion of deaths occurring in women with a known psychiatric history highlights the importance of antenatal and postnatal mental health screening. The adoption of antenatal psychosocial screening and guidelines for the management of psychiatric illnesses in the perinatal period are timely initiatives in preventing maternal deaths related to psychosocial morbidity.

Good practice guidance

- The antenatal period presents an opportunity to assess and monitor women's psychosocial wellbeing and provide access to appropriate mental health services.

Source: NMMAC.

4.3 Obstetric haemorrhage

Obstetric haemorrhage-related maternal mortality

Recent Australian reports indicate that severe postpartum haemorrhage (PPH) and its associated morbidity are increasing in incidence (Roberts et al. 2009), with international data suggesting that increases in uterine atony are involved in many of these instances (Callaghan et al. 2008).

The risk of peripartum hysterectomy associated with morbidly adherent placentation has also risen in recent decades, in association with the increasing caesarean section rate. The UKOSS study, undertaken between February 2005 and February 2006, estimated that the incidence of peripartum hysterectomy to control haemorrhage was 4.1 per 10,000 women who gave birth to 1 or more live or stillborn infants at 24 weeks gestation or above (95% CI 3.6–4.5 per 10,000 women giving birth). Peripartum hysterectomy was strongly associated with previous caesarean section birth, and the risk rose with the increasing number of previous caesarean births, maternal age over 35 and parity greater than 3 (Knight et al. 2008). In 2011, there were 95,894 caesarean sections performed in Australia, or 32.4% of all births (Hilder et al. 2014), and the incidence of caesarean section birth has been increasing steadily for some years.

An AMOSS study, described at <http://www.amoss.com.au/page.php?id=49>, has examined massive obstetric haemorrhage events and publication of the outcomes is awaited.

Deaths from obstetric haemorrhage in 2008–2012

Obstetric haemorrhage remains a major cause of maternal death in Australia and worldwide. It encompasses both antepartum and postpartum bleeding and can be defined as bleeding from the genital tract with an estimated blood loss of >500 mL, with blood loss of >1,000 mL or a blood loss that causes clinical signs of shock. Because obstetric blood loss is difficult to quantify, clinical signs of shock were recommended by RCOG as an addition to the volumetric definition (RCOG 2009b). Other non-obstetric causes of major bleeding (such as splenic artery aneurysm rupture) may also occur during pregnancy and the postpartum period, and these are reported in 'Section 4.4 Non-obstetric haemorrhage'.

There were 12 deaths due to obstetric haemorrhage between 2008 and 2012, giving an MMR of 0.8 per 100,000 women who gave birth (Table 4.7). Eleven (11) of these deaths were classified as direct maternal deaths and 1 as an indirect maternal death because it occurred following blunt trauma to the abdomen.

Obstetric haemorrhage continues to be an important cause of maternal mortality, ranking in the top 4 causes of direct death in Australia since 1997 (AIHW et al. 2007). For this reporting period, it is the third most common cause of maternal death, behind cardiovascular and psychosocial deaths and the most common direct cause of maternal death. Table 4.7 shows the MMR for deaths due to obstetric haemorrhage for the last 4 reporting periods.

Table 4.7: Maternal deaths from obstetric haemorrhage, Australia, 2000–2012

Reporting period	Number	Maternal mortality ratio[(a)]
2000–2002	9	1.2
2003–2005	4	0.5
2006–2010[(b)]	8	0.6
2008–2012[(b)]	12	0.8

(a) Per 100,000 women who gave birth.

(b) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Five of the 12 deaths due to obstetric haemorrhage were related to the presence of pathological placentation (placenta accreta and/or percreta), and 5 were due to PPH (Table 4.8). One antepartum haemorrhage was related to blunt abdominal trauma.

Table 4.8: Maternal deaths due to obstetric haemorrhage by cause, Australia, 2006–2012

Cause of death	2006–2010[(a)]	2008–2012[(a)]
Postpartum haemorrhage	3	5
Intrapartum haemorrhage	1	0
Combined intrapartum and postpartum haemorrhage	1	1
Placenta percreta/accreta	2	5
Traumatic placental laceration and haemorrhage	1	1
Total	**8**	**12**

(a) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

The women who died of obstetric haemorrhage were aged from 23 to 50, with 5 of the twelve aged 35 or over. Two had spontaneous normal vaginal births, 7 gave birth by caesarean section and 1 had a forceps-assisted vaginal birth. Two of the women had not given birth at the time of their death.

Table 4.9 shows details of the women who died from obstetric haemorrhage including age group, parity, BMI, smoking status, Indigenous status and timing of death in 2008–2012.

Table 4.9: Maternal deaths due to obstetric haemorrhage, Australia, 2008–2012

Cause of death	Maternal age group	Parity[(a)]	BMI[(b)]	Smoking status	Indigenous status	Timing of death
Placenta accreta	20–24	M	39.8	Did not smoke	Non-Indigenous	Postpartum
Placenta praevia/percreta	35–39	GM	28.7	Smoked	Not stated	Postpartum
Placenta accreta/percreta	20–24	M	Not stated	Did not smoke	Non-Indigenous	Antepartum
Placenta accreta/percreta	35–39	M	21.5	Did not smoke	Non-Indigenous	Postpartum
Placenta accreta/percreta	20–24	M	28.1	Did not smoke	Non-Indigenous	Postpartum
Postpartum haemorrhage	30–34	M	21.5	Not stated	Non-Indigenous	Postpartum
Postpartum haemorrhage	30–34	N	Not stated	Did not smoke	Non-Indigenous	Postpartum
Postpartum haemorrhage	25–29	M	Not stated	Did not smoke	Not stated	Postpartum
Postpartum haemorrhage	35–39	M	22.3	Did not smoke	Non-Indigenous	Postpartum
Postpartum haemorrhage	≥40	M	27.8	Did not smoke	Non-Indigenous	Postpartum
Uterine rupture	≥40	GM	28.6	Smoked	Non-Indigenous	Postpartum
Blunt trauma to abdomen	25–29	M	32.3	Not stated	Non-Indigenous	Antepartum

(a) Parity is denoted by the following abbreviations: N = nullipara; M = multipara; GM = grand multipara.

(b) BMI = body mass index.

Postpartum haemorrhage

Four of the 5 women who died as a result of PPH were of parity greater than 2, while 1 had given birth to her first baby. In addition, the woman who had a uterine rupture in spontaneous labour died as a consequence of severe PPH.

Case summary

A 34-year-old woman who had previously given birth twice by caesarean section suffered a catastrophic postpartum haemorrhage of unknown cause in association with a repeat caesarean section, and died after a cardiac arrest in the course of management of her PPH. At a coronial inquest (DAGJ 2011), it was noted that prostaglandin F2 alpha (PGF2α) was administered to this woman in 2 intramyometrial doses of 1.5 mg very close to each other, rather than the usual recommended several small doses some minutes apart from each other with a maximum not to exceed 3 mg. Cardiac arrest occurred shortly afterwards. The Coroner highlighted the importance of taking care with administering PGF2α in the appropriate dilutions. Recommendations made by that Coroner include:

- An agreed and documented protocol for the management of postpartum haemorrhage and other obstetric emergencies should be made available to maternity service staff.
- All birth attendants should be trained in the management of postpartum haemorrhage.
- A flow chart should be freely available in the operating theatre and labour ward, and clear dosage instructions should be available in the emergency box for the use of PGF2α, especially as this is a drug that is used infrequently and with which staff may not be completely familiar.
- A laminated diagram showing how to insert a uterine compression suture should be available in the operating theatre.

Good practice guidance

- All hospitals with maternity services should have clear guidance regarding the use of prostaglandin F2 alpha (PGF2α), which should be freely available in the operating theatre and birth suite.

Sources: NMMAC; DAGJ 2011.

Case summary

A woman in her 20s, with a history of caesarean section in her 1 previous birth, laboured spontaneously in a low-risk care maternity setting. After an unassisted vaginal birth of a healthy baby, she had persistent excessive primary postpartum blood loss. After several hours of various attempts to stop her PPH, the woman remained hypotensive and developed acute circulatory collapse. She was transferred to a major maternity service with access to intensive care but died 2 days later with multi-organ failure. Review found that the assessment of blood loss and recognition of PPH and subsequent management were inadequate. Delay in the first blood transfusion and delay in escalation procedures in the first 4–6 hours were thought to be pivotal to this fatal outcome.

For the most part, PPH is unpredictable and sudden, and when catastrophic may result in serious morbidity or death.

A Cochrane review showed that active management of the third stage, when compared with physiological management, decreases the risk of blood transfusion (Begley et al. 2011). A further Cochrane review showed that 'Prophylactic oxytocin at any dose used routinely after birth can reduce blood loss with fewer side effects than ergot alkaloids' (Westhoff et al. 2013). Active management includes the administration of prophylactic oxytocics and controlled cord traction (RANZCOG 2014b).

Good practice guidance

- Active management of the third stage of labour (use of prophylactic oxytocics and controlled cord traction) decreases the risk of PPH and blood transfusion and should be recommended to all women.

Sources: RANZCOG 2014b; RCOG 2009b.

Placenta accreta

Five of the women who died of obstetric haemorrhage had a morbidly adherent placenta as the underlying cause of their haemorrhage. All 5 women had had at least 1 previous caesarean section and all developed disseminated intravascular coagulopathy during the course of their terminal event.

Additionally, a woman who had a caesarean hysterectomy for a known placenta percreta, and who had Factor V Leiden deficiency, subsequently died from pulmonary thromboembolism in association with a postpartum hernia repair procedure.

Case summary

A multipara who had previously had 2 caesarean sections presented to hospital and collapsed after several hours of abdominal pain and sudden onset of shortness of breath. Prompt laparotomy revealed uterine rupture and evidence of placenta percreta and a hysterectomy was performed. She subsequently developed disseminated intravascular coagulopathy and signs of persistent intra-abdominal haemorrhage. She died shortly after a repeat laparotomy failed to find a controllable source of persistent intra-abdominal blood loss. There were no potentially avoidable factors found. Review noted that this cause of severe obstetric haemorrhage was becoming more frequent in association with the rising caesarean section rate in Australia.

Morbid adherence of the placenta to the uterine wall is a potentially life-threatening condition, and may be suspected when there is a placenta praevia in a woman with a history of caesarean section or other uterine surgery. The incidence of placenta accreta has increased with the rising caesarean section rate and increasing maternal age (RANZCOG 2014a). Accurate diagnosis antenatally may allow for appropriate planning of delivery to minimise morbidity.

The Royal Australian and New Zealand College of Obstetrics and Gynaecology (RANZCOG) has released the following statement on the management of placenta accreta (RANZCOG 2014a).

RANZCOG statement on the management of placenta accreta

- Where there is suspected or known placenta accreta, delivery should occur in a place with the necessary medical facilities and expertise to manage these high-risk cases. It is important to be cognisant of the risk of placental growth to the serosa of the uterus, and into adjacent organs such as the bladder in extreme circumstances.
- Antenatal attention to optimisation of haemoglobin and iron stores is important.
- Such facilities would include access to 'cellsaver', an ability to cope with high-volume blood transfusion, availability of other blood products (e.g. platelets, clotting factors) and appropriate specialised expertise (e.g. neonatal, senior obstetric and anaesthetic, haematological and intensive care). A multidisciplinary approach is required, including possible prior consultation with other medical specialists such as urologists, gynaecological oncologists, vascular surgeons, intensivists and interventional radiologists.
- As with all women at risk of major obstetric haemorrhage, those with suspected placenta accreta should be encouraged to remain close to the planned hospital of confinement for the duration of the third trimester of pregnancy. An emergency contingency plan is strongly recommended.
- The timing of the caesarean section should consider the desirability of performing it as an elective rather than an emergency procedure. The caesarean section should therefore usually be undertaken at an earlier gestation than for uncomplicated elective caesarean births or uncomplicated placenta praevia.

(continued)

RANZCOG statement on the management of placenta accreta (continued)

Three surgical management choices may be considered according to available expertise, geographical and individual circumstances:

1. Delivery of the baby and attempted delivery of the placenta. This is associated with a high likelihood of hysterectomy but not invariably so. If this option is chosen, the surgeon must be prepared to proceed promptly to hysterectomy if needed and the anaesthetist prepared for massive transfusion as bleeding may be considerable while the hysterectomy is being undertaken.
2. Delivery of the baby via a uterine incision distant from the placenta, quick repair of the uterus and en bloc hysterectomy.
3. Delivery of the baby via a uterine incision distant from the placenta, trimming of the cord close to insertion site, full repair of the uterus and conservative management. About two-thirds of women will avoid a hysterectomy; one-third will still require a hysterectomy because of uncontrollable bleeding, which may be delayed up to several weeks, and this approach also has a significant risk of infectious morbidity. In addition, uncertainty as to the time of onset of secondary bleeding can tax available resources. This has serious implications if the patient is returning to a remote area with little facility to cope with sudden severe haemorrhage.

Source: RANZCOG 2014b.

Summary

Obstetric haemorrhage remains a key cause of maternal mortality and severe morbidity. Identification of placentas encroaching on the lower uterine segment, especially in women who previously gave birth by caesarean section, is critical. Maternity units should have well-rehearsed protocols for team management of catastrophic obstetric haemorrhage. Active management of the third stage of labour, when compared with physiological management, decreases the risk of PPH and blood transfusion.

4.4 Non-obstetric haemorrhage

Deaths from non-obstetric haemorrhage in 2008–2012

Non-obstetric haemorrhage is defined as haemorrhage occurring from sites other than the genital tract.

There were 12 maternal deaths due to non-obstetric haemorrhage between 2008 and 2012, giving an MMR of 0.8 per 100,000 women who gave birth (Table 4.10). In previous reporting periods, there were 12 deaths due to non-genital tract haemorrhage between 2006 and 2010, 5 deaths between 2003 and 2005 and 9 deaths between 2000 and 2002 (Table 4.10).

Table 4.10: Maternal deaths from non-obstetric haemorrhage, Australia, 2000–2012

Reporting period	Number	Maternal mortality ratio[(a)]
2000–2002	9	1.2
2003–2005	5	0.6
2006–2010[(b)]	12	0.8
2008–2012[(b)]	12	0.8

(a) Per 100,000 women who gave birth.

(b) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

There were 5 deaths from ruptured splenic artery aneurysm, 5 deaths from intracranial haemorrhage and 1 each from haemorrhage from a pulmonary arteriovenous malformation and a retroperitoneal haemorrhage secondary to anticoagulation (Table 4.11).

Table 4.11: Maternal deaths due to non-obstetric haemorrhage by cause, Australia, 2006–2012

Cause of death	2006–2010[(a)]	2008–2012[(a)]
Ruptured splenic artery aneurysm	5	5
Intracranial haemorrhage	7	5
Haemorrhage from a pulmonary arteriovenous malformation	–	1
Retroperitoneal haemorrhage	–	1
Total	**12**	**12**

(a) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

The age group, parity, BMI, smoking status, Indigenous status and timing of death of the 12 women who died are shown in Table 4.12. The majority of these women were aged over 30 (9 of 12) and 4 of the 6, where BMI was known, were overweight or obese. Parity ranged from 0 to 4, and the majority of the women were postpartum at the time of death.

Table 4.12: Maternal deaths due to non-obstetric haemorrhage, Australia, 2008–2012

Cause of death	Maternal age group	Parity[a]	BMI[b]	Smoking status	Indigenous status	Timing of death
Ruptured splenic artery aneurysm	35–39	M	28.2	Smoked	Non-Indigenous	Antepartum
Ruptured splenic artery aneurysm	≥40	M	41.7	Did not smoke	Non-Indigenous	Postpartum
Ruptured splenic artery aneurysm	30–34	N	Not stated	Did not smoke	Non-Indigenous	Postpartum
Ruptured splenic artery aneurysm	25–29	M	32.4	Smoked	Non-Indigenous	Postpartum
Ruptured splenic artery aneurysm	25–29	N	32.3	Did not smoke	Non-Indigenous	Postpartum
Intracranial haemorrhage	30–34	M	Not stated	Not stated	Non-Indigenous	Antepartum
Intracranial haemorrhage	35–39	M	Not stated	Did not smoke	Non-Indigenous	Postpartum
Intracranial haemorrhage	30–34	M	19.9	Did not smoke	Non-Indigenous	Postpartum
Intracranial haemorrhage	25–29	GM	Not stated	Smoked	Non-Indigenous	Postpartum
Intracranial haemorrhage	30–34	M	Not stated	Not stated	Non-Indigenous	Postpartum
Anticoagulation and retroperitoneal haemorrhage	35–39	M	Not stated	Not stated	Not stated	Postpartum
Haemorrhage from pulmonary arteriovenous malformation	35–39	M	25.6	Did not smoke	Not stated	Antepartum

(a) Parity is denoted by the following abbreviations: N = nullipara; M = multipara; GM = grand multipara.

(b) BMI = body mass index.

Ruptured splenic artery aneurysm

Five women died as a result of rupture of a splenic artery aneurysm (Table 4.12). These women were aged between 25 and 42; 3 of 5 were parous women and 4 of the 5 were overweight or obese (BMI not stated for the fifth woman). One woman was an insulin-treated gestational diabetic.

Although possible delay in making the diagnosis was noted in 1 woman, there were no specific avoidable factors found.

Splenic artery aneurysm rupture is a rare and life-threatening condition. The majority of cases are asymptomatic until rupture, with sudden onset of abdominal pain followed by circulatory collapse. Prodromal signs of rupture, such as intermittent epigastric pain, left-side pain or chest pain radiating to the left arm do occur in some cases. Confusion in diagnosis with other common maternity emergencies such as placental abruption, uterine

rupture or amniotic fluid embolism, as well as other conditions such as pulmonary thromboembolism, cholecystitis, appendicitis or perforated peptic ulcer disease may occur. Good maternal fetal outcome can only be achieved by early diagnosis and prompt treatment. (Sadat et al. 2008; Selo-Ojeme & Welch 2003).

Good practice guidance

- Ruptured splenic artery aneurysm should be considered in the differential diagnosis of a pregnant woman with severe and unexplained abdominal pain, regardless of whether pain or shock is the most prominent feature at the time of evaluation.

Sources: NMMAC; Sadat et al. 2008.

Case summary

A multipara who had developed gestational diabetes was admitted to the maternity service with upper abdominal pain in the middle of the third trimester. There was some upper abdominal tenderness and a differential diagnosis of cholecystitis or gastro-oesophageal reflux was considered. She was given analgesia and an upper abdominal ultrasound was planned. Before that ultrasound examination appointment, she was found collapsed at home and was not able to be resuscitated. Autopsy revealed an upper abdominal collection of blood clot and a ruptured splenic artery aneurysm. There were no potentially avoidable factors found.

Intracerebral haemorrhage

Only 1 of the 5 acute intracranial haemorrhages was associated with a vascular malformation. Age at death ranged from 29 to 38 (Table 4.12) and parity ranged from 0 to 4. Four of the 5 women were postpartum when the haemorrhage occurred.

None of the haemorrhages were associated with labour. One of the women had been anticoagulated as she was known to be heterozygous for Leiden Factor V and had had thromboembolism in a previous pregnancy; 1 had post-caesarean section hypertension; and 1 haemorrhage was associated with significant substance abuse. Causative factors were not found in 2 cases. Delay in understanding the causation of symptoms was noted as potentially avoidable in 2 of the 5 cases.

The women who died either collapsed suddenly at home or presented to hospital with a headache, and in some cases other neurological symptoms, and subsequently lost consciousness.

The United Kingdom (UK) report, *Saving lives*, *improving mothers' care* noted 26 deaths from intracerebral haemorrhage between 2009 and 2012. In most of these cases, there were no significant prodromal or warning symptoms. The UK report recommends that 'Neurological examination including assessment for neck stiffness is mandatory in all new-onset headaches or headache with atypical features, particularly focal symptoms' (Knight et al. 2014).

Good practice guidance

- Neurological symptoms in pregnant women require an urgent neurological review and cerebral imaging if indicated.

Sources: NMMAC; Knight et al. 2014.

Case summary

A multipara in her late 20s had an uneventful repeat elective caesarean section at 38 weeks gestation at the end of an uneventful pregnancy. Two weeks after discharge from hospital, she complained of leg pain, but there were no abnormal clinical findings on medical review on that day. Two days later, her partner found her dead in bed. Autopsy revealed a subarachnoid haemorrhage secondary to a ruptured berry aneurysm. There were no potentially avoidable factors found.

Summary

Splenic artery aneurysm rupture most commonly occurs in multiparous women in the third trimester of pregnancy. It is a rare, but catastrophic, condition and should be included in the differential diagnosis for any pregnant women presenting with severe abdominal pain. Multidisciplinary care, specifically the involvement of a general surgeon, may improve chances of survival.

Women presenting to hospital with potentially serious neurological conditions should be investigated as a matter of urgency and appropriate imaging undertaken.

4.5 Sepsis

Sepsis-related maternal mortality

There is currently limited available information on sepsis in pregnancy.

A prospective UKOSS population-based case-control study on all severe infection in pregnancy from June 2011 to May 2012 has been undertaken to estimate the incidence of severe maternal sepsis in the UK (UKOSS 2014). The study aimed to investigate and quantify the associated risk factors, causative organisms, management and outcomes, and to explore whether any factors are associated with poor outcomes. The incidence of severe sepsis was 4.7 per 10,000 maternities, and 5 women in this study group died (Acosta et al. 2014). The study report recommended that 'Signs of severe sepsis in peripartum women, particularly with confirmed or suspected Group A streptococcal infection, should be regarded as an obstetric emergency'.

Deaths from sepsis in 2008–2012

Overall, there were 12 maternal deaths due to sepsis between 2008 and 2012, giving an MMR of 0.8 maternal deaths per 100,000 women who gave birth. This compares with an MMR of 0.7 deaths due to sepsis per 100,000 women who gave birth between 2006 and 2010, and 0.6 deaths due to sepsis per 100,000 women who gave birth between 2003 and 2005 (Table 4.13).

Table 4.13: Maternal deaths from sepsis, Australia, 2000–2012

Reporting period	Number	MMR[(a)]
2000–2002	15	2.0
2003–2005	5	0.6
2006–2010[(b)]	10	0.7
2008–2012[(b)]	12	0.8

(a) Per 100,000 women who gave birth.

(b) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

For this report, deaths due to sepsis have been grouped into obstetric and non-obstetric infections. Differences in the circumstances of each case and classification method used across jurisdictions mean that the classification of direct versus indirect varies within these groups. Table 4.14 shows the maternal deaths from 2006 to 2012 due to sepsis and the cause of these deaths.

There were 4 maternal deaths due to sepsis relating to pregnancy and its care. These women died from the following causes: endometritis, chorioamnionitis, postpartum puerperal sepsis and sepsis originating in a caesarean section wound. Three deaths from H1N1 influenza and 1 death from influenza B were caused by respiratory infections that led to maternal deaths. Four disparate other septic deaths occurred due to: pneumococcal meningitis; an acute cholecystitis and toxic shock-like syndrome; necrotising fasciitis; and acute pyelonephritis.

Table 4.14: Maternal deaths from sepsis, Australia, 2006–2012

Cause of death	2006–2010	2008–2012
H1N1 influenza and its complications	3	3
Influenza B	–	1
Endometritis/chorioamnionitis	2	2
Puerperal sepsis	2	1
Caesarean section wound sepsis	–	1
Acute cholecystitis and toxic shock-like syndrome	1	1
Pneumococcal meningitis	1	1
Lobar pneumonia	1	–
Necrotising fasciitis of leg—group A streptococcus	–	1
Acute pyelonephritis	–	1
Total	**10**	**12**

Table 4.15 shows the causes of direct and indirect maternal death from sepsis, type and site of infection, and the age group of the women who died between 2008 and 2012. The age at death ranged from 20 to 42 and parity ranged from 0 to 4. Ten of the 12 women who died were postpartum at the time of their death. Five of the women were smokers, 3 women did not smoke, and the smoking status of the remaining women was unknown. BMI was known for 6 of the women: it was over 25 kg/m^2 in all cases; the highest BMI was 53 kg/m^2.

Table 4.15: Deaths from sepsis, Australia, 2008–2012

Cause of death	Maternal age group	Parity[(a)]	BMI[(b)]	Smoking status	Indigenous status	Timing of death
H1N1 Influenza	≥40	M	36.8	Did not smoke	Non-Indigenous	Postpartum
H1N1 Influenza	35–39	M	Not stated	Not stated	Non-Indigenous	Postpartum
H1N1 Influenza	20–24	N	Not stated	Did not smoke	Non-Indigenous	Postpartum
Influenza B	<20	N	26.5	Not stated	Non-Indigenous	Antepartum
Endometritis	≥40	GM	36.7	Not stated	Indigenous	Postpartum
Chorioamnionitis	35–39	M	Not stated	Smoked	Not stated	Postpartum
Puerperal sepsis	Not stated	N	Not stated	Not stated	Not stated	Postpartum
Caesarean wound sepsis	≥40	GM	Not stated	Smoked	Non-Indigenous	Postpartum
Cholecystitis	20–24	M	27.1	Smoked	Indigenous	Postpartum
Pneumococcal meningitis	35–39	M	Not stated	Smoked	Non-Indigenous	Antepartum
Necrotising fasciitis	20–24	M	28.4	Did not smoke	Non-Indigenous	Postpartum
Acute pyelonephritis	25–29	GM	53.0	Smoked	Non-Indigenous	Postpartum

(a) Parity is denoted by the following abbreviations: N = nullipara; M = multipara; GM = grand multipara.

(b) BMI = body mass index.

Obstetric infections

Four of the women who died between 2008 and 2012 died from obstetric-related infections. Three of these 4 deaths were classified as direct maternal deaths and the course of events described for these women showed a rapid deterioration from mild onset of symptoms to death within hours or days.

Case summary

A multipara with a history of several previous caesarean sections and of intravenous substance abuse miscarried a second trimester pregnancy at home after a period of days in which she felt unwell. On subsequent admission to a maternity service, she was found to be highly febrile. Broad spectrum antibiotic cover was commenced and manual removal of placental tissue was undertaken, but was incomplete. She was subsequently transferred to a tertiary hospital with signs of an acute abdomen, impending disseminated intravascular coagulopathy and multi-organ failure. Despite ultrasound guided removal of further retained placental tissue, she died of the effects of septicaemia. Culture of the placental tissue showed *Escherichia coli* and *Staphylococcus aureus*. Review suggested that delay in seeking care on the part of the woman was a potential avoidable factor.

Non-obstetric infections

Physiological and immune changes occur in pregnancy, making women more susceptible to infections (Logan & Price 2011). Additionally, pregnancy can lead to delay in investigation, diagnosis and treatment of systemic infections. For these reasons, deaths due to non-genital tract infection, such as meningitis, are considered related to pregnancy and classified as indirect maternal deaths.

Eight women died as a result of non-obstetric related (non-genital tract sepsis) infections. Three deaths were from H1N1 influenza; 1 death from influenza B; 1 death was from pneumococcal meningitis; 1 death was from subdural empyema and purulent meningitis with group A beta haemolytic streptococcal sinusitis; 1 was from cholecystitis following complicated recovery from a caesarean section; and 1 was consequent on necrotising fasciitis of the leg.

Deaths from influenza

There were 3 reported deaths from H1N1 influenza during the 2009–2010 pandemic and they have been examined in detail in the *Maternal deaths in Australia 2006–2010* report (AIHW et al. 2014). A further death occurred in 2011 due to influenza B. All 4 deaths were classified as indirect.

A collaborative AMOSS and Australian and New Zealand Intensive Care Society (ANZICS) study identified 3 maternal deaths in Australia and 3 maternal deaths in New Zealand during the 2009 H1N1 pandemic (ANZIC Influenza Investigators & AMOSS 2010). This population-based cohort study demonstrated that pregnant women, particularly in the second half of pregnancy, were more likely than non-pregnant women to develop critical illness associated with the 2009 H1N1 influenza, and there were poorer outcomes, including the death of the mother or baby for such women. Outcomes from intensive care treatment in this pandemic were also reviewed in conjunction with the UKOSS (Knight et al. 2011). Immunisation programs for pregnant women in such circumstances were supported.

Group A beta haemolytic streptococcus

There were 3 deaths identified as being caused by group A beta haemolytic streptococcal (GAS) infection, accounting for 25% of all maternal deaths due to sepsis between 2008 and 2012. Similarly, GAS infection accounted for 25% of all maternal deaths due to sepsis between 2006 and 2010. GAS is a community-acquired bacterium and up to 30% of individuals are asymptomatic carriers of GAS, whether in the throat or on the surface of the skin (Nicoll et al. 2012). Clinical signs of systemic GAS infection and management of severe sepsis are described in the box below.

Good practice guidance

- Diarrhoea and/or vomiting in pregnant women may be serious signs of sepsis and an indication for commencing antibiotic therapy.
- Early investigation of non-specific symptoms in pregnant women is necessary to exclude serious infection.
- Where an autopsy is performed, blood cultures should be taken for all cases as soon as is possible.

Sources: NMMAC; Knight et al. 2014.

Summary

Overall, there were 12 maternal deaths due to sepsis between 2008 and 2012, giving an MMR of 0.8 per 100,000 women who gave birth. GAS was the most common bacterial pathogen associated with mortality in both Australia and the UK. All of the women who died deteriorated rapidly from mild onset of symptoms to death with hours or days. Early investigation of non-specific symptoms in pregnant women is necessary to exclude serious infection. Influenza poses a particular risk for pregnant women and vaccination against influenza should be encouraged.

4.6 Thromboembolism

Thromboembolism-related maternal mortality

Venous thromboembolism is the obstruction of a blood vessel, usually a large vein, with thrombotic material carried in the blood from its site of origin to block another vessel (Medforth et al. 2011). The most common sites for such thrombotic material to lodge when thromboembolism complicates pregnancy are the pulmonary circulation (pulmonary embolism) and the cerebral veins (cerebral venous thrombosis). The most common sources of thrombotic material are deep vein thrombosis in the leg or in the pelvic veins.

Until recently, there was no reliable information available in Australia on the number of women who experience antenatal pulmonary thromboembolism or their outcomes. The first national population-based AMOSS study of antenatal pulmonary embolism was undertaken in Australia and New Zealand for the period 2010–2012, and has recently completed the data collection. Preliminary results for 2010–2011 showed an incidence of 1.2 cases per 10,000 women giving birth to a baby of at least 20 weeks gestation or at least 400 grams birthweight (PMMRC 2013). There were no maternal deaths from the 104 antenatal pulmonary embolism cases in the AMOSS study.

The 2009–2012 UK maternal mortality study (Knight et al. 2014) reported 26 direct maternal deaths due to thromboembolism with a maternal mortality rate of 1.08 per 100,000 maternities. Though there was little comment in the 2009–2012 report, the previous UK report (Cantwell et al. 2011) noted that the incidence of major thromboembolism in the UK had decreased, and opined that this was related to the introduction of effective thromboembolic prophylaxis programs (RCOG 2007, 2009a). Identifiable risk factors for thromboembolic disease were noted in 70% of the women who died; the main risk factors identified were multiparity, obesity, older age, smoking and operative delivery.

There is no published information on thromboprophylaxis use in pregnancy across maternity units in Australia. These data are collected in some states as a requirement for hospital accreditation, but are not available on a national basis.

Deaths from thromboembolism in 2008–2012

There were 10 maternal deaths due to thromboembolism between 2008 and 2012. The MMR for thromboembolism for 2008–2012 is 0.7 per 100,000 women who gave birth, which is slightly higher than the rate for 2006–2010 and 2003–2005 (Table 4.16). All of the women died from pulmonary thromboembolism and their deaths were all classified as direct deaths.

Table 4.16: Maternal deaths from thromboembolism, Australia, 2000–2012

Reporting period	Number	MMR[(a)]
2000–2002	3	0.4
2003–2005	5	0.6
2006–2010[(b)]	9	0.6
2008–2012[(b)]	10	0.7

(a) Per 100,000 women who gave birth.

(b) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Table 4.17 is a summary of all maternal deaths, in which thromboembolism was a principal or contributory cause, that have been documented in Australia since 2000. Thromboembolism is still a leading cause of direct maternal death in Australia, ranging from 18% of deaths in 1967–1969 to 5.6% in 2003–2005. When reviewed in conjunction with the UK research, the downward trend in the number of maternal deaths from thromboembolism is likely to reflect improved identification and management of at-risk women during the antenatal period.

Table 4.17: Maternal deaths from thromboembolism, Australia, 2000–2012

	Maternal deaths with thromboembolism as a principal or contributory cause							
Reporting period	During pregnancy	After miscarriage or TOP[a]	After ectopic pregnancy	After vaginal birth	After caesarean section	Total	Total number of deaths	Thrombo-embolism deaths as a percentage of total
2000–2002	2	0	0	2	2	6	84	7.1
2003–2005[b]	n.a.	n.a.	n.a.	n.a.	n.a.	5	90	5.6
2006–2010[c]	2	0	0	3	4	9	99	9.0
2008–2012[c]	3	2	0	2	3	10	105	9.5

(a) TOP = termination of pregnancy.

(b) The total number of deaths includes 5 deaths where the timing of death was unknown.

(c) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Table 4.18 is a summary of the timing of deaths from thromboembolism in relation to pregnancy and some demographic characteristics of these women. The women who died due to thromboembolism between 2008 and 2012 were aged between 26 and 42, with the majority being in their 20s. Parity ranged from 0 to 4, with 8 of the 10 women being parous. BMI was only stated for 3 of the women, and was in the significantly obese range for 2 of those 3.

Four of the deaths occurred in early pregnancy, 1 in late pregnancy and 5 in the postpartum period. The early pregnancy deaths occurred: in a woman with a twin pregnancy at 11 weeks gestation; in a woman with benign intracranial hypertension and a benign pituitary tumour at 9 weeks gestation; in a woman with an in vitro fertilisation (IVF) pregnancy at 5 weeks gestation; and in a woman after a complete miscarriage at 6 weeks gestation. The death in later pregnancy occurred at 37 weeks gestation with no known risk factors for thromboembolism.

Three of the postnatal deaths due to thromboembolism occurred after caesarean section. One women had a lethal pulmonary embolus 2 weeks post-caesarean section, despite being treated with a prophylactic anticoagulant regimen. A second woman, who was known to be heterozygous for Factor V Leiden deficiency and who had a caesarean hysterectomy for placenta percreta, had a pulmonary embolus after her prophylactic anticoagulant regimen was ceased. A third woman, who had an emergency caesarean section in the presence of HELLP (haemolysis, elevated liver enzymes, low platelet count) syndrome, with a further laparotomy for a subcapsular liver rupture, died at home 34 days postpartum. The remaining 2 women who died postnatally had their pulmonary embolus at 13 and 16 days postpartum; no risk factors for thromboembolism were identified in either woman.

Table 4.18: Deaths from thromboembolism, Australia, 2008–2012

Cause of death	Maternal age group	Parity[a]	BMI[b]	Smoking status	Indigenous status	Timing of death
Pulmonary embolism	25–29	M	Not stated	Smoked	Non-Indigenous	Postpartum
Pulmonary embolism	≥40	N	Not stated	Not stated	Not stated	Early pregnancy
Pulmonary embolism	35–39	GM	42.2	Smoked	Not stated	Postpartum
Pulmonary embolism	25–29	M	19.9	Did not smoke	Non-Indigenous	Postpartum
Pulmonary embolism	≥40	M	Not stated	Did not smoke	Non-Indigenous	Antepartum
Pulmonary embolism	25–29	N	Not stated	Not stated	Not stated	Early pregnancy
Pulmonary embolism	35–39	M	35.3	Did not smoke	Not stated	Early pregnancy
Pulmonary embolism	25–29	M	Not stated	Not stated	Non-Indigenous	Postpartum
Pulmonary embolism	25–29	M	Not stated	Did not smoke	Non-Indigenous	Postpartum
Pulmonary embolism	25–29	M	Not stated	Not stated	Non-Indigenous	Early pregnancy

(a) Parity is denoted by the following abbreviations: N = nullipara; M = multipara; GM = grand multipara.

(b) BMI = body mass index.

Data on contributing factors were poorly reported. The data collected for these women were of variable quality and adequate details of death were only provided for 4 of the 10 women described here. For the other 6 women, details of the use of thromboprophylaxis were unavailable. In most cases, it is not known whether they experienced respiratory symptoms prior to the morbid event.

Case summary

A multipara in her early 30s had a caesarean section at 33 weeks gestation in response to a major antepartum haemorrhage in association with a known placenta accreta. An intra-operative decision was made to extend the procedure to a caesarean hysterectomy to control haemorrhage. She was known to be a heterozygous carrier of the Leiden V mutation and had prophylactic heparin regimen until fully mobile 12 days post-operatively. Eight days after cessation of the heparin, she collapsed and was not able to be resuscitated. A large saddle pulmonary embolus was found at autopsy. Review suggested that an anticoagulation regimen should have been continued for 6 weeks.

Autopsy

Of the 10 women who died of thromboembolism, there were 8 autopsies. In the cases of sudden death, all of these autopsies resulted in the cause of death being identified. In the 2 other cases, the cause of death was diagnosed by imaging prior to death. In any case where the cause of death is not clearly known, it is necessary to proceed to autopsy to establish the cause of death.

The NMMAC firmly recommends autopsy in all cases of apparently embolic death and/or sudden unexpected death in association with pregnancy, because differentiation between pulmonary thromboembolism, amniotic fluid embolism and sudden death of cardiac origin is not always accurate.

Good practice guidance

- Where the cause of death is not clearly known, autopsy should be advocated to establish the cause of death.

Source: NMMAC.

Risk assessment and prevention

In light of the Royal College of Obstetricians and Gynaecologists (RCOG) guidelines regarding risk and management of thromboembolism (RCOG 2007, 2009a, 2009b), all women should undergo a documented assessment of risk factors for thromboembolism in early pregnancy or before pregnancy. Women are at risk of venous thromboembolism (VTE) throughout pregnancy and into the postpartum period, and this assessment should be repeated if the woman is admitted to hospital for any reason or develops other inter-current problems.

More than 2 in every 1,000 women giving birth in Australia are extremely morbidly obese (AIHW et al. 2007). Obesity remains a significant risk factor for VTE in pregnancy. Maternity service providers should ensure they have current guidelines/protocols on thromboprophylaxis in pregnancy including weight-specific advice on thromboprophylaxis (McLintock et al. 2012). The box below describes risk factors for thromboembolism in pregnancy.

Risk factors for venous thromboembolism in pregnancy

Pre-existing

- Previous venous thromboembolism
- Thrombophilia
- Heritable
- Antithrombin deficiency
- Protein C deficiency
- Protein S deficiency
- Factor V Leiden
- Prothrombin gene G20210A
- Acquired (antiphospholipid syndrome):
- Persistent lupus anticoagulant
- Persistent moderate/high-titre anticardiolipin antibodies or β2 glycoprotein 1 antibodies
- Medical comorbidities (e.g. heart or lung disease, systemic lupus erythematosus, cancer, inflammatory conditions (inflammatory bowel disease or inflammatory polyarthropathy), nephrotic syndrome (proteinuria > 3 g/day), sickle cell disease, intravenous drug user
- Age >35
- Obesity (BMI >30 kg/m^2) either pre-pregnancy or in early pregnancy
- Parity ≥3
- Smoking
- Gross varicose veins (symptomatic or above knee or with associated phlebitis, oedema/skin changes)
- Paraplegia

Obstetric

- Multiple pregnancy
- Assisted reproductive therapy
- Pre-eclampsia
- Caesarean section
- PPH (>1 L) requiring transfusion
- Prolonged labour
- Mid-cavity rotational operative delivery

(continued)

Risk factors for venous thromboembolism in pregnancy (continued)

New-onset/transient

- Surgical procedures in pregnancy or puerperium (e.g. evacuation of products of conception, appendectomy, postpartum sterilisation)
- Potentially reversible conditions (e.g. hyperemesis gravidarum, dehydration)
- Ovarian hyperstimulation syndrome
- Systemic infection requiring antibiotics or admission to hospital (e.g. pneumonia, pyelonephritis, postpartum wound infection)
- Long distance travel (>4 hours)

BMI = body mass index; PPH = postpartum haemorrhage

Note: Systemic lupus erythematosus may develop at later stages in gestation than the initial risk assessment, or may resolve; therefore, continuing individual risk assessment is important.

Source: RCOG 2009a.

Good practice guidance

- All women should undergo a documented assessment of risk factors for VTE in early pregnancy or before pregnancy. This assessment should be repeated if the woman is admitted to hospital for any reason or develops other inter-current problems (McLintock et al. 2012; RCOG 2009b).
- Institutions should have guidelines on the management of obesity in pregnancy and women requiring thromboprophylaxis should be placed on doses appropriate to their weight.

Source: NMMAC.

Summary

Thromboembolism still remains a leading cause of maternal death in Australia. Several of the women who died had known risk factors, and in some cases these were multiple risk factors. However, this information was not available in all cases.

Women are at risk of thromboembolism throughout pregnancy and into the postpartum period. All women should undergo a documented assessment of risk factors for thromboembolism in early pregnancy or before pregnancy. Institutions should ensure they have current guidelines/protocols on thromboprophylaxis in pregnancy and ensure that clinicians looking after pregnant women are aware of these guidelines and undertake risk assessments, because this has been shown to save mothers' lives (McLintock et al. 2012; RCOG 2009b).

4.7 Hypertensive disorders

Hypertensive disorder-related maternal mortality

Hypertensive disorders in pregnancy are among the most common pregnancy complications and have been a leading cause of maternal death around the world for many years. The Society of Obstetric Medicine of Australia and New Zealand (SOMANZ) defines hypertension in pregnancy as systolic blood pressure greater than or equal to 140 mmHg and/or diastolic blood pressure greater than or equal to 90 mmHg (Lowe et al. 2015). Severe hypertension requiring urgent treatment is defined as a systolic blood pressure greater than or equal to 170 mmHg with or without diastolic blood pressure greater than or equal to 110 mmHg.

Hypertension in pregnancy may be due to a number of conditions, with pre-eclampsia and eclampsia being the most common causes. Pre-eclampsia is a multi-system disorder unique to human pregnancy characterised by hypertension and multi-system involvement of renal, haematological, hepatic and neurological systems, and the fetus. Early onset pre-eclampsia (late second trimester and early third trimester) requires multidisciplinary care in a major maternity service with associated maternal fetal and neonatal intensive care specialists and services available. Continued careful postnatal observation of previously diagnosed pre-eclampsia is necessary because the disease does not necessarily resolve after birth and many complications can occur at this time.

Good practice guidance

- The significance of hypertension in pregnancy should not be underestimated, and any woman who presents with signs or symptoms that are possibly due to pre-eclampsia should undergo a full clinical and laboratory assessment and early referral to a consultant obstetrician at a hospital with a service capability level for managing high-risk pregnancies.
- The management of women with pre-eclampsia between gestational ages of 24 and 32 weeks should be undertaken in consultation with a tertiary institution. Prior to the birth of the baby, all efforts should be used to safely transfer a woman with pre-eclampsia at such gestations to a facility with appropriate neonatal and maternal care capabilities.
- Regular blood pressure monitoring should be undertaken at all antenatal visits past 20 weeks gestation. The NMMAC recommends that urine testing be undertaken at all antenatal visits past 20 weeks gestation; at a minimum, urine testing be undertaken at all antenatal visits past 20 weeks gestation in women who are at particular risk of pre-eclampsia and in all women where a raised blood pressure is found.

Source: NMMAC.

Deaths from hypertensive disorders of pregnancy in 2008–2012

There were 9 maternal deaths related to hypertensive disorders of pregnancy between 2008 and 2012 (Table 4.19). All of these deaths were due to pre-eclampsia and its complications, and all deaths were classified as direct. The MMR during 2008–2012 for hypertensive disorders of pregnancy was 0.6 per 100,000 women who gave birth compared with 0.4 per 100,000 women who gave birth in 2006–2010, and 0.8 per 100,000 women who gave birth in 2003–2005.

Table 4.19: Maternal deaths from hypertensive disorders, Australia, 2000–2012

Reporting period	Number	MMR[(a)]
2000–2002	5	0.7
2003–2005	6	0.8
2006–2010[(b)]	6	0.4
2008–2012[(b)]	9	0.6

(a) Per 100,000 women who gave birth.

(b) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Table 4.20 details deaths from hypertensive disorders of pregnancy by cause in Australia from 2000 to 2012. All 9 maternal deaths related to hypertensive disorders of pregnancy between 2008 and 2012 were due to sequelae of pre-eclampsia. Intracranial haemorrhage was the most commonly reported cause of death (7 women in total), although the majority suffered multiple complications and organ failure. One woman died as a result of a hepatic rupture and another woman died from hypoxic ischaemic encephalopathy.

Good practice guidance

- The major cause of death in women with hypertension in pregnancy is intracranial haemorrhage. Systolic blood pressure of 170 mmHg or above, or diastolic blood pressure of 110 mmHg or above, is a medical emergency and requires urgent in-patient assessment and management in a specialist maternity service.

Source: NMMAC.

Table 4.20: Maternal deaths from hypertensive disorders, Australia, 2000–2012

Cause of death	2000–2002	2003–2005	2006–2010[(a)]	2008–2012[(a)]
Hypertension/pre-eclampsia	3	–	–	–
Intracranial haemorrhage	–	4	4	7
Eclampsia	1	–	1	–
Hepatic rupture	–	–	1	1
Hypoxic ischaemic encephalopathy	–	–	–	1
Other	1	1	–	–
Total	**5**	**5**	**6**	**9**

(a) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

The women who died were aged between 25 and 41 (Table 4.21). Parity ranged from 0 to 2. All of the women who died were at greater than 37 weeks gestation. It is disappointing that BMI information was not available for 7 of the 9 women.

All 9 women had given birth prior to their death: 6 by caesarean section, 2 by vaginal birth after induced labour and 1 by vaginal birth after spontaneous labour.

Table 4.21: Deaths from hypertensive disorders, Australia, 2008–2012

Cause of death	Maternal age group	Parity[(a)]	BMI[(b)]	Smoking status	Indigenous status	Timing of death
Intracranial haemorrhage	35–39	M	Not stated	Not stated	Non-Indigenous	Postpartum
Intracranial haemorrhage	≥40	M	Not stated	Not stated	Non-Indigenous	Postpartum
Intracranial haemorrhage	≥40	M	Not stated	Not stated	Non-Indigenous	Postpartum
Intracranial haemorrhage	30–34	M	Not stated	Did not smoke	Non-Indigenous	Postpartum
Intracranial haemorrhage	35–39	M	Not stated	Not stated	Non-Indigenous	Postpartum
Intracranial haemorrhage	25–29	N	Not stated	Did not smoke	Not stated	Postpartum
Intracranial haemorrhage	35–39	M	Not stated	Not stated	Non-Indigenous	Postpartum
Hypoxic ischaemic encephalopathy	25–29	M	25.8	Not stated	Non-Indigenous	Postpartum
Hepatic rupture	30–34	N	27.8	Did not smoke	Non-Indigenous	Postpartum

(a) Parity is denoted by the following abbreviations: N = nullipara; M = multipara.

(b) BMI = body mass index.

Pre-eclampsia

All of the women who died developed multiple complications of pre-eclampsia and eclampsia, such as hepatic rupture, adult respiratory distress syndrome and disseminated intravascular coagulation, and all were admitted to an intensive care unit prior to their deaths. All these deaths occurred postpartum.

Case summary

A young primigravida presented to hospital in spontaneous labour near term after an uneventful pregnancy. Hypertension, low platelets and raised liver enzymes were found when she presented in labour; there had been no recorded hypertension prior to labour. Control of her blood pressure was problematic during labour, and became more difficult postpartum. She collapsed on the first postpartum day. Autopsy revealed an acute brain stem haemorrhage. Case review concluded that initial management of the hypertension on presentation in labour was sub-optimal.

Summary

Early recognition and appropriate management of pre-eclampsia saves women's lives. Antenatal care should be oriented to ensuring that early signs of pre-eclampsia are not missed. Women with signs and symptoms of pre-eclampsia should be referred early for care by a specialist obstetrician. Each maternity unit should develop/adopt protocols for the management of hypertension in pregnancy and regularly audit their outcomes. Pre-eclampsia does not necessarily resolve after birth and complications can occur at this time.

4.8 Early pregnancy deaths

Early pregnancy maternal mortality

For the purpose of this report, an early pregnancy death is defined as a maternal death during the first 14 weeks of pregnancy.

There is no national collection of data regarding early pregnancy loss and information regarding these pregnancies is not routinely collected in the perinatal or hospital administrative data collections. The National Perinatal Data Collection only contains information on births of at least 20 weeks gestation (or greater than 400 grams birthweight).

Equally, there is no national data collection on the conditions relating to termination of pregnancy. In Australia, legislation regarding termination of pregnancy varies across jurisdictions. The RANZCOG is supportive of the monitoring and collection of statistics relating to termination of pregnancy, including the occurrence of complications of these procedures. Non-availability of termination of pregnancy services has been shown to increase maternal morbidity and mortality in population studies (WHO 2004).

The rate of ectopic pregnancy in the UK was found to be 11 per 1,000 pregnancies, with a maternal mortality of 0.2 per 1,000 estimated ectopic pregnancies (NICE 2012). Atypical presentation for ectopic pregnancy is common, from unexpected collapse with severe abdominal pain to a variety of pregnancy-related and apparently unrelated symptoms. In the event that trans-vaginal ultrasound shows an intrauterine sac of 25 mm or more without a fetal heart beat being visualised and/or a serum hCG level greater than or equal to 1,500 IU/L, ectopic pregnancy should be actively excluded.

Good practice guidance

- An early pregnancy ultrasound that fails to identify a intrauterine sac in the presence of a positive serum hCG titre should stimulate active exclusion of tubal pregnancy (NICE 2012).

Sources: NMMAC; NICE 2012.

Early pregnancy deaths in 2008–2012

There were 15 deaths that occurred in the first 14 weeks of pregnancy between 2008 and 2012. The MMR for all deaths occurring in the first 14 weeks of pregnancy (15) is 1.0 per 100,000 women who gave birth (Table 4.22).

Table 4.22: Early pregnancy deaths, Australia, 2000–2012

Reporting period	Number	MMR[(a)]
2000–2002	4	0.5
2003–2005	6	0.8
2006–2010[(b)]	15	1.0
2008–2012[(b)]	15	1.0

(a) Per 100,000 women who gave birth.

(b) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Table 4.23 shows the MMR from early pregnancy deaths between 2000 and 2012. Five women died following an ectopic pregnancy and will be reported in this chapter. Ten of the early pregnancy deaths are reported and counted in other chapters, including 1 death related to psychosocial morbidity, 1 death from cardiovascular disease and 4 deaths from thromboembolism; 4 deaths were due to 'other causes'.

Table 4.23: Early pregnancy deaths, Australia, 2000–2012

Cause of death	2000–2002	2003–2005	2006–2010[(a)]	2008–2012[(a)]
Ectopic pregnancy	1	1	3	5[(b)]
Psychosocial	0	2	5	1
Cardiac	1	2	2	1
Non-obstetric haemorrhage	1	0	1	0
Thromboembolism	0	0	1	4
Epilepsy	0	1	0	0
Other	1	0	3	4
Total	**4**	**6**[(c)]	**15**	**15**

(a) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

(b) Includes 2 deaths from intra-abdominal haemorrhage secondary to surgery for ectopic pregnancy.

(c) Number reported differs from those reported in *Maternal deaths in Australia 2003–2005* due to differences in definitions used to determine an early pregnancy death.

Five women died following an ectopic pregnancy (Table 4.24), including 2 who died from complications of the associated laparoscopic surgery. In 2 cases, delay in transfer to a facility able to provide appropriate care was noted as a consequence of the differential diagnosis of ectopic pregnancy not being considered initially.

Good practice guidance

- The first clinical sign of an ectopic pregnancy may be a catastrophic collapse.
- Ectopic pregnancy should be considered a possibility in any apparently healthy woman of reproductive age who collapses suddenly.
- All maternity units, including those in rural settings, are recommended to have established guidelines for the management of a collapse associated with the ectopic pregnancy. Such guidelines should include access to blood products to assist resuscitation of associated severe haemorrhage.

Source: NMMAC.

Table 4.24: Early pregnancy deaths, Australia, 2008–2012

Cause of death	Maternal age group	Parity[(a)]	BMI[(b)]	Smoking status	Indigenous status
Ectopic pregnancy	30–34	N	Not stated	Smoked	Non–indigenous
Ectopic pregnancy	35–39	M	27.7	Not stated	Non-indigenous
Ectopic pregnancy[(c)]	25–29	N	19.6	Not stated	Non-indigenous
Ectopic pregnancy	30–34	Not stated	Not stated	Not stated	Non-indigenous
Ectopic pregnancy[(c)]	25–29	M	26.6	Did not smoke	Non-indigenous
Pulmonary thromboembolism	35–39	M	35.3	Did not smoke	Not stated
Pulmonary thromboembolism	25–29	N	Not stated	Not stated	Not stated
Pulmonary thromboembolism	25–29	M	Not stated	Not stated	Non-indigenous
Pulmonary thromboembolism	>40	N	Not stated	Not stated	Not stated
Infective endocarditis	20–24	N	19.7	Smoked	Indigenous
Freshwater drowning	35–39	N	Not stated	Did not smoke	Non-indigenous
Intractable cerebral hypertension	35–39	Not stated	Not stated	Not stated	Indigenous
Suicide	20–24	Not stated	Not stated	Not stated	Indigenous
Unclassified	35–39	Not stated	23.1	Not stated	Non-indigenous
Undetermined	>40	M	44.0	Not stated	Not stated

(a) Parity is denoted by the following abbreviations: N = nullipara; M = multipara.

(b) BMI = body mass index.

(c) Death from intra-abdominal haemorrhage secondary to surgery for ectopic pregnancy.

Case summary

Several months after the birth of her most recent baby, a multipara woke with abdominal pain. The day before, she had a weak positive result to a home pregnancy test. The pain rapidly escalated and she collapsed; when paramedics arrived, they were not able to resuscitate her. Autopsy revealed a massive intra-abdominal haemorrhage secondary to a ruptured tubal ectopic pregnancy. There were no potentially avoidable factors found.

Summary

Although ectopic pregnancies are rare, they are potentially fatal. Women who do not know they are pregnant may present to medical or ambulance services with a catastrophic collapse, and the resuscitation decisions involve difficult decisions relating to the unexpected hypovolaemic cause of the collapse in a young woman with no external blood loss. An early pregnancy ultrasound that fails to identify an intrauterine sac in the presence of a positive serum hCG titre should stimulate active exclusion of tubal pregnancy; the presence of a small intrauterine sac does not exclude ectopic pregnancy.

4.9 Amniotic fluid embolism

Amniotic fluid embolism (AFE) is a rare, but often fatal, condition of pregnancy and occurs when amniotic fluid enters the maternal circulation. Although originally thought to result from fetal skin cells or meconium in the amniotic fluid causing platelet thrombi to form blocking the pulmonary vessels (Medforth et al. 2011), it has more recently been postulated that immune-based mechanisms are involved in triggering the severe physiological changes that occur in the pulmonary circulation (McDonnell et al. 2013). Severe disseminated intravascular coagulopathy, leading to a dysfunctional failure of the woman's clotting system, is a major component of this potentially lethal condition.

Amniotic fluid embolism-related maternal mortality

The diagnosis of AFE is difficult and often based on a process of exclusion. The difficulties with identifying AFE, and the small number of cases, mean that it is challenging to study and there is limited information available about this disease. In the absence of an autopsy in the instance of a maternal death, it may be difficult to distinguish AFE from other causes of maternal collapse in pregnancy, such as pulmonary embolism.

A review of available data sources on the incidence of AFE internationally found a reported incidence of AFE ranging from 1.9 cases per 100,000 maternities in the UK to 6.1 per 100,000 women who gave birth in Australia. Maternal mortality ratios ranged from 0.4 per 100,000 live births in the Netherlands from 1993–2005 to 1.3 per 100,000 live births in the United States in 1997–2001 and 1.1 in Australia (excluding Victoria) in 1994–2005. Case-fatality rates ranged from 11% to 43%. Older maternal age and induction of labour were consistently associated with AFE (Knight et al. 2012).

Although approximately two-thirds of women and their babies survive AFE, studies show that many of these women go on to develop serious morbidity (Knight et al. 2012; Roberts et al. 2010). Cerebral injury was noted in 6% of women with AFE in the UK, and cerebral infarction occurred in 20% of women in New South Wales (Knight et al. 2012). There is, however, limited information available on the long-term effects on women who survive.

A recent article published in association with the AMOSS study on AFE, which was undertaken in Australia and New Zealand for the period 2010–2012, suggests that the incidence of maternal death from AFE is decreasing, and questions whether this change is related to improved recognition and improved care in the acute setting (McDonnell et al. 2013).

Good practice guidance

- The immediate management of women with suspected AFE is prompt cardiopulmonary resuscitation and coagulation support by a multidisciplinary team, and should be undertaken in the same manner as for any other cause of collapse with coagulation failure (RCOG 2011b).

Sources: NMMAC; RCOG 2011b.

Deaths from amniotic fluid embolism in 2008–2012

In Australia, the death rate from AFE remained relatively stable over the period 2000–2010; however, there were only 4 deaths in the period 2008–2012, giving an MMR of 0.3 per 100,000 women who gave birth (Table 4.25). All of these deaths were classified as direct maternal deaths. A similar MMR (0.33 per 100,000 maternities) was reported in the UK for the years 2010–2012 (Knight et al. 2014).

Table 4.25: Maternal deaths from amniotic fluid embolism, Australia, 2000–2010

Reporting period	Number	MMR[(a)]
2000–2002	10	1.3
2003–2005	8	1.0
2006–2010[(b)]	9	0.6
2008–2012[(b)]	4	0.3

(a) Per 100,000 women who gave birth.

(b) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Table 4.26 shows the type of labour and type of birth for the women who died from AFE. The 4 women who died were aged between 23 and 35 and parity ranged from 0 to 2. All of the women who died with known gestational age were over 36 weeks gestation at the time of their death, and all died postpartum.

There has been a suggested link between induction of labour and AFE (Roberts et al. 2010). Three of the 4 women who died had an induction of labour and prostaglandins were used in each case.

Table 4.26: Maternal deaths from amniotic fluid embolism, Australia, 2008–2012

Maternal age group	Parity[(a)]	BMI[(b)]	Smoking status	Indigenous status	Timing of death	Onset of labour	Mode of birth
20–24	N	20.2	Did not smoke	Non-Indigenous	Intrapartum	No labour	Caesarean section
35–39	M	Not stated	Not stated	Non-Indigenous	Intrapartum	Spontaneous	Vacuum extraction
25–29	M	27.0	Did not smoke	Not stated	Postpartum	Induced	Forceps
35–39	M	Not stated	Not stated	Not stated	Postpartum	Induced	Caesarean section

(a) Parity is denoted by the following abbreviations: N = nullipara; M = multipara.

(b) BMI = body mass index.

The diagnosis of AFE can be difficult and is often one of exclusion or identified at the autopsy (Knight et al. 2012; Roberts et al. 2010; Tuffnell 2002). However, despite the difficulties, in many cases a characteristic series of events is highly suggestive of the diagnosis (see box below). Early recognition and immediate resuscitation of women with suspected AFE are essential to survival. Prompt caesarean section following collapse may be required to facilitate adequate cardiopulmonary resuscitation.

Characteristics of amniotic fluid embolism

Most are likely to occur during labour and birth.

Signs and symptoms include:

- dyspnoea
- restlessness, panic, feeling cold, paraesthesia
- sudden unexpected collapse.

Findings on investigation:

- disseminated intravascular coagulation
- chest X-ray: pulmonary oedema, adult respiratory distress syndrome, right atrial enlargement, prominent pulmonary artery.

Case summary

A multiparous woman had labour induced for post-dates after an uneventful pregnancy. She suffered sudden catastrophic collapse in labour. An immediate caesarean section was performed to assist with cardiopulmonary resuscitation. Severe PPH in association with disseminated intravascular coagulopathy followed. Despite appropriate resuscitation and massive blood product replacement, death subsequently occurred in an intensive care unit. The cause of death was AFE, confirmed by the finding of fetal debris in the pulmonary circulation at autopsy. No potentially avoidable factors were found on review.

Diagnosing amniotic fluid embolism

Three of the 4 women who died of AFE had an autopsy; the family of the fourth woman did not consent to an autopsy. AFE was confirmed at autopsy for the 3 cases, all by the presence of fetal squames in the maternal pulmonary circulation.

Good practice guidance

- Autopsy should be advocated in all deaths suspected of being caused by AFE.

Sources: NMMAC; RCOG 2011b.

Summary

AFE, one of the most common causes of direct maternal death in previous report periods in Australia, remains a poorly understood cause of maternal deaths. The persistence of AFE as a cause of direct maternal death is unlikely to change in light of current knowledge. Given the unexpected nature of AFE, it would be wise for maternity services to ensure that they have readily accessible guidelines for immediate management, and that they regularly undertake AFE management training. A high index of suspicion of AFE should be considered if there are signs of respiratory distress, restlessness and altered behaviour indicative of cerebral hypoxia. Early and aggressive resuscitation provides the best chance of survival. Autopsy is the gold standard of diagnosis in fatal AFE, and should be sought whenever maternal death follows unexpected collapse.

4.10 Anaesthesia-related deaths and deaths due to other causes

Anaesthesia-related deaths

There were 2 anaesthetic-related deaths during 2008–2012. The most common reasons for anaesthesia to be administered during labour or birth are for caesarean section and for pain relief in labour (usually by epidural injection).

A multiparous woman with a high BMI suffered a cardiac arrest in a recovery unit following a second trimester termination of pregnancy. She developed global cerebral ischaemia and further treatment was withdrawn. The relevant state maternal mortality committee considered that failure to provide an adequate airway and adequate ventilation were potentially avoidable factors.

The only information that was available regarding the second woman, due to legislative restrictions on that state's maternal mortality committee, was that she died as a consequence of cerebral oedema and that craniostenosis was present and relevant.

Although 43 of the 105 (41%) women who died in 2008–2012 gave birth by caesarean section, only 1 death (the woman above with craniostenosis) was thought to be anaesthetic-related. A death that occurred with cardiac arrest during a spinal anaesthetic was thought to be primarily associated with cardiovascular disease. The cause of death of these 43 women is shown in Table 4.27.

Table 4.27: Cause of direct and indirect deaths of women who gave birth by caesarean section, Australia, 2008–2012

Cause of death	Number of cases
Cardiovascular	8
Non-obstetric haemorrhage	8
Obstetric haemorrhage	7
Hypertensive disorders	6
Sepsis (including H1N1 influenza)	4
Thromboembolism	3
Amniotic fluid embolism	2
Psychosocial	2
Other	2
Anaesthetic related	1

Other deaths

There were 5 deaths due to 'other' causes between 2008 and 2012, with an MMR of 0.3 per 100,000 women who gave birth (Table 4.28).

Table 4.28: Maternal deaths from 'other' causes, Australia, 2000–2012

Reporting period	Number	MMR[(a)]
2000–2002	10	1.3
2003–2005	8	1.0
2006–2010[(b)]	9	0.6
2008–2012[(b)]	5	0.3

(a) Per 100,000 women who gave birth.

(b) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Table 4.29 shows causes of death and classification of deaths from 'other' causes between 2008 and 2012. These 5 cases are summarised below:

- A morbidly obese woman in her 40s with mastitis and sleep apnoea died of an undetermined cause.
- A woman in her mid-30s developed multi-organ failure in association with acquired haemolytic anaemia and postpartum coagulation defects.
- A woman in her early 30s died of a malignancy that was diagnosed late due to inadequate antenatal care and investigation of her abdominal pain.
- A teenage woman with severe asthma died, having not had any specialist review regarding management of asthma treatment during pregnancy.
- A woman with epilepsy in her mid-30s died in her bath by drowning. This woman was 1 of 3 highlighted in the *Maternal deaths in Australia 2006–2010* report (AIHW et al. 2014).

Table 4.29: Maternal deaths from other causes, Australia, 2008–2010

Maternal age group	Principal cause of death	Contributing cause of death	Gestation at death (weeks)	Classification of death
≥40	Undetermined	Mastitis, obesity, sleep apnoea	6	Indirect
35–39	Multi-organ failure	Acute renal failure, postpartum coagulopathy, acquired haemolytic anaemia	35	Indirect
30–34	Cancer	None	38	Indirect
≤20	Asthma	Not stated	20	Indirect
35–39	Freshwater drowning	Epilepsy	13	Indirect

Case summary

An older woman suffered a sudden cardiac death at home in early pregnancy. Her husband administered cardiopulmonary resuscitation (CPR) and paramedics found her to be in ventricular fibrillation. Treatment by the paramedics resulted in reversion to a normal cardiac rhythm. Despite prolonged CPR and subsequent brain injury management in intensive care, there was no recovery of brain function. Autopsy found bilateral cerebral infarcts consistent with hypoxic ischaemic brain injury and some minor abnormalities in her heart. Because this death was unexplained, the death could not be classified, though the most likely direct cause of death was a cardiac arrhythmia. There were no potentially avoidable factors found.

Summary

Two deaths were associated with anaesthesia: 1 for termination of pregnancy and 1 for caesarean section. Forty-two other maternal deaths where the woman gave birth by caesarean section had other specific causation.

There were 5 'other' maternal deaths caused by asthma, epilepsy, cancer, acquired haemolytic anaemia and undetermined causation in a morbidly obese woman with sleep apnoea.

5 Aboriginal and Torres Strait Islander women

The MMR for the period 2008–2012 for Aboriginal and Torres Strait Islander women was more than double that for non-Indigenous women (including those where Indigenous status was unknown), with MMRs of 13.8 and 6.6 deaths, respectively, per 100,000 women who gave birth (risk ratio 2.09; 95% confidence limits 1.02–4.30). Caution should be used when interpreting these results due to the small number of deaths on which these calculations are based.

5.1 Aboriginal and Torres Strait Islander maternal deaths in 2008–2012

There were 12 Aboriginal and Torres Strait Islander women who died during their pregnancy, labour or in the postnatal period between 2008 and 2012. Of these, 8 were maternal deaths and 4 were incidental deaths.

In 23 of the 2008–2012 maternal deaths (including 17 direct and indirect deaths), Indigenous status was not known.

The 8 maternal deaths among Aboriginal and Torres Strait Islander women in the current reporting period comprised 4 direct maternal deaths and 4 indirect maternal deaths. Table 5.1 presents a summary of maternal deaths in Aboriginal and Torres Strait Islander women between 2008 and 2012.

Table 5.1: Maternal deaths in Aboriginal and Torres Strait Islander women, Australia, 2008–2012

Cause of death	Maternal death classification	Maternal age group	Parity[(a)]	BMI[(b)]	Smoking status	Timing of death	Mode of birth
Psychosocial	Indirect	20–24	Not stated	Not stated	Not stated	Early pregnancy	Termination of pregnancy
Sepsis	Direct	20–24	M	27.1	Smoked	Postpartum	Caesarean section
Sepsis	Direct	≥40	GM	36.7	Not stated	Postpartum	Birth at term; mode not stated
Early pregnancy death	Indirect	35–39	Not stated	Not stated	Not stated	Early pregnancy	Normal vaginal birth
Anaesthesia-related death	Direct	≥40	GM	>30.0	Not stated	Mid-pregnancy	Mid-trimester termination of pregnancy
Cardiovascular	Direct	20–24	M	32.9	Did not smoke	Postpartum	Normal vaginal birth
Cardiovascular	Indirect	20–24	P	19.7	Smoked	Early pregnancy	No birth occurred
Psychosocial	Indirect	<20	P	22.2	Smoked	Antepartum	No birth occurred

(a) Parity is denoted by the following abbreviations: P = primipara, M = multipara; GM = grand multipara

(b) BMI = body mass index.

The median age of the Aboriginal and Torres Strait Islander women who died was 23.5, compared with the median age of the non-Indigenous women who died (including those 'not stated') of 32. All 6 women for whom parity was known were parous, with 2 being grand multipara (4 or more previous births).

Three deaths were related to early pregnancy events. One was an Aboriginal and Torres Strait Islander woman in her 30s who died from intractable intracerebral hypertension following a ruptured cerebral aneurysm. The second was a young woman who developed cardiac failure and bronchopneumonia associated with infective endocarditis. The third was a woman in her 20s who committed suicide 4 weeks after a termination of pregnancy in association with significant substance abuse.

One woman who died was an obese multipara who suffered cardiac arrest in the recovery room following a mid-trimester termination of pregnancy.

A young woman with a known history of depression committed suicide late in pregnancy. No health-care preventable factors were found during a State and Territory Maternal Mortality Committees (STMMC) review of this death.

The 3 postpartum deaths included 2 septic direct deaths: 1 due to a streptococcal endometritis and the other to a toxic shock-like syndrome secondary to cholecystitis. The third death was an obese woman in her 20s who developed a lethal peripartum cardiomyopathy secondary to a Haemophilus influenza infection in late pregnancy.

Trends in maternal mortality by Indigenous status

There were 8 maternal deaths of Aboriginal and Torres Strait Islander women during 2008–2012 compared with 9 in 2006–2010 (Table 5.2).

Table 5.2: Trends in maternal mortality in Aboriginal and Torres Strait Islander women and other Australian women, 1991–2012

	Maternal deaths in Aboriginal and Torres Strait Islander women			Maternal deaths in other Australian women[a]			
Period	Direct	Indirect	MMR[b]	Direct	Indirect	MMR[b]	Relative MMR[c]
1991–1993	1	4	23.2	26	17	5.8	4.0
1994–1996	3	1	17.4	43	19	8.3	2.1
1997–1999	1	5	23.5	33	23	7.7	3.1
2000–2002	4	8	45.8	28	44	10.0	4.6
2003–2005	2	4	21.7	27	32	8.0	2.7
2006–2010[d]	5	4	16.4	35	52	6.2	2.6
2008–2012[d]	4	4	13.8	45	49	6.6	2.1

(a) Other Australian women include women whose Indigenous status was not known. Previous reports have included women with missing Indigenous status together with those for non-Indigenous women. For consistency, this grouping has been applied to all periods.

(b) MMR is reported per 100,000 women who have given birth. The number of Aboriginal and Torres Strait Islander women or other women who gave birth is the sum of numbers reported in *Australia's mothers and babies* for the years referenced.

(c) Relative MMR is the ratio of the MMR for Aboriginal and Torres Strait Islander women to the MMR for other women who gave birth in Australia. No difference between groups will yield an MMR equal to 1.

(d) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

The MMR for Aboriginal and Torres Strait Islander women has been consistently higher than that for other Australian women (Figure 5.1). *Maternal deaths in Australia* reports have included women where Indigenous status was not reported along with women reported as non-Indigenous. These women are collectively referred to as 'other Australian women'.

Over the period 1991–1993 to 2008–2012, the MMR for Aboriginal and Torres Strait Islander women has fluctuated, but it is still unacceptably double that of other Australian women. Though there have been some small variations in the MMR for other Australian women, this rate has not changed significantly over this period. Fluctuations that do occur in the MMRs reflect both the rarity of maternal death and the smaller population of Aboriginal and Torres Strait Islander women.

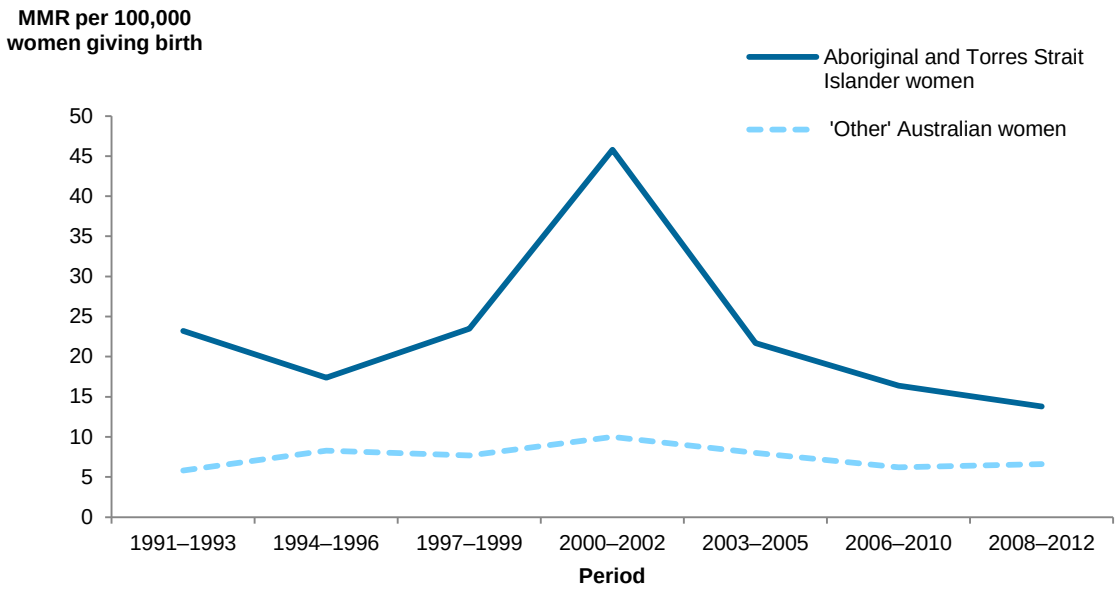


Figure 5.1: Maternal mortality rates for Aboriginal and Torres Strait Islander women compared with 'other Australian women', 1991–2012

The causes of maternal death of Aboriginal and Torres Strait Islander women reported between 2000 and 2012 have been classified to categories of maternal death used in the current report. Cardiovascular conditions, psychosocial conditions and sepsis were the leading cause categories among Aboriginal and Torres Strait Islander women (Table 5.3). In contrast, the most common specific causes of death for other Australian women in this period were hypertensive disorders and non-obstetric haemorrhage, followed by cardiovascular conditions.

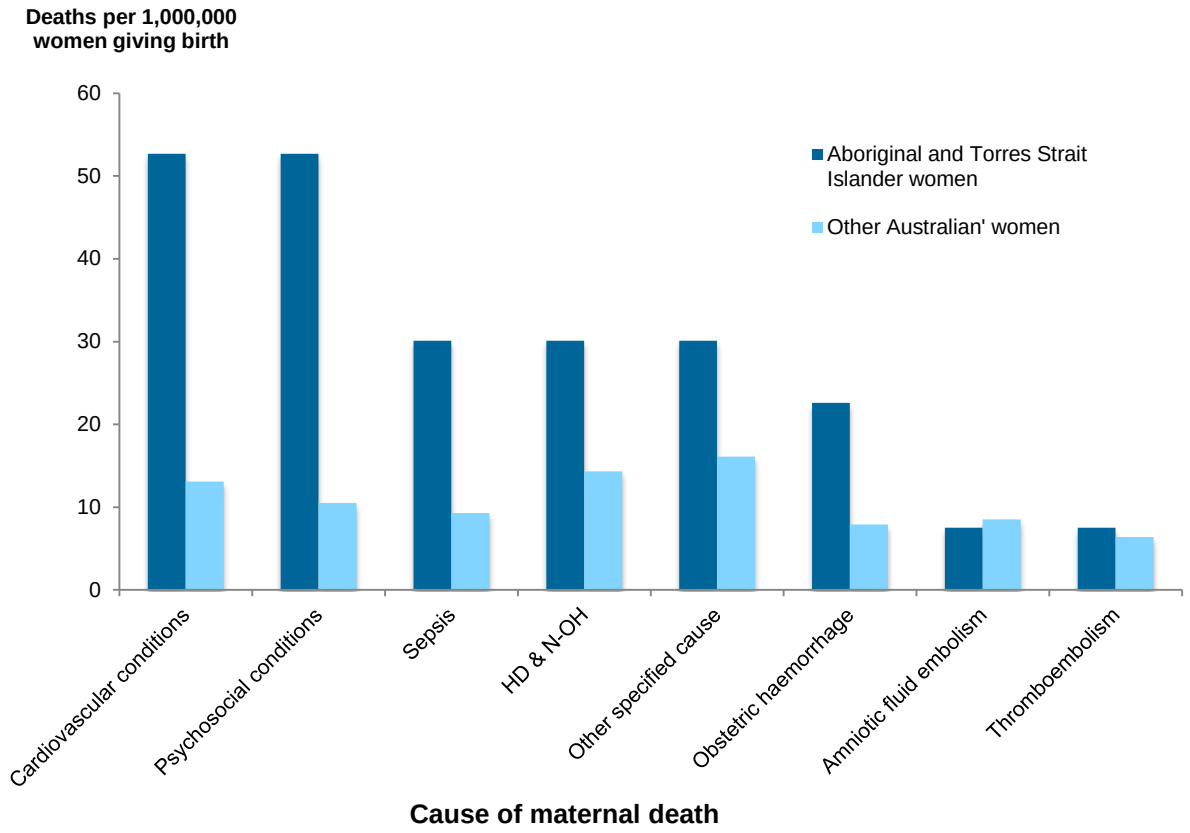
Table 5.3: Aboriginal and Torres Strait Islander maternal deaths, Australia, 2000–2012

Cause of death	2000–2002	2003–2005	2006–2010[(a)]	2008–2012[(a)]
Amniotic fluid embolism	1	0	0	0
Thrombosis and thromboembolism	1	0	0	0
Sepsis	1	0	3	2
Cardiovascular	2	1	2	2
Hypertensive disorder	1	2	1	0
Obstetric haemorrhage	2	0	1	0
Non-obstetric haemorrhage	1	0		0
Psychosocial	3	1	1	2
Early pregnancy	0	0	0	0
Anaesthesia-related	0	0	0	1
Other	0	2	1	1
Total	**12**	**6**	**9**	**8**

(a) 2006–2010 and 2008–2012 are 5-year periods; previously 3-year reporting periods were used.

Cause-specific MMR (CS-MMR) is a measure of the risk of maternal death from specific conditions. These are shown for Aboriginal and Torres Strait Islander women and other Australian women in Figure 5.2 and Table 5.4, expressed per million women who gave birth. The relative CS-MMR quantifies the effect of Indigenous status on the risk of mortality from each cause. 'Other specified cause' comprises a varied group of conditions. Hypertensive disorders and non-obstetric haemorrhage were combined because these conditions may co-exist.

The risk of maternal death from psychosocial conditions was fivefold higher among Aboriginal and Torres Strait Islander women compared with other Australian women for the period 2000–2012, and the risk of cardiovascular conditions was fourfold higher. Higher risks of maternal death from sepsis, obstetric haemorrhage, and hypertensive disorders and non-obstetric haemorrhage combined, are also seen among Aboriginal and Torres Strait Islander women, compared with other women.



Note: HD&N-OH = Hypertensive disorders and non-obstetric haemorrhage.

Figure 5.2: Cause of maternal death among Aboriginal and Torres Strait Islander women and other Australian women, 2000–2012

Table 5.4: Cause of maternal death among Aboriginal and Torres Strait Islander women and other Australian women, 2000–2012

	Maternal deaths in Aboriginal and Torres Strait Islander women			Maternal deaths in other Australian women[a]			
Cause of maternal death	**Number**	**Per cent**	**CS-MMR[b]**	**Number**	**Per cent**	**CS-MMR[b]**	**Relative CS-MMR[c,d]**
Cardiovascular conditions	7	22.6	52.7	45	15.3	13.1	4.0
Psychosocial conditions	7	22.6	52.7	36	12.2	10.5	5.0
Sepsis	4	12.9	30.1	32	10.8	9.3	3.2
Hypertensive disorders and non-obstetric haemorrhage[e]	4	12.9	30.1	49	16.6	14.3	2.1
Other specified cause	4	12.9	30.1	55	18.6	16.1	1.9
Obstetric haemorrhage	3	9.7	22.6	27	9.2	7.9	2.9
Amniotic fluid embolism	1	3.2	7.5	29	9.8	8.5	0.9
Thromboembolism	1	3.2	7.5	22	7.5	6.4	1.2
Total	**31**	**100.0**	**233.3**	**295**	**100**	**86.1**	**2.7**

(a) In this table 'other Australian women' include women whose Indigenous status was not known. Previous reports have variously reported maternal deaths with unknown Indigenous status together with those for non-Indigenous women. This limits the choice of comparator group. The MMR for 'other Australians' will be higher than for 'non-Indigenous women'.

(b) CS-MMR (cause-specific MMR) is derived using the deaths for the cause as the numerator and the number of women who gave birth as the denominator. It is reported per million women who gave birth.

(c) Relative MMR measures the effect of Indigenous status on maternal mortality. This is derived by dividing the cause-specific MMR for Aboriginal and Torres Strait Islander women by the cause-specific MMR for other Australian women.

(d) Statistically significant differences in the CS-MMR for Aboriginal and Torres Strait Islander women suggest that their mortality relative to other Australian women is not due to chance. This can be inferred if the 95% confidence limits for the relative MMR do not include 1.

(e) Hypertensive disorders and non-obstetric haemorrhage are combined in this table because they tend to overlap.

In comparison with non-Indigenous women, Aboriginal and Torres Strait Islander women more commonly die from pre-existing and chronic conditions.

Good practice guidance

- Antenatal care early in pregnancy is particularly important for Aboriginal and Torres Strait Islander women to ensure that there is provision to detect and appropriately manage chronic disease, and services need to be aware of the higher rates of depression and suicide risk in Aboriginal and Torres Strait Islander women compared with non-Indigenous women.

5.2 Identifying Aboriginal and Torres Strait Islander women

Aboriginal and Torres Strait Islander status has been collected for cases categorised as direct maternal deaths since 1970, and for indirect maternal deaths and incidental deaths since 1991. For this report, Aboriginal or Torres Strait Islander status was not reported for 23 women who died during pregnancy or within 42 days of giving birth, including 17 direct or indirect maternal deaths, representing 22%of maternal deaths.

An Aboriginal and Torres Strait Islander woman is defined for Australian health data collections as a woman of Aboriginal or Torres Strait Islander descent who identifies herself as such. For this report, information on Indigenous status was collected using the National Maternal Death Reporting (NMDR) form 2006–2010, using the standard categories.

The quality of Aboriginal and Torres Strait Islander status data, as measured by the proportion of clients with a not-stated response in specific data collections, has improved in most data collections since the AIHW's 2007 data quality report (AIHW 2012). Since the 2007 report, a number of activities have been, or are being, undertaken to improve the identification of Indigenous people in the community services' data collections. These include modifying client forms and client information management systems and the provision of staff training, including cultural awareness training, and training on how to collect Indigenous status data.

Summary

In this 5-year period, Aboriginal and Torres Strait Islander women were twice as likely to die during their pregnancy or the puerperium as other Australian women. Pre-existing and non-obstetric conditions are more common causes of maternal death for Aboriginal and Torres Strait Islander women than for other women. Cardiovascular conditions, sepsis and psychosocial conditions were the leading cause categories of deaths among Aboriginal and Torres Strait Islander women between 2000 and 2012.

Antenatal care early in pregnancy is particularly important for Aboriginal and Torres Strait Islander women to ensure that there is provision for early detection and appropriate management of chronic disease that may have an impact on pregnancy.

6 Incidental deaths

6.1 Causes of incidental maternal deaths

Incidental maternal deaths are deaths that happen to occur in pregnancy or the puerperium from causes unrelated to pregnancy. Internationally, cases of such incidental deaths are included in maternal mortality reporting, although only direct, indirect and unclassified deaths are counted for statistical purposes. In addition to the 105 maternal deaths reported to the NPESU between 2008 and 2012, there were 27 incidental maternal deaths (Table 6.1).

Table 6.1: Causes of incidental maternal deaths, Australia, 2006–2012

Cause of death	2006–2010	2008–2012
Medical causes	11	11
Motor vehicle accident	7	9
Homicide	3	2
Accidental injury	2	2
Undetermined	2	2
Overdose	1	1
Total	**26**	**27**

Incidental deaths resulting from motor vehicle accidents were the most common single cause, accounting for 9 of the 27 incidental maternal deaths. The incidental maternal deaths from medical causes were the most common category and included deaths due to a variety of conditions such as asthma, sepsis, malignancy, intracranial haemorrhage and probable cardiac arrhythmia consequent on the excessive use of stimulants. There were 2 deaths due to homicide, where the deaths were attributed to known partner violence; these were additional to the 2 indirect deaths due to homicide reported in 'Section 4.2 Psychosocial'. Two accidental injury deaths, 1 overdose and 2 deaths due to undetermined causation were also reported.

Summary

All maternal deaths occurring in pregnancy or the puerperium should be reviewed by the relevant state or territory maternal mortality committee. Information on incidental maternal deaths is needed to inform prevention strategies. Motor vehicle accidents during pregnancy are a major cause of traumatic fetal mortality and serious maternal injury. Correct maternal seatbelt use is to be advocated.

Appendix A: National Maternal Mortality Advisory Committee membership

Dr Steven Adair	Chair, Australian Capital Territory Maternal Perinatal Data Collection
Dr Fadwa Al-Yaman	Head, Indigenous and Children's Group, Australian Institute of Health and Welfare
Professor Marie-Paule Austin	The Royal Australian and New Zealand College of Psychiatrists
Dr Georgina Chambers	Director, National Perinatal Epidemiology and Statistics Unit
Assoc. Professor Alicia Dennis	Australian and New Zealand College of Anaesthetists
Assoc. Professor Amanda Dennis	Chair, Tasmanian Council of Obstetric and Paediatric Mortality and Morbidity, Maternal Mortality Subcommittee
Professor Jodie Dodd	Chair, South Australian Maternal and Neonatal Clinical Network
Professor David Ellwood	Professor of Obstetrics & Gynaecology, School of Medicine, Gold Coast Campus, Griffith University
Professor Cynthia Farquhar	Past-Chair, Perinatal and Maternal Mortality Review Committee New Zealand
Professor Michael Humphrey (Chair)	Chair, Queensland Maternal and Perinatal Quality Council
Dr Jenny Hunt	Representative for the National Aboriginal Community Controlled Health Organisation
Ms Rebecca Jenkinson	Consumer representative, The Maternity Coalition
Professor Yee Khong	The Royal College of Pathologists of Australasia
Ms Ann Kinnear	Executive Officer, Australian College of Midwives
Dr Karin Lust	Council Member, Society of Obstetric Medicine Australia and New Zealand
Professor John Newnham	Western Australian Maternal Mortality Committee
Dr Nhi Nguyen	The College of Intensive Care Medicine

Professor Jeremy Oats	Chairman, Consultative Council on Obstetric and Paediatric Mortality and Morbidity, Victoria, and NT Integrated Maternity Services, Northern Territory Department of Health and Families
Professor Michael Permezel	President, The Royal Australian and New Zealand College of Obstetrics and Gynaecology
A/Professor John Smoleniec	New South Wales Perinatal and Maternal Mortality Committee
Professor Elizabeth Sullivan	Associate Dean (Research), University of Technology Sydney
Dr Nikki Whelan	Chair, Maternal Mortality Sub-Committee, Queensland Maternal and Perinatal Quality Council

Appendix B: Data quality statement

B.1 National Maternal Death Report Data Set

Summary of key issues

- The National Maternal Death Report Data Set provides national information for use in preparing a national report on women who died while pregnant or within 42 days of termination of pregnancy, between 2008 and 2012.
- Data sources, supply and quality varied considerably by state and territory.
- Legislative privacy restrictions and data approval processes differed by state and territory, and in some jurisdictions precluded full supply of maternal death data.
- Not all states and territories had active maternal mortality committees or subcommittees for the period of deaths. This has limited the quality and completeness of data supplied.
- National data were published less than 1 year after collection by the National Perinatal Epidemiology and Statistics Unit (NPESU) and within 3 years of the time frame for including maternal deaths of 31 December 2012.
- Data collection for some jurisdictions were retrospective and not from existing collections. Retrospective data collection limited the quality and completeness of data supplied.
- Methodology, definitions, classifications and reference periods for maternal death data collections differ significantly across states and territories, and comparisons between collections should be made with caution.

Description

The National Maternal Death Report Data Set (NMDRDS) is an ad-hoc national research data set collated from state and territory sources to be used in the preparation of the national report. The data set contains information on the deaths of women reported to have died while pregnant or within 42 days of termination of pregnancy, between 2008 and 2012. Data were supplied by state and territory health authorities to the NPESU. The data supplied by states and territories were primarily compiled from state and territory maternal death data collections or, where not available, other data sources. Data in the NMDRDS include data collected retrospectively and specifically by some states and territories to produce the maternal deaths report for 2008–2012. The state and territory health authorities receive clinical data on the women who died from patient administrative and clinical records, as well as from the state and territory maternal mortality committees or subcommittees where death reviews are undertaken. This information is usually collected through a variety of sources, including notifications from health professionals involved in the case, coronial reports and notifications from related data collections, including the jurisdictional register of births, deaths and marriages. States and territories use these data to determine cause of death, classification of death and for service planning, monitoring and internal and public reporting.

The organisational structure, roles and responsibilities of State and Territory Maternal Mortality Committees (STMMC) vary across states and territories. There is no standardised

method of identifying and collecting data on maternal deaths, and no nationally agreed process of reporting or investigation. Data from the NMDRDS, used to populate this report, reflect these inconsistencies.

States and territories supplied these data subject to national and jurisdictional ethics committee approvals. Ethics approval for this study was obtained from the: Australian Institute of Health and Welfare Human Research Ethics Committee (HREC); New South Wales Population Health HREC; Consultative Council on Obstetric and Paediatric Mortality and Morbidity HREC; Queensland Health HREC; Western Australia Department of Health HREC; Western Australian Aboriginal Health Ethics Committee; South Australia Health HREC; Health and Medical HREC, University of Tasmania; Australian Capital Territory Department of Health HREC; Northern Territory Department of Health and Menzies School of Health Research HREC; Aboriginal Health Research Ethics Committee, the National Coronial Information Service HREC; and the University of New South Wales HREC.

Institutional environment

The NPESU was established in 1979 to provide information and statistics in reproductive and perinatal health. The Unit is part of the University of New South Wales (UNSW) and is located at the Randwick Hospitals Campus, and since 1987 has been a collaborating unit of the Australian Institute of Health and Welfare (AIHW).

The AIHW is a major national agency set up by the Australian Government under the *Australian Institute of Health and Welfare Act 1987* to provide reliable, regular and relevant information and statistics on Australia's health and welfare. It is a corporate Commonwealth entity established in 1987, governed by a management board, and accountable to the Australian Parliament through the Health portfolio.

The AIHW aims to improve the health and wellbeing of Australians through better health and welfare information and statistics. It collects and reports information on a wide range of topics and issues, ranging from health and welfare expenditure, hospitals, disease and injury, and mental health to ageing, homelessness, disability and child protection.

The Institute also plays a role in developing and maintaining national metadata standards. This work contributes to improving the quality and consistency of national health and welfare statistics. The Institute works closely with governments and non-government organisations to achieve greater adherence to these standards in administrative data collections to promote national consistency and comparability of data and reporting.

One of the main functions of the AIHW is to work with the states and territories to improve the quality of administrative data and, where possible, to compile national data sets based on data from each jurisdiction, to analyse these data sets and disseminate information and statistics.

The *Australian Institute of Health and Welfare Act 1987*, in conjunction with compliance to the *Privacy Act 1988* (Cwlth), ensures that the data collections managed by the NPESU are kept securely and under the strictest conditions with respect to privacy and confidentiality.

For further information, see the AIHW website <www.aihw.gov.au>.

Timeliness

The NMDRDS is a report-specific ad-hoc data collection used to prepare the intended national report. Data are published in the *Maternal deaths in Australia* series. National data were published less than 1 year after collection of the data by the AIHW, and within 3 years of the time frame for including maternal deaths of 31 December 2012.

Accessibility

The NPESU provides a variety of products that draw upon the NMDRDS. Published products available are:

- *Maternal deaths in Australia* series
- *Maternal mortality: data linkage methodology – foundations for enhanced maternity data collection and reporting in Australia: National Maternity Data Development Project Stage 1* (publication second half 2015).

Data are also used in a number of other AIHW products including *Australia's health* and the *Australia's mothers and babies* series. Data are subject to strict confidentiality restrictions due to the small number of deaths and potential for identification, and is not generally available on request. In accordance with the HREC approvals, these data will be kept for 7 years from the date of report publication and will then be destroyed.

Interpretability

The organisational structure, including relevant legislation, policy and process for maternal death data collection, varies by state and territory. The NMDRDS reflects these variations. In all cases, the best available information was used to form the NMDRDS. Data provided by Western Australia has been subject to legislative privacy restrictions, and limited information was initially provided to the NPESU. Data as collected by the Western Australian Perinatal and Infant Mortality Committee were not provided and data were sourced from the Department of Health, Western Australia perinatal and hospital administrative data collections. Classification of death, as decided by the Maternal Mortality Committee, was subsequently supplied at a later date for some cases. During the development of the report, the New South Wales Maternal and Perinatal Committee were out of term and a number of cases were provided to the NPESU as not yet reviewed by the New South Wales Maternal and Perinatal Committee. For some cases, only very limited information was available.

An overview of each state's maternal death data collection process is outlined below:

- The New South Wales Ministry of Health is notified of maternal deaths through a variety of organisations and methods, including hospitals, the Department of Forensic Medicine at Glebe, Ministry of Health systematic searches of New South Wales population health data sets (e.g. Admitted Patient Data Collection and the New South Wales Perinatal Data Collection) and through the National Coronial Information System. The number of maternal deaths for each year is assessed against Australian Bureau of Statistics (ABS) mortality data, where available (deaths with an International Statistical Classification of Diseases and Related Health Problems, 10th edition (ICD-10) cause of death code commencing with an 'O') to maximise ascertainment.
- In Victoria, maternal deaths are identified through direct notification by health services, Victorian Perinatal Data Collection Unit (birth forms), the Coroner's Office, the Registrar

of Births, Deaths and Marriages and through media reports. In 2010, automatic electronic notification through coronial e-Medical Deposition Form was introduced.

- Queensland Health conducts dedicated searches of hospital administrative data sets intended for the sole purpose of identifying maternal deaths. In 2012, the Minister of Health approved consideration of changes to the *Public Health Act 2005* to mandate reporting of maternal deaths to the Department (working with the Queensland Maternal and Perinatal Quality Council).
- South Australia Health has no formal process of maternal death notification in place. The Maternal Mortality Committee accesses multiple notifications, including review of media articles, word of mouth, clinicians, pathologists and sentinel event reporting from hospitals. Although there is a tick box on death certificates to indicate if a woman has been pregnant in the last 3 months, this has never been a source of notification to the Maternal Mortality Committee of a maternal death. Hospital separation discharge codes are also reviewed as a quality check to identify maternal deaths. However, to date, this process has never informed the Maternal Mortality Committee of a maternal death the Committee was not already aware of. Similarly, sentinel event reporting has not identified a new maternal death to this Committee.
- The Tasmanian Department of Health and Human Services is notified of maternal deaths through the following sources: health statistics, the Register of Births, Deaths and Marriages and local clinicians who are members of the Tasmanian Council of Obstetric and Paediatric Mortality & Morbidity (COPMM) (state-wide) and local hospital Morbidity and Mortality Committees.
- Information on the process of notification and data collection were not provided by the Australian Capital Territory Department of Health.

Northern Territory Department of Health undertook a process of maternal death ascertainment and review specifically to supply data to the NMDRDS.

Relevance

The NMDRDS is a specification for data compiled primarily from state and territory maternal death data collections or, where not available, other data sources. Data were requested on the death of all women reported to have died while pregnant or within 42 days of termination of pregnancy in Australia in hospitals, birth centres and the community between 2008 and 2012. Information was collected from each state and territory health department through the completion of a standardised data collection form: the NMDR form 2006–2010. Specifications for the NMDR form 2006–2010 were developed using nationally standardised data as entered into the National health data dictionary, which has an repository, METeOR—AIHW online metadata repository. It includes data items relating to the mother, including demographic characteristics and factors relating to the pregnancy, labour and birth; details of death; classification of death and data items relating to the baby, including birth status; and any additional case summaries.

A National Maternal Mortality Advisory Committee (NMMAC) was convened to oversee the process of data collection for the maternal death report. A subcommittee of the NMMAC, the National Maternal Mortality Advisory Committee—Report Working Group, was established to oversee the development of NMDR form 2006–2010 and a system of maternal death classification.

The NMDR form 2006–2010 was limited in the information that could be collected due to the retrospective data collection and advice from states and territories regarding availability of data. NMMAC revised the process for data collection for the maternal death report for the years 2011 and 2012, with NMDR form 2011–2012, as part of a broader project to produce a uniform National Maternal Death Reporting form for use by clinicians reporting deaths to the jurisdictional STMMC.

Accuracy

Inaccurate responses may occur in all data provided to the NPESU. The NPESU does not have direct access to maternal mortality committee records to determine the accuracy of the data provided. However, the NPESU undertakes validation on receipt of data. Data received from states and territories are checked for completeness, validity and logical errors. Potential errors are queried with jurisdictions, and corrections and resubmissions are made in response to these edit queries. Any cases without outstanding issues are reviewed by the NMMAC. The NPESU does not adjust data to account for possible data errors.

Errors may occur during the processing of data by the states and territories or at the NPESU. Processing errors prior to data supply may be found through the validation checks applied by the NPESU. The data are corrected when verification of an error was supplied.

The NPESU does not adjust the data to correct for missing values.

Prior to publication, data are referred back to jurisdictions for checking and review. Note that because of data editing and subsequent updates of state/territory information, numbers reported may differ from those in reports published by the states and territories.

Coherence

The NMDRDS is a one-off data set collected specifically for use in *Maternal deaths in Australia 2008–2012*. Similar data sets have been compiled for previous reports in the *Maternal deaths in Australia* series. Although definitions and some individual data elements have changed over time in response to expert review, changes in international definitions and coding relating to maternal deaths, in many cases it is possible to map these changes and make meaningful comparisons over time. However, due to the overlapping time periods in the *Maternal deaths in Australia 2006-2010* and *Maternal deaths in Australia 2008–2012* reports, caution should be used in interpreting recent trends.

State and territory health authorities compile statistics and publish reports on maternal deaths. Methodology, definitions, classifications and reference periods for these collections differ significantly across states and territories, and comparisons between states and territories should be made with caution.

Appendix C: Ethics approval

Human research ethical approval for compilation of the research data set and *Maternal deaths in Australia 2006–2010* report (AIHW et al. 2014) was obtained from the following Human Ethics Research Committees (HRECs), and has been extended to cover the period 2011–2012:

- The Australian Institute of Health and Welfare Ethics Committee
- The University of New South Wales Human Research Ethics Committee
- The Consultative Council on Obstetric and Paediatric Mortality and Morbidity (Victoria)
- New South Wales Population Health Services Research Ethics Committee
- Government of Western Australia, Department of Health, Human Research Ethics Committee
- Government of South Australia, SA Health, Human Research Ethics Committee
- Queensland Government, Queensland Health, Human Research Ethics Committee, Centre for Healthcare Improvement
- University of Tasmania, Human Research Ethics Committee (Tasmania) Network
- Human Research Ethics Committee of Northern Territory, Department of Health and Menzies School of Health Research
- The National Coronial Information System, Department of Justice, Human Research Ethics Committee
- Australian Capital Territory, Department of Health, ACT Health Human Research Ethics Committee

  In satisfaction of the conditions of the ethics approval from the Australian Capital Territory, it is noted that the Australia Capital Territory Health's Directorate Human Research Ethics Committee approved this project on 8 February 2012.

Aboriginal Health Ethics Committee approval was sought from states and territories where a separate committee or subcommittee was established. Approval was obtained from:

- Aboriginal Health Council of South Australia, Aboriginal Health Research Ethics Committee
- Western Australian Aboriginal Health Ethics Committee
- Northern Territory Department of Health and Menzies School of Health Research Aboriginal Ethics Sub Committee.

Glossary

Aboriginal and Torres Strait Islander: A person of Aboriginal and/or Torres Strait Islander descent who identifies as an Aboriginal and/or Torres Strait Islander. See also **Indigenous**.

acute: Coming on sharply and often brief, intense and severe.

administrative data collection: A data set that results from the information collected for the purposes of delivering a service or paying the provider of the service. This type of collection is usually complete (i.e. all in-scope events are collected), but it may not be fully suitable for population-level analysis because the data are collected primarily for an administrative purpose. An example is the Alcohol and Other Drug Treatment Services National Minimum Data Set.

amniotic fluid embolism (AFE): A rare obstetric emergency in which it is postulated that amniotic fluid, fetal cells, hair or other debris enter the maternal circulation, causing cardiorespiratory collapse.

antenatal: The period covering conception up to the time of birth. Synonymous with **prenatal**.

arrhythmia: A disturbed rhythm of the heartbeat—too fast, too slow or irregular.

assisted reproductive technology: Treatments or procedures that involve the in vitro handling of human oocytes (eggs) and sperm or embryos for the purposes of establishing a pregnancy.

asthma: A common, chronic inflammatory disease of the air passages that presents as episodes of wheezing, breathlessness and chest tightness due to widespread narrowing of the airways and obstruction of airflow. The symptoms may reverse without treatment, but often treatment is required. Different medications can prevent the episodes or relieve them.

atherosclerosis: A process in which fatty and fibre-like deposits build up on the inner walls of arteries, often forming plaques that can then cause blockages. It is the main underlying condition in heart attack, angina, stroke and peripheral vascular disease.

birth status: Status of the baby immediately after birth.

birthweight: The first weight of the baby (stillborn or liveborn) obtained after birth (usually measured to the nearest 5 grams and obtained within 1 hour of birth).

blood pressure: The force exerted by the blood on the walls of the arteries as it is pumped around the body by the heart. It is written, for example, as 134/70 mmHg, where the upper number is the systolic pressure (the maximum force against the arteries as the heart muscle contracts to pump the blood out) and the lower number is the diastolic pressure (the minimum force against the arteries as the heart relaxes and fills again with blood). Levels of blood pressure can vary greatly from person to person and from moment to moment in the same person.

body mass index (BMI): The most commonly used method of assessing whether a person is normal weight, underweight, overweight or obese (see **obesity**). It is calculated by dividing the person's weight (in kilograms) by their height (in metres) squared; that is, kg ÷ m^2. For both men and women, underweight is a BMI below 18.5, acceptable weight is from 18.5 to less than 25, overweight is from 25 to less than 30, and obese is 30 and over. Sometimes overweight and obese is combined, and is defined as a BMI of 25 and over.

caesarean birth (also caesarean section or c-section): A method of birth in which a surgical incision is made into the mother's womb via the abdomen to directly remove the baby.

cholecystitis: Inflammation of the gallbladder.

chorioamnionitis: An inflammation, usually from an infection, of the membranes surrounding the fetus.

confidence interval (CI): A statistical term describing a range (interval) of values within which we can be 'confident' that the true value lies, usually because it has a 95% or higher chance of doing so.

diabetes (diabetes mellitus): A chronic condition in which the body cannot properly use its main energy source: the sugar glucose. This is due to a relative or absolute deficiency in insulin: a hormone that is produced by the pancreas and helps glucose enter the body's cells from the bloodstream and then be processed by them. Diabetes is marked by an abnormal build-up of glucose in the blood, and it can have serious short- and long-term effects.

eclampsia: The occurrence of 1 or more convulsions not caused by other conditions, such as epilepsy or cerebral haemorrhage, in a woman with pre-eclampsia. The onset of convulsions may be preceded by a sudden rise in blood pressure and/or a sudden increase in oedema and development of oliguria.

ectopic pregnancy: The development of a fetus at a site other than in the uterus. This may happen if the fertilised egg cell remains in the ovary or in the tube leading from near the ovary to the uterus (the Fallopian tube), or if it lodges in the free abdominal cavity.

embolism: The condition in which an embolus becomes lodged in an artery and obstructs its blood flow. The most common form of embolism is pulmonary embolism, in which a blood clot is carried in the circulation to lodge in the pulmonary artery.

epilepsy: A disturbance of brain function marked by recurrent fits and loss of consciousness.

factor V Leiden deficiency: a genetically inherited disorder of blood clotting that causes an increase in blood clotting (thrombophilia).

fetal death (stillbirth): Death before the complete expulsion or extraction from its mother of a product of conception of 20 or more completed weeks of gestation or of 400 grams or more birthweight. The death is indicated by the fact that after such separation, the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles.

gestational age: The duration of pregnancy in completed weeks calculated from the date of the first day of a woman's last menstrual period and her baby's date of birth, or via ultrasound, or derived from clinical assessment during pregnancy or from examination of the baby after birth.

gestational diabetes: A form of diabetes that is first diagnosed during pregnancy (gestation). It may disappear after pregnancy but signals a high risk of diabetes occurring later on.

grand multipara: Pregnant woman who has had 4 or more previous pregnancies resulting in a live birth or stillbirth.

haemorrhage (bleeding): The escape of blood from a ruptured blood vessel, externally or internally.

HELLP syndrome: A severe complication of pre-eclampsia characterised by Haemolysis, Elevated Liver enzymes and Low Platelet count; the syndrome name is an abbreviation of the 3 main features of the syndrome.

Indigenous: A person of Aboriginal and/or Torres Strait Islander descent who identifies as an Aboriginal and/or Torres Strait Islander. See also **Aboriginal and Torres Strait Islander**.

induction of labour: Intervention to stimulate the onset of labour.

influenza (flu): An acute contagious viral respiratory infection marked by fevers, muscle aches, headache, cough and sore throat.

intrapartum: Occurring during childbirth or during the birth process.

ischaemic heart disease: Also heart attack and angina (chest pain). Also known as 'coronary heart disease'.

live birth: The complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered live born (WHO definition).

Marfan's syndrome: A hereditary condition that affects the musculoskeletal system and is often associated with abnormalities of the cardiovascular system and the eyes. Inherited as an autosomal-dominant trait, Marfan's syndrome affects men and women equally. Its major musculoskeletal effects include muscular underdevelopment, ligamentous laxity, joint hypermobility and bone elongation.

maternal age: Mother's age in completed years at the birth of her baby.

maternities: In the NZ/UK, defined as the number of pregnancies that result in a live birth at any gestation or stillbirths occurring at or after 24 completed weeks of gestation.

median: The midpoint of a list of observations that have been ranked from the smallest to the largest.

menarche: The start of the menstrual periods and other physical and mental changes associated with puberty.

morbidity: Refers to ill health in an individual and to levels of ill health in a population or group.

mortality: Death.

multipara: Pregnant woman who has had at least 1 previous pregnancy resulting in a live birth or stillbirth.

neonatal death: Death of a live born baby within 28 days of birth.

non-Indigenous: People who have declared they are not of Aboriginal or Torres Strait Islander descent. Compare with **other Australians**.

nullipara: A women who has not given birth prior to the current pregnancy.

obesity: Marked degree of overweight, defined for population studies as a **body mass index** of 30 or over.

other Australians: People who have declared they are not of Aboriginal or Torres Strait Islander descent, and those for whom their Indigenous status is unknown. Compare with **non-Indigenous**.

parity: Number of previous pregnancies resulting in live births or stillbirths, excluding the current pregnancy.

perinatal: Pertaining to or occurring in the period shortly before or after birth (usually up to 28 days after).

postnatal: Occurring after birth, with reference to the newborn.

postpartum: Occurring after childbirth, with reference to the mother.

psychosocial morbidity: Describes deaths in which a psychiatric condition contributed to the cause of death.

puerperal psychosis: Covers a group of mental illnesses with the sudden onset of psychotic symptoms following childbirth.

puerperium: The period of up to about 6 weeks after childbirth, during which the uterus returns to its normal size.

rate: Is 1 number (the numerator) divided by another number (the denominator). The numerator is commonly the number of events in a specified time. The denominator is the population 'at risk' of the event. Rates (crude, age-specific and age-standardised) are generally multiplied by a number such as 100,000 to create whole numbers.

relative risk: The relative risk compares 2 groups for their likelihood of an event. Another term for the relative risk is the risk ratio because it is the ratio of the risk in the 'exposed' divided by the risk in the 'unexposed'. It is also known as the rate ratio.

sepsis: Refers to a bacterial infection in the bloodstream or body tissues. This is a very broad term covering the presence of many types of microscopic disease-causing organisms.

spontaneous vaginal birth: Birth without intervention in which the baby's head is the presenting part.

stillbirth: see **fetal death (stillbirth)**.

suicide: Deliberately ending one's own life.

tetralogy of Fallot: Congenital heart defect that is classically understood to involve 4 anatomical abnormalities of the heart.

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Related publications

- AIHW, *Maternal deaths in Australia* series. Canberra: AIHW.
- AIHW, *Australia's mothers and babies* in Perinatal statistics series. Canberra: AIHW.

Maternal deaths in Australia 2008–2012 is the 16th report on women who die in association with pregnancy and childbirth. Maternal death review is one of the oldest known forms of clinical care quality assurance. Maternal death in Australia is a rare event in the context of worldwide maternal deaths. In 2008–2012, there were 105 maternal deaths in Australia that occurred within 42 days of the end of pregnancy, representing a maternal mortality ratio (MMR) of 7.1 deaths per 100,000 women who gave birth. All such deaths should be seen as devastating for the woman's family and community, and should be carefully examined for possible lessons learned that may prevent future similar events.