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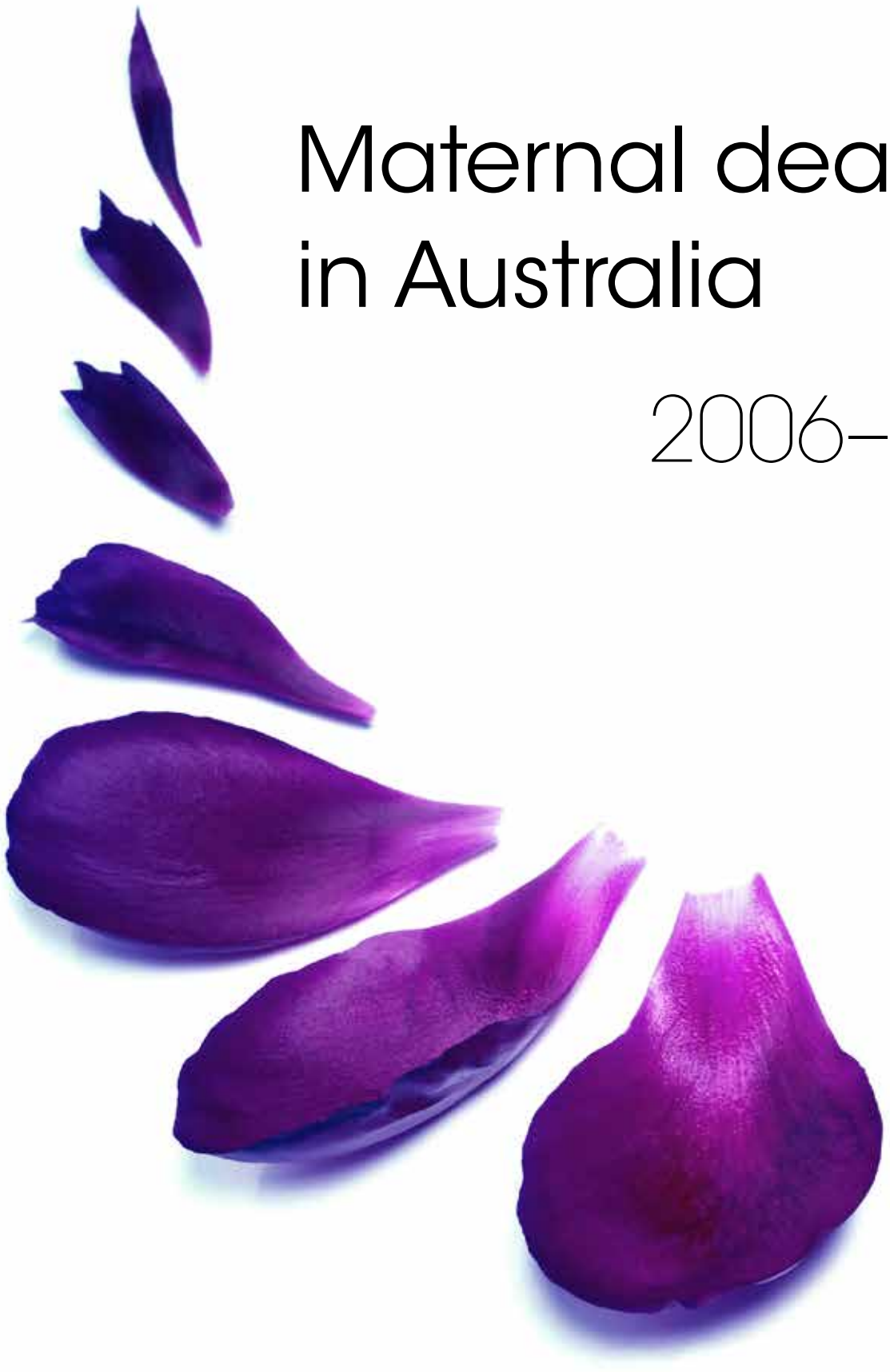

Maternal deaths in Australia

2006–2010

Australian Government
Australian Institute of Health and Welfare

Authoritative information and statistics to promote better health and wellbeing

MATERNAL DEATH SERIES
Number 4

Maternal Deaths in Australia

2006–2010

Australian Institute of Health and Welfare
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Contents

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6 Incidental deaths: Professor Hank Weiss
7 Aboriginal and Torres Strait Islander Women: The National Aboriginal Perinatal Reference Group
8 Coronial review: Professor Yee Khong and the Royal College of Pathologists of Australasia Forensic Advisory Committee

Abbreviations

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AFE	amniotic fluid embolism
AH&MRC	Aboriginal Health and Medical Research Council of NSW
AHS	Aboriginal Health Service
AIHW	Australian Institute of Health and Welfare
AMI	acute myocardial infarction
AMOSS	Australasian Maternity Outcomes Surveillance System
AMSANT	Aboriginal the Medical Services Alliance Northern Territory
ANZICS	Australian and New Zealand Intensive Care Society
ASGC	Australian Standard Geographical Classification
AVSD	atrial ventricular septal defect
BMI	body mass index
CI	confidence interval
CMACE	Centre for Maternal and Child Enquiries
CS-MMR	cause-specific maternal mortality ratio
GAS	group A beta haemolytic streptococcus
hCG	human chorionic gonadotropin
HREC	Human Research Ethics Committee
ICU	intensive care unit
INOSS	International Network of Obstetric Survey Systems
LMWH	low molecular weight heparin
MDG	Millennium Development Goals
MMR	maternal mortality ratio
MMRWG	Maternal Mortality Review Working Group
MSIJC	Maternity Services Inter-jurisdictional Committee
NACCHO	National Aboriginal Community Controlled Health Organisations
NHMRC	National Health and Medical Research Council
NMMAC	National Maternal Mortality Advisory Committee
NMMAC-CCWG	National Maternal Mortality Advisory Committee–Clinical Classifications Working Group

NMMAC–RWG	National Maternal Mortality Advisory Committee–Report Working Group
NMDR	National Maternal Death Reporting
NMDRD	National Maternal Death Report Data Set
NMDDP	National Maternity Data Development Project
NPDI	National Perinatal Depression Initiative
NPESU	National Perinatal Epidemiology and Statistics Unit
PMMRC	Perinatal and Maternal Mortality Review Committee
PPH	postpartum haemorrhage
PPROM	prolonged premature rupture of membranes
PRERU	Perinatal and Reproductive Epidemiology Research Unit
QAIHC	Queensland Aboriginal and Islander Health Council
RANZCOG	The Royal Australian and New Zealand College of Obstetrics and Gynaecology
RCA	root cause analysis
RCOG	Royal College of Obstetricians and Gynaecologists
RCPATH	Royal College of Pathologists
RHD	rheumatic heart disease
SOMANZ	Society of Obstetric Medicine of Australia and New Zealand
SAA	splenic artery aneurysm
SAC	Severity Assessment Code
STMMC	State and Territory Maternal Mortality Committee
TOP	termination of pregnancy
UH	unfractionated heparin
UK	United Kingdom
UKOSS	United Kingdom Obstetric Surveillance System
UNSW	University of New South Wales
US	United States
VACCHO	Victorian Aboriginal Community Controlled Health Organisation
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 2006–2010 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.

Maternal mortality rates remained low for Australian women

In 2006–2010 in Australia, there were 99 maternal deaths that occurred within 42 days of the end of pregnancy. The maternal mortality ratio (MMR) was 6.8 deaths per 100,000 women who gave birth. The MMR for 2003–2005 was 8.4 and 11.1 for 2000–2002. These data should be interpreted with caution due to the rarity of maternal deaths in Australia and the associated volatility of small numbers.

There were 39 maternal deaths directly related to the pregnancy in 2006–2010. Fifty-seven deaths were indirect maternal deaths and due to non-pregnancy-related conditions. Women aged 40 and over, with higher parity, of Aboriginal and Torres Strait Islander origin, or with *Remote* or *Very remote* usual residence were among those at increased risk of maternal death.

Australia's MMR is lower than New Zealand and United Kingdom for comparable years but accurate comparisons are limited due to different maternal mortality review processes, classifications and ascertainment measures.

Maternal mortality rates were higher for Aboriginal and Torres Strait Islander women

Aboriginal and Torres Strait Islander women were almost 3 times as likely to die as non-Indigenous women, with a maternal mortality ratio of 16.4 deaths per 100,000 Indigenous women giving birth. Sepsis and cardiac conditions were the leading causes of maternal death for Indigenous Australians.

Key causes of direct and indirect maternal deaths in Australia in 2006–2010

- The leading causes of direct maternal deaths were amniotic fluid embolism (9), thromboembolism (8), obstetric haemorrhage (7) and eclampsia (6), and, when combined, accounted for more than three-quarters of all direct maternal deaths.
- There were 15 deaths due to cardiac disease, the leading cause of indirect maternal death. Preconception counselling and assessment for women with cardiac disease and referral to appropriate multidisciplinary tertiary services is essential.
- There were 13 deaths due to psychosocial causes, including 9 due to suicide. Universal psychosocial screening is critical in identifying women at risk of psychosocial morbidity in the antenatal period, and clear referral guidelines and the treatment of significant maternal psychiatric morbidity important in preventing maternal deaths.
- Five non-obstetric haemorrhage deaths resulted from rupture of a splenic artery aneurysm.
- There were 3 deaths due to ectopic pregnancy in 2006–2010. Seven pregnant women died in motor vehicle accidents. Three women died from epilepsy.

1 Introduction

The World Health Organization (WHO) estimates that worldwide 287,000 women die each year from complications of pregnancy and childbirth (Lee et al. 2012; WHO 2012). Each of these deaths is a tragedy for the women who die and the families they leave behind. Maternal mortality is rare in Australia and only a small portion of pregnancy-related morbidity. Nevertheless, it remains an important measure of maternity services and obstetric care. This is the 15th 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 publishing data on maternal mortality for the triennium 1964–1966, maternal deaths have decreased by nearly two-thirds. There are impressive examples of how maternal mortality reporting has influenced maternity services policy and planning, which has resulted in a decline in cause-specific maternal deaths (CMACE 2011). This was illustrated in the United Kingdom (UK) where there was a significant fall in the number of deaths from thromboembolism from 41 deaths in 2003–2005 to 16 deaths in 2006–2008 following the publication of guidelines on the management of thromboprophylaxis during pregnancy, labour and after normal birth (CMACE 2011:57).

1.1 Background to the report

This report has been developed in the context of international and national actions to improve maternity care and outcomes for mothers and their babies.

The United Nations Millennium Development Goals (MDGs) were developed as a framework for the international community to work together to improve the health of all people. The fifth MDG is 'Improve maternal health', and this improvement will be measured using 2 targets:

1. Reduce the maternal mortality ratio by three-quarters, between 1990 and 2015.
2. Achieve universal access to reproductive health by 2015.

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 (Australian Health Ministers' Conference 2011).

The National Maternity Services Plan

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 (Australian Health Ministers' Conference 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 (Australian Health Ministers' Conference 2011). In

particular, the Plan's priority areas are: to meet the needs of women and their families living in rural and remote areas; improving birth outcomes for Aboriginal and Torres Strait Islander people; and meeting the requirements of women who are vulnerable due to medical or other risk factors (Australian Health Ministers' Conference 2011). The Plan targets primary maternity services during the antenatal, intrapartum and 6-week postnatal period for both women and babies. In 2011, the then Australian Government Department of Health and Ageing provided funding for the National Maternity Data Development Project (NMDDP).

National Maternity Data Development Project—Stage 1

The NMDDP was set up in response to Recommendation 1 of the *Improving maternity services in Australia: the report of the Maternity Services Review* and Action Item 4.1.5 of the Plan to develop a nationally consistent and comprehensive maternal and perinatal mortality and morbidity data collection in Australia. The NMDDP is made up of a number of inter-related components (Figure 1.1).

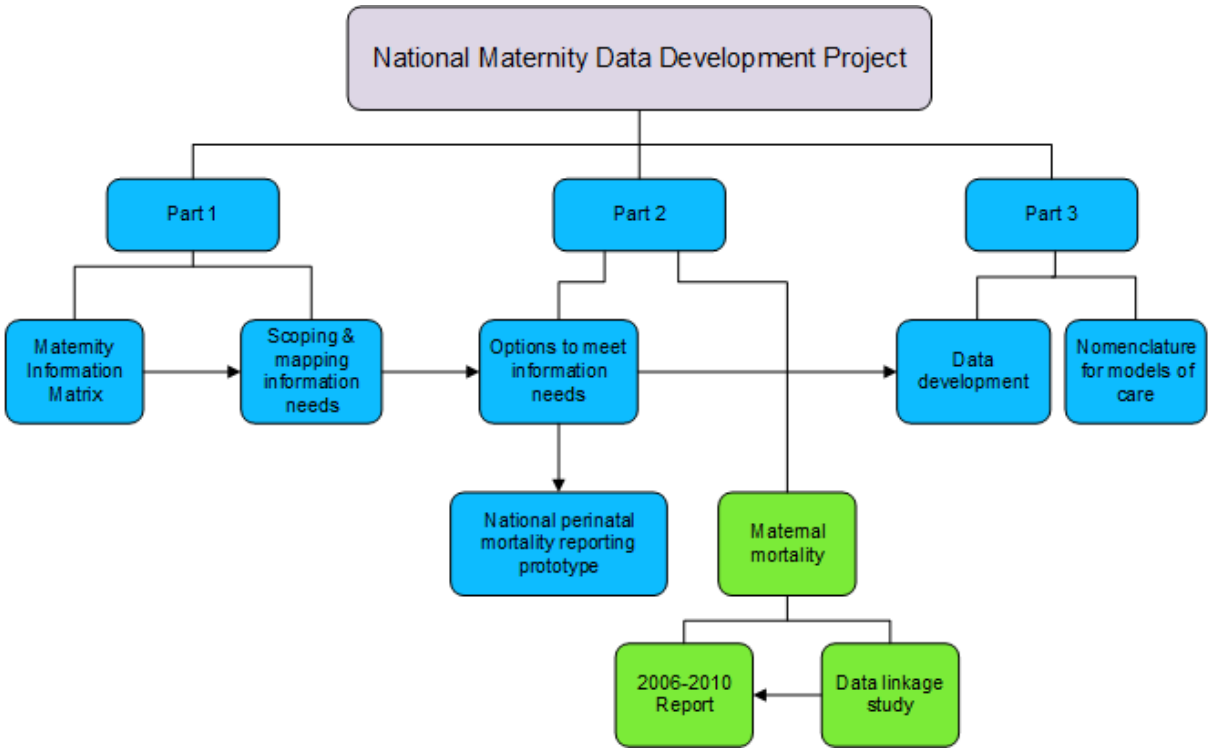


Figure 1.1: National Maternity Data Development Project—Stage 1 components

The primary aims of the NMDDP are to develop a nationally consistent and comprehensive maternal and perinatal mortality and morbidity data collection in Australia. The availability of high-quality and nationally consistent data is required to assess the safety and outcomes of current and emerging models of maternity care in Australia. This will also enable the monitoring of disparities in health outcomes for population sub-groups compared with the general population. The publication, *Foundations for enhanced maternity data collection and reporting in Australia: National Maternity Data Development Project Stage 1* reports on the progress and achievements of the first stage of the NMDDP from 2011–2013 (AIHW 2014).

National Maternal Mortality Advisory Committee

The National Maternal Mortality Advisory Committee (NMMAC) was convened to provide guidance and national relevance to the development of the national maternal death report (refer to Appendix A for a list of members). It is a subcommittee of the NMDDP Advisory Group. The NMMAC provided expert advice to the project, including strategic advice, facilitation of data supply and provision of clinical commentary and good practice guidance.

Two subcommittees of the NMMAC were convened to provide expert advice regarding clinical classification and interpretation of data, and to assist with specific components of the project:

- National Maternal Mortality Advisory Committee–Report Working Group (NMMAC–RWG): to oversee the development of national data collection forms and a system of maternal death classification (refer to Appendix B for a list of members).
- National Maternal Mortality Advisory Committee–Clinical Classifications Working Group (NMMAC–CCWG): for national classification of maternal deaths not previously classified by the State and Territory Maternal Mortality Committees (refer to Appendix C for a list of members).

1.2 Purpose of this report

The 'maternal mortality' component of the NMDDP specifically addresses the National Maternity Services Plan Priority Action 2.1, which recommends that a national maternal mortality review process be established and that national maternal mortality reports are produced (Australian Health Ministers' Conference 2011). This report details a national observation of 5 years of maternal deaths from 2006 to 2010.

National data systems and processes can drive improved performance in both private and public maternity care settings. Internationally, maternal mortality is used in comparisons of maternal health outcomes across countries, and is also used as an indicator of society's health-care services. Detailed examination and reporting of these deaths can inform policy and improve maternity care practices.

1.3 Aims of this report

- Provide an overview of maternal mortality from collated information on maternal deaths in Australia during the period 1 January 2006 to 31 December 2010.
- 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.
- 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 and nationally.

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 2006 to 2010.

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

Chapter 5 provides detailed information on maternal deaths related to psychosocial morbidity.

Chapter 6 provides detailed information on incidental maternal deaths.

Chapter 7 provides detailed information on maternal deaths of Aboriginal and Torres Strait Islander women.

Chapter 8 provides an overview of the role of the coroner in reporting of maternal deaths.

Chapter 9 outlines the sources that provide review of maternal deaths.

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

2 Definitions, classifications 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 edn* (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[(a)] 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, which 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
Unclassifiable maternal 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 edn, 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 jurisdictional or coronial investigation were not completed, and 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'.

Classification of deaths related to psychosocial morbidity

Psychosocial illness is 1 of the leading causes of maternal death in Australia. Since the 1997–1999 triennium, Australia has classified, for national reporting, maternal 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 an indirect maternal death, and deaths deemed unrelated to the pregnancy due to 'external causes' as incidental. The classification practice for psychosocial deaths that occurred between 2006 and 2010 remained unchanged from the previous triennia.

2.2 Measuring maternal mortality

The maternal mortality ratio (MMR) is used to measure maternal mortality. In line with international conventions (WHO 1992), the MMR is calculated using direct and indirect deaths combined, but excludes coincidental (termed 'incidental' in Australia) deaths (see Box 2.1).

The WHO definition specifies that the number of live births or the number of total births (live births plus fetal deaths) can be used as the denominator, and where both denominators are available, both calculations are made (WHO 1992). Internationally, there are a number of different denominators used for calculating maternal mortality, dependent upon the data available. The most appropriate denominator for estimating maternal mortality is the number of women at risk; that is, the number of pregnant or recently pregnant women. These data are not available in Australia, with the number of pregnancies ending before 20 weeks gestation 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 or more completed gestation or 400 grams or more birthweight and this is the denominator population used to calculate the MMR in this report.

Box 2.1: 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 before 1997–1999 included incidental deaths in the definition and calculation of the MMR. Caution must therefore be taken when comparing MMRs from triennia before 1997–1999 with MMRs from the 1997–1999 triennium onwards.

Data for 2006–2010 maternal deaths

Comprehensive review of maternal deaths and the comparison of outcomes across jurisdictions and internationally requires complete ascertainment and a consistent classification system (Allen et al. 2010). During the period 2006–2010, there were no recognised standard definitions or criteria that defined which causes of death should be counted as direct or indirect maternal deaths. *Application of ICD-10 to deaths during pregnancy, childbirth and the puerperium: ICD-MM* (WHO 2012) meets this need, but was not available for the entire 2006–2010 maternal death data collection period.

There is a 2-tier arrangement for reviewing and classifying maternal deaths in Australia: the primary review is undertaken by states and territories and a subsequent review is undertaken by the NMMAC after collation of the data into the National Maternal Death Report Data Set.

State and Territory Maternal Mortality Committees and subcommittees

For the period 2006–2010, confidential enquiry was undertaken by 7 State and Territory Maternal Mortality Committees (STMMCs) or subcommittees. 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.

Deaths are notified to the STMMCs by a wide variety of sources and professional groups, including clinicians, midwives, hospitals, health departments and coroners, and also via notifications from autopsy investigations, perinatal and hospital morbidity collections and from the Registrars of Births, Deaths and Marriages. The committees operate under legal privilege and are provided with clinical information and the results of autopsy investigations where available. This enables the STMMCs 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. A more detailed review of these is provided in 'Chapter 9 Quality of maternal death reviews in Australia'.

National data collection form

Collection of data for the 2006–2010 maternal deaths report was achieved using the National Maternal Death Reporting form 2006–2010 (NMDR form 2006–2010). This form was developed to standardise data collection from STMMCs and was developed in consultation with the NMMAC–Report Working Group (RWG). This form was based on the form used for previous reports and enhanced by a review of data items against the New Zealand retrospective maternal death reporting form, the UK's maternal death surveillance form and from feedback from the NMMAC–RWG. In response to concerns about maternal death data availability and completeness, the form was shortened to reduce the burden on the jurisdictional health authorities, and to improve jurisdictional capacity to provide the data requested within the necessary timeframe.

The NMDR form 2006–2010 was used to collect information across jurisdictions on all known deaths occurring during the period from 1 January 2006 to 31 December 2010. Information was requested about each death notified to STMMCs and the outcome of the confidential enquiry.

National maternal death report database

The information provided on the NMDR 2006–2010 form was checked and internal validation carried out before the data were compiled into the National Maternal Death Report Database 2006–2010 (NMDRD 2006–2010).

Most jurisdictions returned completed NMDR 2006–2010 forms to the Australian Institute of Health and Welfare (AIHW) National Perinatal Epidemiology and Statistics Unit (NPESU) and the data were entered into the NMDRD 2006–2010. The New South Wales Ministry of Health provided an extract from their maternal deaths database that was used to enter information directly into the NMDRD 2006–2010. Ten per cent of records had dual entry to check for logical errors and validity of data.

The database was updated in March 2013 when the Western Australian Department of Health supplied cause of death and classification of death from the Perinatal and Infant Mortality Committee of Western Australia.

The NMDR form 2006–2010 requested limited information on the babies of the women who died. These data were incomplete and have not been included in this report.

A data quality statement for the NMDRD 2006–2010 is set out in Appendix D. The database was used to generate standard reports on deaths for review by the NMMAC and the final classifications were used to produce tabulations for this report.

National review of maternal death classifications

Details of the maternal deaths, including the preliminary cause of death and the classifications provided by STMMCs, were reviewed by the NMMAC Clinical Classifications Working Group subcommittee in October 2012 to ensure national consistency of classification.

In most cases, the STMMC classification was applied. The NMMAC Clinical Classifications Working Group reviewed 21 cases of maternal death. Cases from some jurisdictions had not been assigned a classification of death. There were 8 deaths that the NMMAC Clinical Classifications Working Group was unable to classify fully. However, further correspondence with jurisdictions on a number of deaths occurred subsequently. The Department of Health in Western Australia subsequently supplied classifications of maternal deaths in March 2013. These classifications were used in the report. Seven maternal deaths were unable to be classified. Four complex cases had insufficient information to categorise the specific cause of maternal death and assign them as direct or indirect deaths. They were considered as maternal deaths, not further classified and included in the calculations for the MMR. One is considered in 'Section 4.2 Non-obstetric haemorrhage', 1 in 'Section 4.7 Sepsis' and the 2 other cases are included in 'Section 4.10 Deaths due to other causes'. The remaining 3 cases had inadequate information to determine whether a maternal death classification or a classification as an incidental death should be applied and were thus unclassifiable. These cases were not included in MMR calculations.

Supplementary data

Survey on jurisdictional maternal death reporting practices

A survey on jurisdictional maternal death reporting practices was undertaken in June 2012. State and territory health authorities were asked to provide details about jurisdictional legislation and data collection practice and processing, and systems of review of material related to maternal deaths, in particular the process of referral to the coroner. This survey informed 'Chapter 8 Coronial review' and 'Chapter 9 Quality of maternal death reviews in Australia'.

The Australasian Maternity Outcomes Surveillance System

Supplementary data were provided from the Australasian Maternity Outcomes Surveillance System (AMOSS) that conducts prospective, national population-based studies and surveillance of serious morbidity in pregnancy in nearly 300 maternity units across Australia and New Zealand. Research and support for translation of evidence-based practice and education for clinicians are carried out in conjunction with international collaborations with UK Obstetric Surveillance System (UKOSS) and International Network of Obstetric Survey Systems (INOSS). Selected information on the incidence, management and outcomes of severe and rare conditions in pregnancy has been gained through AMOSS studies, and were included in relevant chapters of this report from AMOSS studies on the H1N1 influenza pandemic and influenza A with admission to intensive care, and from 2010–2012, antenatal pulmonary embolism, amniotic fluid embolism, eclampsia, placenta accreta and peripartum

hysterectomy studies. The AMOSS project was funded by the National Health and Medical Research Council (NHMRC) Project Grant #510298 (2008–2012).

Reporting maternal deaths 2006–2010

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. A number of these components were out of scope for the previous maternal death report, *Maternal deaths in Australia 2003–2005* (Sullivan et al. 2007), published in 2008, and have been re-introduced for this report following consultation with the NMMAC.

Historically, data have been collected for 3-year reporting periods. For this report, 5 years of data were collected. The rationale for the longer reporting period is to aggregate larger numbers of deaths, which increases the capacity to identify trends, maintain privacy and improve the timeliness of reporting.

Information related to the assessment of avoidable factors or preventability surrounding the deaths has not been included in this report. This was a decision of the NMMAC and was made due to the lack of a nationally consistent approach to assessment of preventability and the retrospective nature of the data collection. This information is not readily available or routinely collected in all jurisdictions. The most recent data available for inclusion in this report were from 2010. For some STMMCs, a number of deaths remain unreviewed as late as 2012. These deaths were reviewed by the NMMAC–CCWG with all available information, and a classification of death was assigned if possible. Western Australia provided limited data for inclusion in the report due to legislative privacy restrictions on the sharing of data.

Case summaries

Case summaries or vignettes have been incorporated to provide opportunities for teaching and learning and practice improvement. The NMMAC–RWG developed a list of essential criteria for the case summaries, which were piloted by the Queensland Maternal and Perinatal Quality Council. Each jurisdiction was requested to prepare 2 case histories from deaths in their state or territory from the period 2006–2010 for potential inclusion in the maternal death report. The New South Wales Maternal and Perinatal Committee declined to provide case summaries, citing concerns regarding privacy. Case summaries were provided by Queensland Health, South Australia Health, the Department of Health, Victoria and the Department of Health, Tasmania. Care was taken to remove or change information that could potentially identify any individual. A decision was made by the NMMAC not to identify Aboriginal or Torres Strait Islander status in the case summaries and not to have any case summaries in the Aboriginal or Torres Strait Islander chapter. Perturbation, where a number of cases may have been combined, was used in the case summaries to prevent identification.

Quality of maternal deaths review in Australia

The method of maternal death reporting in Australia varies between states and territories. A review of the sources of maternal death notification, the supply and sharing of this information, confidential enquiries in Australia and internationally and the future of

reporting maternal deaths in Australia is discussed in 'Chapter 9 Quality of maternal death reviews in Australia'.

Confidentiality and small number reporting

Maternal deaths are unexpected events and women who die are unable to provide consent for participation in research or inclusion in the national report. In many instances, there has been widespread reporting of the deaths in the public domain by the media or through the coronial processes. Nevertheless, it is essential that measures are taken to maintain privacy and limit reporting of identifiable information about individual women. Concurrent to this, it is also critical that information on these deaths is made available for review and learning purposes so that it can be used to inform prevention strategies, maternity policy, clinical audit and practice improvement, and education of future maternity-care providers. The use of data from rare occurrences raises critical issues with regards to the protection of individual privacy. There has been considerable discussion with regards to this issue throughout the development of this report.

This report is an observational epidemiological report of all maternal deaths in Australia. The rationale for small number reporting is to provide, at a national level, information regarding the causes of maternal death, to be able to analyse and present data on the distribution of deaths, and to determine if there are modifiable factors for deaths that vary by different population groups, such as Aboriginal and Torres Strait Islander women. Although all available measures have been employed to prevent the identification of individual women, small numbers are unavoidable in this context and have been included in this report in accordance with ethical approval obtained from the relevant Human Research Ethics Committees (HRECs). Measures have been employed to prevent the identification of individual women and limit the range of information available through the use of perturbated case summaries and the application of broad categories for information other than cause of death.

Maternal deaths are rare in Australia. The data should be interpreted with caution due to the volatility of small numbers and the different data collection practices of jurisdictions.

Privacy

Maternal deaths are rare events in Australia and women are potentially identifiable. Inadvertent identification or spontaneous recognition is a particular concern for Aboriginal and Torres Strait Islander women, who make up 3% of women giving birth in Australia. There has been extensive consultation and discussion with regards to the reporting of maternal deaths in Aboriginal and Torres Strait Islander women. The report aims to use the data collected in a way that maximises the potential for benefit while minimising the potential for harm. For this reason, detailed case summaries have not been included in 'Chapter 7 Aboriginal and Torres Strait Islander Women'.

Aboriginal and Torres Strait Islander engagement

University of New South Wales, with the support from the National Aboriginal Community Controlled Health Organisations (NACCHO), convened a National Aboriginal Perinatal Reference Group (members listed in Appendix E) to provide expert advice on matters relating to perinatal health at a national level, and sought their advice on 'Chapter 7

Aboriginal and Torres Strait Islander Women', which reports maternal mortality among Aboriginal and Torres Strait Islander women.

Ethics approval

Human research ethical approval for compilation of the research data set and *Maternal deaths in Australia 2006–2010* report was obtained from the following HRECs:

- Australian Institute of Health and Welfare Ethics Committee
- University of New South Wales, Human Research Ethics Committee
- 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
- 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 and Medical Research Council of New South Wales
- 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.

Deaths related to anaesthesia

Previous reports in the *Maternal Deaths* series have included specific chapters that describe deaths related to anaesthesia. For this reporting period, there were no deaths directly related to anaesthesia. Although 8 deaths occurred in theatre, there was insufficient information to provide a useful commentary on the circumstances of these deaths or the care provided. The new National Maternal Death Reporting form (see 'Chapter 9 Quality of maternal death reviews in Australia') will collect more detailed information on the details of anaesthetic treatment.

3 Maternal deaths in Australia 2006–2010

Information about the deaths of 128 women that occurred during pregnancy or up to 42 days postpartum in Australia for the period 2006–2010 was provided to the AIHW NPESU. Following review by jurisdictional and national committees, 99 (77%) were classified as being directly or indirectly related to pregnancy.

Figure 3.1 shows the distribution of maternal deaths between 2006 and 2010. Overall, 39 (31%) were directly related to or aggravated by the pregnancy or its management and occurred while the woman was pregnant or within 42 days of the termination of the pregnancy. Fifty-seven (45%) were classified as indirect maternal deaths. These were considered to be due to non-pregnancy-related conditions that were aggravated by the pregnancy or its management. Three maternal deaths (2%) were considered to be related to the pregnancy or its management, but could not be further classified as either direct or indirect. Further information about deaths from these 3 categories is presented in this chapter and in 'Chapter 4 Direct and indirect maternal deaths' and 'Chapter 5 Deaths related to psychosocial morbidity'.

Twenty-six of the remaining 29 deaths, or 20%of all reported maternal deaths, were considered to be incidental to the pregnancy or its management. These deaths are reported in 'Chapter 6 Incidental deaths'. Of the remaining 3 (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 the report. Incidental and unclassified deaths are not included in the calculation of MMRs.

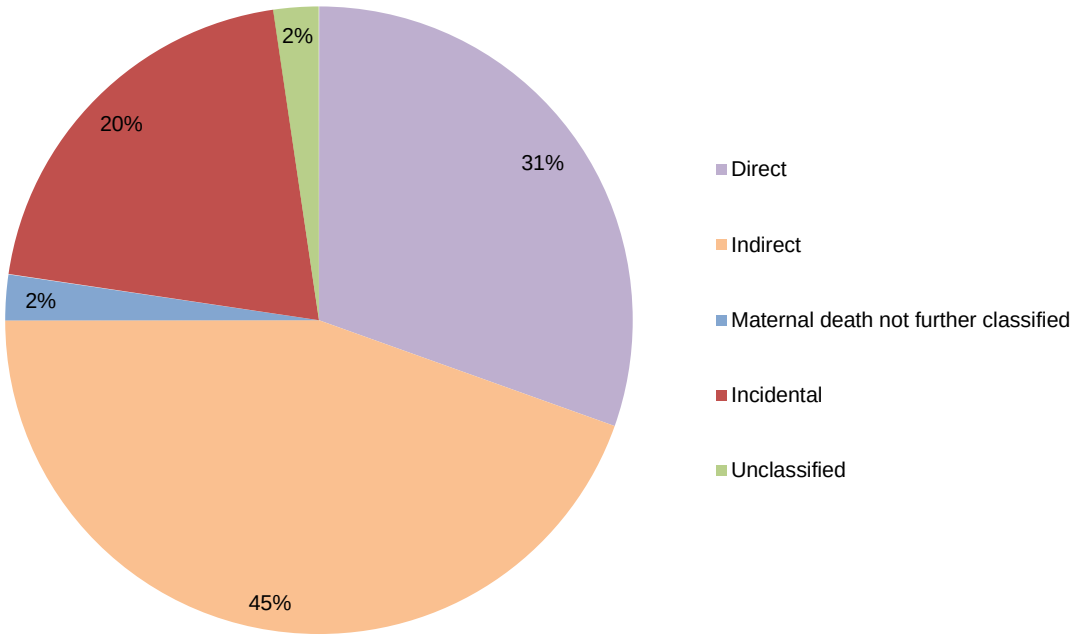


Figure 3.1: The proportion of maternal deaths by classification, Australia, 2006–2010

3.1 Maternal mortality ratio

There were 99 maternal deaths between 2006 and 2010. 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 to babies of at least 400 grams birthweight, or at least 20 weeks gestation in Australia, as the denominator. It is calculated over a defined time period. The MMR for the period 2006 to 2010 is 6.8 per 100,000 women who gave birth (Table 3.1).

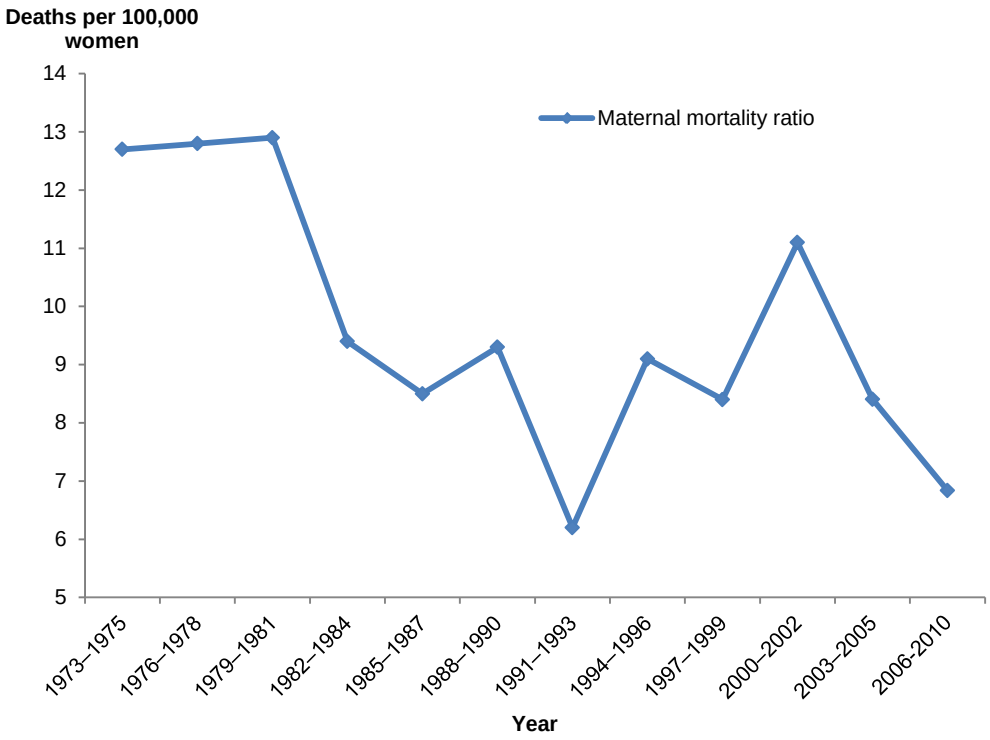
Table 3.1: Maternal mortality ratio, Australia, 2006–2010

Type of death	Number of deaths	Maternal mortality ratio[(a)(b)]
Direct	39	2.7
Indirect	57	3.9
Maternal death not further classified	3	0.2
Total	**99**	**6.8**

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

The MMR for 2006–2010 is similar to the most recently reported MMR for the 2003–2005 triennium and significantly lower than the MMR of 11.1 per 100,000 women who gave birth reported for the 2000–2002 triennium (Figure 3.2 and Table 3.2). However, the data should be interpreted with caution due to the rarity of maternal deaths in Australia and the associated volatility of small numbers. In particular, variability in ascertainment of maternal deaths may partially explain the lower MMR compared with the 2000–2002 triennium. Additionally, the processes for maternal death notification and review at a jurisdictional level were not standard, and, for some states and territories, the maternal mortality committees and subcommittees were not active for periods during 2006–2013 when the review of this report's maternal deaths was expected to be undertaken. More detail is provided in 'Chapter 8 Coronial review' and 'Appendix D: Data Quality Statement'. These factors need to be considered when interpreting the data. Figure 3.2 and Table 3.2 present triennial reporting of the MMR in Australia from 1973 to 2005 and a 5-year reporting period, 2006–2010. Apart from the 2000–2002 triennium, the MMR in Australia has not significantly changed since 1982–1984, and the fluctuations in the MMR over the period reflect the volatility of rare death reporting.



Note: 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

Figure 3.2: Maternal mortality ratios, Australia, 1973–2010

Table 3.2: Maternal mortality ratios, Australia, 1973–2010

Triennium	Direct deaths	Indirect deaths	Number of women who gave birth	Maternal mortality ratio[(a)]
1973–1975	60	32	726,690	12.7
1976–1978	52	35	678,098	12.8
1979–1981	54	34	682,880	12.9
1982–1984	42	25	713,985	9.4
1985–1987	32	30	726,642	8.5
1988–1990	37	33	754,468	9.3
1991–1993	27	22	769,253	6.2
1994–1996	46	20	767,448	9.1
1997–1999	34	30	758,030	8.4
2000–2002	32	52	753,901	11.1
2003–2005	29	36	773,248	8.4
2006–2010[(b)(c)]	39	57	1,448,445	6.8

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

(c) There are 3 unclassifiable maternal deaths included in the MMR calculation for the 2006-2010 reporting period.

3.2 State and territory maternal mortality ratio

The MMR varied by state and territory of death (Table 3.3). For cases of transfer of care across jurisdictional borders, deaths were attributed to the state in which the death occurred, not the state of usual residence. The MMRs ranged from 3.2 deaths per 100,000 women who gave birth in Tasmania to 21.3 deaths per 100,000 women who gave birth in the Northern Territory, the least populous state in Australia. Fewer than 20,000 women gave birth in the Northern Territory between 2006 and 2010. The impact of the volatility of the small number of deaths indicates caution should be used when interpreting the state and territory MMRs.

The Northern Territory has the highest proportion of Aboriginal and Torres Strait Islander mothers in Australia. During the period 2006–2010, 38.1% of women who gave birth in the Northern Territory were Aboriginal and Torres Strait Islanders. Aboriginal and Torres Strait Islander women have 3 times the risk of maternal death compared with other Australian women. More detailed information on maternal deaths of Aboriginal and Torres Strait Islander women is presented in 'Chapter 7 Aboriginal and Torres Strait Islander Women'. These factors are not adjusted when reporting the state- and territory-specific MMR, and the MMRs should be interpreted with caution.

Table 3.3: Maternal deaths by type of death, state and territory of usual residence, 2006–2010

State and territory	Number of women who gave birth	Direct deaths[(a)]	Indirect deaths[(a)]	Direct and indirect deaths	Unclassified	Maternal mortality ratio[(b)]
NSW and ACT	502,372	10	11	21	3	4.8
Vic	348,854	8	22	30	0	8.6
Qld	298,525	9	15	24	0	8.0
WA[(c)]	149,956	4	5	9	0	6.0
SA	96,688	5	1	6	0	6.2
Tas	30,946	n.p.	n.p.	1	0	3.2
NT	18,739	3	1	4	0	21.3
Total[(d)]	**1,448,445**	**39**	**57**	**96**	**3**	**6.8**

(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 STMMC.

(b) Deaths per 100,000 women who gave birth.

(c) Includes1 woman who died in the NT.

(d) Includes 1 woman who died in Tasmania with unknown state of usual residence.

n.p. Data not published to maintain confidentiality of small numbers

Causes of direct deaths

There were 39 direct maternal deaths, with an average of 8 deaths per year over the 5-year reporting period. The leading cause of direct deaths remained amniotic fluid embolism (AFE) followed closely by thromboembolism and obstetric haemorrhage, which together accounted for more than half of all direct maternal deaths (Table 3.4). The leading cause of direct maternal death in New Zealand was AFE for the period 2006–2009, which was the same as in Australia. In contrast, the leading cause of direct maternal death in the UK was genital tract infection (sepsis) for the 2006–2008 triennium. The number of deaths from infection fluctuated over the previous 3 reporting periods (5 deaths in the 2000–2002

triennium, 1 death in the 2003–2005 triennium and 5 deaths between 2006 and 2010), reflecting the inherent instability of small numbers for rare events such as deaths, and caution should be used when interpreting the data. Deaths due to sepsis are discussed in 'Section 4.7 Sepsis'. Of concern, were the 3 potentially preventable early pregnancy-related deaths due to ectopic pregnancy, which are discussed in 'Section 4.9 Early pregnancy deaths'. The MMR by cause of death is presented in more detail in Sections 4.1 to 4.10.

Table 3.4: Causes of direct maternal deaths, Australia, 2006–2010

Cause of death	Number	%
Amniotic fluid embolism	9	23.1
Thromboembolism	8	20.5
Obstetric haemorrhage	7	17.9
Eclampsia	6	15.4
Sepsis	5	12.8
Early pregnancy death	3	7.7
Non-obstetric haemorrhage	1	2.6
Total	**39**	**100.0**

Causes of indirect deaths

There were 57 indirect maternal deaths between 2006 and 2010, with an average of 11 deaths per year. Cardiac deaths and deaths related to psychosocial morbidity remain the leading causes of indirect maternal death in Australia (Table 3.5). This was similar to the leading causes of indirect maternal death in New Zealand and the UK, 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 (5) from rupture of a splenic artery aneurysm which are discussed in 'Section 4.2 Non-obstetric haemorrhage'. There were 3 deaths related to the 2009 H1N1 influenza pandemic. Caution should be used in interpreting these data. Further information on indirect deaths is presented in in 'Chapter 4 Direct and indirect maternal deaths' and 'Chapter 5 Deaths related to psychosocial morbidity'.

Table 3.5: Indirect maternal deaths, Australia, 2006–2010

Cause of death	Number	%
Cardiac	15	26.3
Psychosocial	13	22.8
Other	13	22.8
Non-obstetric haemorrhage	10	17.5
H1N1 influenza	3	5.3
Sepsis	1	1.8
Obstetric haemorrhage	1	1.8
Early pregnancy death[(a)]	1	1.8
Total	**57**	**100.0**

(a) Includes 1 woman who died after termination of pregnancy for intractable intracerebral hypertension.

Sociodemographic and pregnancy factors

Understanding the sociodemographic and pregnancy characteristics of women who die is essential to interpreting health statistics such as the MMR. This is because demographic factors, such as maternal age, social deprivation and Aboriginal and Torres Strait Islander status, are important determinants of health. For example, the incidence of cardiac disease in women between 30 and 45 years of age is higher than in women aged under 30. Therefore, a woman aged 45 is theoretically at a higher risk of cardiac morbidity before pregnancy than a woman aged 20. Similarly, a woman who lives in a remote area, with perhaps more limited access to health care, is potentially at higher risk of mortality than a woman living in a major city who would have easier access to tertiary health-care services. In order to calculate and interpret the MMR accurately and plan services appropriately, an understanding of the context in which maternal deaths occur and the characteristics of the women who died is required.

Age

Table 3.6 shows maternal deaths between 2006 and 2010 by age group. The age of the women who died ranged between 17 and 45. Mothers aged 40 or older have the highest risk of mortality, with an MMR of 25.7 per 100,000 women who gave birth (Table 3.6). The highest number of deaths (27.3%) occurred in the 35–39 years age group and this group accounted for almost 1 in 5 women who gave birth in Australia. The MMR was lowest for women aged 25–29 at 3.3 women per 100,000 who gave birth.

Table 3.6: Maternal deaths[(a)] by age group and percentage of women who gave birth by age group, Australia, 2006–2010

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	4	4.0	59,198	4.1	6.8
20–24	17	17.2	208,840	14.4	8.1
25–29	13	13.1	391,036	27.0	3.3
30–34	22	22.2	463,254	32.0	4.7
35–39	27	27.3	271,169	18.7	10.0
≥40	14	14.1	54,525	3.8	25.7
Total[(c)]	**99**	**100.0**	**1,448,445**	**100.0**	**6.8**

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

(b) Deaths per 100,000 women who gave birth.

(c) Includes about 2.1% of deaths where maternal age is not stated.

Age-standardised death rates for direct and indirect deaths between 2006 and 2010 are presented in Tables 3.7 and 3.8. The numbers of deaths are small and reflect the volatility of the rates over time by age groups. For direct maternal deaths, women aged 35 and older had the highest rates of maternal mortality. For indirect deaths, however, there was no obvious trend. For both direct and indirect deaths, the overall age-standardised rate for maternal mortality was the lowest reported since the 1973–1975 triennium. Note that the age-standardised rates are expressed per 100,000 female population, in contrast to the crude MMRs, which are expressed per 100,000 women who gave birth.

Table 3.7: Age-specific and age-standardised maternal mortality rates: direct maternal deaths, Australia, 1973–2010

Triennium	Direct deaths	Aged 15–19	Aged 20–24	Aged 25–29	Aged 30–34	Aged 35–39	Aged 40–44	Age-standardised rate[a]
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	[b]0.13	0.25
2003–2005	29	0.10	0.15	1.00	0.22	0.40	0.13	0.34
2006–2010[c]	39	0.06	0.13	0.16	0.16	0.28	0.23	0.17

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

(b) Includes 1 woman aged over 44.

(c) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

Note: Rates expressed per 100,000 female population.

Table 3.8: Age-specific and age-standardised maternal mortality rates: indirect maternal deaths, Australia, 1973–2010

Triennium	Indirect deaths	Aged 15–19	Aged 20–24	Aged 25–29	Aged 30–34	Aged 35–39	Aged 40–44	Age-standardised rate[a]
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	[b]28	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
2006–2010	[c]57	0.06	0.32	0.19	0.40	0.38	0.13	0.25

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

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

(c) Includes 1 woman aged over 44.

Notes

1. 2006–2010 is a 5-year period; previously 3-year reporting periods were used.
2. Rates expressed per 100,000 female population.

Parity

Table 3.9 shows the direct maternal deaths by parity and age group. Parity is the number of a woman's previous pregnancies that result in a live birth. Fifteen per cent of the women who died had 4 or more previous births. Only 3.9% of the women who gave birth in 2006–2010 had 4 or more previous births, indicating that women of high parity are at greater risk of mortality.

Table 3.9: Direct maternal deaths by parity and age group, Australia, 2006–2010

	Parity (number)					
Age group	**0**	**1**	**2**	**3**	**≥4**	**Total**
<25	3	2	2	0	0	7
25–29	1	3	1	1	0	6
30–34	2	1	1	0	2	6
35–39	2	2	2	3	2	11
≥40	1	3	1	2	2	9
Total	**9**	**11**	**7**	**6**	**6**	**39**

Remoteness

In Australia, remoteness is an important demographic variable that can be used as a proxy for access to health care. Data on area of usual residence were supplied as a postcode. Postcode is not designed as a geographical instrument, and in some cases can be inaccurate as an indicator of usual residence. These postcodes have been mapped to levels of remoteness using the Australian Bureau of Statistics (ABS) Australian Standard Geographical Classification (ASGC) Remoteness Area structure. Postcode was not reported in 35.6% of maternal deaths. This reflected largely the non-supply of that data by 1 jurisdiction. Over the period 2006–2010, 69.6% of births and 41.4% of maternal deaths occurred in *Major Cities* (Table 3.10). However, 2.8% of births occurred in *Remote/Very remote* areas, 5.1% of direct and 1.8% of indirect deaths occurred in *Remote/Very remote* areas. Some women, especially those with identified chronic or pregnancy-related diseases who are residents in *Remote* areas, are relocated to cities to give birth and have their temporary, rather than usual, address recorded. As a result, the actual number of women resident in *Very remote* areas is understated.

Table 3.10: Number and percentage of women who gave birth by remoteness area of usual residence and type of death, Australia, 2006–2010

Remoteness area of usual residence	Number of women who gave birth	Percentage of total number of women who gave birth	Percentage of direct deaths	Percentage of indirect deaths	MMR[(a)]	Total (%)
Major cities	1,008,628	69.6	48.7	35.1	4.1	41.4
Inner regional	260,271	18.0	15.4	10.5	4.6	12.1
Outer regional	134,966	9.3	5.1	10.5	5.9	8.1
Remote/Very remote	41,121	2.8	5.1	1.8	7.3	3.0
Not stated	2,891	0.2	25.6	42.1	..	35.4
Total[(b)]	**1,448,445**	**100.0**	**100.0**	**100.0**	**6.8**	**100.0**

(a) Deaths per 100,000 women who gave birth

(b) Includes a non-Australian resident.

Country of birth

For this report, only maternal country of birth was collected; information on ethnicity is not routinely collected in perinatal data collections. No information on whether women were new migrants or refugees was available. The NMMAC has recognised that more detailed information is needed on these groups of women and the new National Maternal Death Reporting (NMDR) form intended for implementation in 2015 includes this information.

Maternal country of birth was unknown in 12 (12%) of the 99 maternal deaths (Table 3.11). Of the 87 women where country of birth was known, 64 (73.6%) were born in Australia. There were 23 maternal deaths of women whose country of birth was other than Australia and these women were born in 18 countries. The proportion of deaths to women born outside of Australia (26.4%, where country of birth was known) was similar to the proportion (25.5%) of births to these women between 2006 and 2010. Women born in New Zealand accounted for 2.7% of women who gave birth in Australia and 7 (7.1%) of the maternal deaths in Australia between 2006 and 2010. There were 2 maternal deaths of women born in the UK. The small number of deaths over the 5-year period limits further analysis by country of birth.

Table 3.11: Maternal deaths by country of birth, Australia, 2006–2010

	Total number of women who gave birth	Percentage of total number of women who gave birth	Number of maternal deaths	MMR
Australia	1,071,065	73.9	64	6.0
Other	368,947	25.5	23	6.2
Unknown	8,433	0.6	12	..
Total	**1,448,445**	**100.0**	**99**	**6.8**

Gestation of pregnancy at time of death

The number of maternal deaths relative to the gestation of pregnancy is presented in Table 3.12. Two-thirds of maternal deaths (65.7%) occurred after the pregnancy had ended (post-pregnancy, 65 deaths), 27.3% occurred during pregnancy (antepartum, 27 deaths) and 7.1% occurred during childbirth (intrapartum, 7 deaths).

The pregnancy associated with a maternal death could end with the death of the baby as a miscarriage or induced abortion before 20 weeks gestation, or with a birth (live or stillborn) if the gestation is 20 or more weeks. In total, 29 (29.3%) maternal deaths occurred in women who had not given birth at the time of death. These included all 27 of the antepartum deaths and 2 of the 7 intrapartum deaths (Table 3.12). There were 19 maternal deaths that occurred on the day of giving birth or termination of pregnancy. A further 14 maternal deaths occurred over the next 2 days. After this time, deaths became increasingly sporadic, with 25 deaths between day 1 and day 20 postpartum and a further 9 deaths between day 21 and day 42. In 3 cases, the interval between the end of pregnancy and the time of maternal death was not known.

Gestational age was measured as completed pregnancy duration. Gestational age was identified for all but 1 of the 34 maternal deaths that occurred during pregnancy or childbirth, but for only 32 of the 65 maternal deaths that occurred after the pregnancy had ended (Table 3.12). Among the 65 maternal deaths with known pregnancy gestation, 43 (66.2%) followed pregnancies with gestational age of less than 37 weeks and 22 (33.8%) with gestations of 37 or more weeks. The type of maternal death differed by known pregnancy gestation. Whereas 74.4% of maternal deaths associated with pregnancies with a gestational age of less than 37 weeks were due to indirect causes, maternal deaths associated with pregnancies of 37 or more weeks' gestational age were predominantly due to direct causes (63.6%). However, caution is required when interpreting the data in view of the large number of cases for which gestational age was not available.

Table 3.12: Maternal deaths by gestation and type of death, Australia, 2006–2010

Time of death by gestation (weeks)	Direct	Indirect	Not classified	Total
Antepartum deaths				
<20[(a)]	3	7	1	11
20–27	1	3	1	5
28–36	n.p.	n.p.	0	5
≥37	2	3	0	5
Not stated	1	0	0	1
Total antepartum	–	–	–	**27**[(b)]
Intrapartum deaths				
<20[(d)]	0	0	0	0
20–27	0	0	0	0
28–36	n.p.	n.p.	0	1
≥37	4	2	0	6
Not stated	0	0	0	0
Total intrapartum	–	–	–	**7**[(c)]
Post-pregnancy deaths[(d)]				
<20[(d)]	1	6	0	7
20–27	1	1	0	2
28–36	2	10	0	12
≥37	8	3	0	11
Not stated	15	17	1	33
Total post-pregnancy				**65**
Total	**39**	**57**	**3**	**99**

(a) Birth is defined as gestation of greater than 20 weeks and/or 400 grams birthweight

(b) All these maternal deaths occurred in women who were pregnant at the time of death

(c) Two of the 7 maternal deaths occurred in women who were pregnant at the time of death

(d) Deaths following a pregnancy of 20 or more weeks gestation are referred to as postpartum deaths

n.p. not published (data cannot be released due to quality issues, confidentiality or permission not granted)

Mode of birth

Of the 65 women whose pregnancies ended during or after childbirth, 7 died during childbirth and 58 died in the postpartum period (Table 3.12). Table 3.13 shows that 41 of the 65 women (63.1%) who gave birth had a caesarean section. The UK's Royal College of Obstetricians and Gynaecologists (RCOG) classification of caesarean section was used to categorise the urgency of the caesarean section, with the addition of the 'peri or post mortem' category of fetal retrieval. There was limited information on the indications for the classification at the national level or if there was morbidity associated with the procedure. There was no such information for 9 (22.0%) women. Sixteen caesarean sections (39.0%) were performed because of an immediate threat to life of the mother or baby. In contrast, 11 (26.8%) were performed with no immediate threat to the life of the mother or baby. Five caesarean sections (12.2%) were performed peri- or post-mortem.

threat to the life of the mother or baby. Five caesarean sections (12.2%) were performed peri- or post-mortem.

Table 3.13: Maternal deaths by type of death and urgency of caesarean section, Australia, 2006–2010

	Type of death		
Urgency of caesarean section	**Direct**	**Indirect**	**Total**
Immediate threat to life of mother or baby	8	8	16
Maternal or fetal compromise with no immediate threat to life	4	3	7
No maternal or fetal compromise but needs early delivery	1	1	2
Delivery timed to suit woman or staff	2	0	2
Peri- or post-mortem	1	4	5
Not stated	4	5	9
Total	**20**	**21**	**41**

Where the women died

For the first time, information is presented on the type of hospital department, unit or service within the hospital setting the woman was admitted to at the time of death. This information was available for 70 deaths that occurred in hospital. Table 3.14 shows that the majority of the women who died in hospital did so outside of the maternity setting, which reflects that the women had access to multidisciplinary care in a variety of hospital settings. The most common place of death was in an intensive care unit (ICU) (37.1%). Among direct deaths, the main causes of death were amniotic fluid embolism, pulmonary embolism, obstetric haemorrhage and eclampsia, with almost two-thirds of deaths occurring in the ICU or theatre. In contrast, for indirect deaths where the main causes of death were cardiac disease or psychosocial morbidity, one-third occurred in the ICU, with only 2.7% in theatre. The place of death has implications for the identification and reporting of maternal deaths. Routine notification of maternal deaths from ICUs should be encouraged. These data provide a snapshot of where women who suffer catastrophic events and severe morbidity are managed and can inform the planning of maternity services.

Table 3.14: Maternal deaths by location and setting of death in hospital and type of death, Australia, 2006–2010

	Number	Direct (%)	Indirect (%)	Unclassified (%)	Total hospital deaths (%)
Maternity setting	4	6.7	2.7	33.3	5.7
Intensive care unit	26	40.0	37.8	0.0	37.1
High-dependency unit	0	0.0	0.0	0.0	0.0
Emergency department	5	3.3	8.1	33.3	7.1
Coronary care unit	0	0.0	0.0	0.0	0.0
Psychiatric unit	2	0.0	5.4	0.0	2.9
Theatre	8	23.3	2.7	0.0	11.4
Other	10	6.7	21.6	0.0	14.3
Unknown	15	20.0	21.6	33.3	21.4
Total	**70**	**100**	**100**	**100**	**100**

In summary

The MMR for 2006–2010 was 6.8 per 100,000 women who gave birth in Australia. Amniotic fluid embolism, pulmonary embolism and obstetric haemorrhage remained the leading causes of direct maternal deaths in Australia, while cardiac deaths and deaths related to psychosocial morbidity continued to be the leading causes of indirect maternal deaths. Older women of higher parity were at higher risk of pregnancy-related mortality.

Australia and New Zealand 2006–2009

The MMR for Australia for the 4-year period 2006–2009 was 7.1 per 100,000 women giving birth. It is significantly lower than the New Zealand MMR of 19.2 per 100,000 women giving birth (maternities) for the same time period (PMMRC 2011). The higher MMR associated with the pregnancy-related H1N1 influenza pandemic in New Zealand in 2009 (4 deaths) has partially contributed to the higher MMR reported in New Zealand. Different denominators were used in the calculation of the MMRs for the 2 countries. The New Zealand denominator for calculating the MMR termed 'maternities' is defined as all live births plus fetal deaths at 20 weeks or beyond, or weighing 400 grams or more if gestational age was unknown. This does not explain the difference in rates because there would be minimal impact on the rates with the Australian denominator defined as the number of women who gave birth to at least 1 or more live born or stillborn baby of at least 20 weeks gestation or at least 400 grams birthweight.

The validity of the comparison of the MMRs between Australia and New Zealand is compromised by the different maternal mortality review processes, classification and ascertainment measures used in New Zealand. The higher MMR for New Zealand may reflect the enhanced surveillance and centralised maternal mortality review established in 2006 under the auspices of the Perinatal and Maternal Mortality Review Committee, and the volatility of small numbers. Further, there are differences in the process for identifying maternal deaths in New Zealand. Although some maternal deaths are identified through the death certificate, the majority of deaths are identified by clinicians.

Australia and the United Kingdom 2006–2008

The MMR for Australia for the 3-year period 2006–2008 was 6.8 per 100,000 women giving birth at ≥24 weeks gestation, which was significantly lower than the UK's MMR of 11.4 per 100,000 maternities (CMACE 2011). As for New Zealand, the validity of the comparison of Australian and the UK's MMRs is limited by the different review processes, classification and ascertainment measures between the countries. Conversely, the UK has the advantage of more accurate denominator data, including both live births at any gestation or stillbirths occurring at or after 24 completed weeks of gestation that are required to be notified by law. The difference in the review process is discussed further in 'Chapter 9 Quality of maternal death reviews in Australia' of this report.

4 Direct and indirect maternal deaths

This chapter presents the findings related to direct and indirect maternal deaths by grouped causes of death. Sections are presented in order of frequency of the conditions that caused the death. The most common cause of death, 'Cardiac disease', is presented first and the least common cause of death, 'Deaths due to early pregnancy', is presented last. The NMMAC decided that deaths related to psychosocial morbidity should be discussed in a separate chapter in order to give prominence to the condition.

For each of the grouped causes of death presented in this chapter, a standard set of information is presented. This includes an introduction to the topic, an introduction to morbidity data for the same condition (where available) and an overview of the information on the women who died. Good practice guidance highlights areas of clinical relevance that have been selected by relevant experts in the field of perinatal health. The good practice guidance includes key findings, reference to published guidelines or position statements and clinical guidance.

4.1 Cardiac disease

Good practice guidance

- All women with high-risk pregnancies due to cardiovascular disease should be referred to appropriate multidisciplinary tertiary services, which provide access to cardiac investigations and cardiologists and/or physicians with expertise in this area.
- 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.
- Autopsy should be advocated on women where the cause of death may be cardiac-related.
- Shortness of breath, palpitations, presyncope and syncope, chest pain and oedema may be symptoms of cardiac disease in a pregnant woman and should be assessed appropriately and referred for physician review if necessary.
- Women with severe chest or abdominal pain must be investigated with appropriate thoracic or abdominal imaging.

Sources: RCOG 2011a; NMMAC review of cases

It is estimated that 5% of Australian women aged under 45 have cardiovascular disease (AIHW 2011). To date there has been no national study on severe maternal morbidity from cardiac causes and the incidence of cardiovascular disease in pregnancy is unknown. The UKOSS undertook a study of acute myocardial infarction (AMI) in pregnancy between 2005 and 2010, which gave an estimated incidence of 0.7 non-fatal MIs per 100,000 women giving birth to 1 or more live or stillborn infants at 24 weeks gestation or more.

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 women 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 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 2006–2010

There were 15 indirect maternal deaths from cardiac-related causes between 2006 and 2010, making cardiovascular disease the most common cause of maternal death for this period. The MMR for cardiac-related deaths for 2006–2010 was 1.0, compared with 1.7 in 2003–2005 (Table 4.1).

Table 4.1: Deaths from cardiac disease, rates per 100,000 women, Australia, 2000–2010

	Number	MMR[(a)]
2000–2002	12	1.6
2003–2005	13	1.7
2006–2010[(b)]	15	1.0

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

The mortality rate for cardiac disease in Australia is similar to comparable countries internationally such as the UK (MMR 2.31 cardiac deaths per 100,000 women giving birth to 1 or more live or stillborn infants at 24 weeks gestation or above) (CMACE 2011). In 2008, a New South Wales-based study linking birth records to death records not only provided additional evidence showing that cardiovascular disease was the leading cause of indirect maternal death, but also showed that many of the deaths identified were late deaths. The current reporting system in Australia does not routinely collect information on late maternal deaths; therefore, given the New South Wales linkage study, the burden of cardiac disease contributing to all maternal deaths may be higher than recorded in this report (Cliffe et al. 2008). These statistics show that women who die in pregnancy are more likely to die from a cardiac condition than from any other cause.

Risk factors contributing to cardiac deaths in pregnancy include: increasing maternal age; increasing adverse lifestyle factors—obesity, smoking, poor diets and alcohol; increased diagnosis of inherited disorders pre-pregnancy, such as inherited cardiomyopathy; and increasing numbers of women with pre-existing congenital heart disease surviving into adulthood due to improved medical treatment and embarking on pregnancies (Lupton et al. 2002). Women are giving birth at older ages, with almost 23% of women who gave birth in 2010 being over the age of 35 (Li et al. 2012). Older mothers have higher rates of comorbidities including obesity, diabetes and hypertension, which increase their risk of developing cardiovascular disease. It is reasonable to expect that with this reproductive trend towards older pregnant women with complex medical problems and more risk factors, the incidence of cardiovascular disease in pregnant women is going to continue to increase. The NMMAC recommends that clinicians understand that cardiovascular diseases in pregnancy are no longer seen as one-off events, but should be recognised as part of a larger spectrum of maternal morbidity and mortality.

There were 4 deaths due to ischaemic heart disease (IHD), 3 due to dissection of the aorta and 3 due to congenital heart disease. The 4 deaths from IHD were caused by myocardial infarction and atherosclerosis. There were 2 deaths from other cardiac causes: 1 from acute bacterial endocarditis and 1 from Takayasu arteritis. There were 3 other deaths where the cause of death could not be determined, one in the absence of autopsy. This death is reported as 'cardiac failure' because the woman had known pulmonary hypertension as a sequela of RHD. The other 2 deaths that were undetermined were both sudden deaths where the coroner concluded a cardiac cause was likely. Table 4.2 compares the causes of indirect deaths due to cardiac disease between 2006 and 2010 with the previous 2 reporting periods.

Table 4.2: Indirect maternal deaths due to cardiovascular disease by cause, Australia, 2000–2010

Cause of death	2000–2002	2003–2005	2006–2010[(a)]
Myocardial infarction	2	..	2
Atherosclerosis	1	..	2
Congenital heart disease	3	3	3
Aortic dissection	2	3	3
Cardiac failure	2	1	1
Undetermined	..	1	2
Peripartum cardiomyopathy	1	1	0
Primary pulmonary hypertension diagnosed at autopsy	..	1	..
Takayasu arteritis	..	..	1
Endocarditis			1
Total	**11**	**10**	**15**

(a) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

Note: Three late maternal deaths were also reported, but not included in this table for the 2000–2002 triennium. Three direct maternal deaths due to peripartum cardiomyopathy were reported but are not included in this table for the 2003–2005 triennium.

There were 2 deaths reported in other chapters of the report where cardiac conditions contributed to the death: 1 from H1N1 influenza on a background of corrected Tetralogy of Fallot, and 1 in a woman with massive haemorrhage on a background of IHD. There was 1 death from hypertensive cardiomyopathy which was classified as an incidental death and is reported in 'Chapter 6 Incidental deaths'.

Table 4.3 shows the cause of death, age group, parity and timing of death for the 15 women who died from cardiac causes. The timing of the deaths range between 11 and 40 weeks gestational age, with more occurring in the third trimester and in the postpartum period. The median maternal age of the women who died due to cardiac disease was 34. The median age of women giving birth in Australia in 2010 was 30 (Li et al. 2012). Of the 15 women who died, 2 died during the antepartum period, 1 died intrapartum at term and 12 died postpartum (Table 4.3).

Table 4.3: Maternal deaths due to cardiac disease by cause, woman's age, parity, timing of death and gestational age, Australia, 2006–2010

Age group	Principal cause of death	Parity[(a)]	Timing of death	Gestational age at birth or death (weeks)
20–24	Pulmonary hypertension	M	Postpartum	29
20–24	Cardiac ischaemia	M	Postpartum	Unknown
20–24	Acute bacterial endocarditis	Not stated	Within 24 hours of giving birth	Unknown
25–29	Ruptured aortic aneurysm	N	Intrapartum	40
30–34	Intracerebral haemorrhage (Takayasu arteritis)	N	Postpartum	Unknown
30–34	Acute myocardial infarction	Not stated	Within 24 hours of giving birth	11
30–34	Mitral valve prolapse	N	Antepartum	15
30–34	Ruptured dissection of thoracic aorta	N	Within 24 hours of giving birth	Unknown
35–39	Type A aortic aneurysm	N	Postpartum	32
35–39	Undetermined	M	Postpartum	18
35–39	Atrial and ventricular septal defect	M	Postpartum	35
35–39	Cardiac	N	Postpartum	Unknown
35–39	Cardiac disease	M	Within 24 hours of giving birth	38
≥40	Coronary artery atherosclerosis	M	Within 24 hours of giving birth	25
≥40	Unascertained	Not stated	Antepartum	37

(a) N = nullipara; M = multipara.

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 was available and it is not known whether they were referred for specialist care earlier in pregnancy.

For the 15 women who died of cardiac disease, comorbidities and lifestyle factors such as body mass index (BMI), smoking status, hypertension and diabetes were inadequately reported. In 40% to 66.7% of cases, these risk factors were not reported to the NPESU and therefore data are not presented in this report.

Thirteen of the 15 women who died were referred to the coroner and 12 had an autopsy. In 1 case, the family did not consent to an autopsy. An 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, which may have implications for family members.

Congenital heart disease

There were 3 deaths in women with congenital heart disease: 1 woman had myocarditis in prolapsed mitral valve; 1 had an undiagnosed atrial ventricular septal defect (AVSD); and 1 where the cause was undetermined at the time of publication but a past history of significant

congenital heart disease was noted in the data collected and at NMMAC review. One woman died from a respiratory infection on a background of corrected Tetralogy of Fallot and is not reported in this chapter. The women who died were aged between 33 and 39. Two women presented with the morbid event near term and 1 early in the second trimester. One died before admission to hospital and 2 had pulmonary hypertension at initial investigation and deteriorated rapidly with death occurring within days of the reported onset of symptoms.

Case summary

A multiparous woman who presented to the emergency department late in second trimester gestation was complaining of shortness of breath for 2 hours. CT pulmonary angiogram findings were consistent with severe pulmonary hypertension. An echocardiogram showed a previously undiagnosed atrial ventricular septal defect, severe right ventricular dilatation and dysfunction and severe pulmonary hypertension. The woman gave birth to a live born infant by caesarean section. Her cardiac condition deteriorated 10 days post-operatively leading to a cardiac arrest. Cause of death: atrial ventricular septal defect and pulmonary hypertension.

Women with known heart disease should be properly assessed pre-conception. 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 presented in this chapter.

Ischaemic heart disease

There were 4 deaths from ischaemic heart disease. Two of the deaths were due to acute myocardial infarction (AMI) in late pregnancy and 2 were due to atherosclerotic disease, with associated comorbidities listed as contributing factors. There was 1 death that is reported in 'Section 4.8 Influenza in pregnancy' where a known background of IHD contributed to the death. The women who died were aged between 24 and 45. All of the women had known risk factors for cardiovascular disease, including hypertension, obesity and diabetes mellitus.

Shortness of breath

Three of the 15 women discussed in this chapter were investigated for symptoms of shortness of breath in pregnancy. For 1 of the women reported here, and for others reported in previous maternal death reports, an initial diagnosis of pulmonary embolus was recorded on the death certificate. Cardiac ischaemia was later discovered at autopsy. It is an important clinical point to note that symptoms of shortness of breath and oedema in a pregnant woman require consideration of cardiac disease as the diagnosis, as well as considering pulmonary embolism.

Case summary

A multiparous woman aged over 35 with previously uncomplicated pregnancies gave birth spontaneously. She re-presented a couple of days postpartum to hospital with signs of presumed acute sepsis and underwent investigation for persistent hypotension and tachycardia. An echocardiogram revealed dilated ventricles indicative of cardiomyopathy. On intubation to provide life support, cardio-respiratory arrest occurred; resuscitative measures, including cardio-pulmonary bypass and open cardiac massage, were unsuccessful. Cause of death: acute congestive cardiac failure with pulmonary oedema in association with myocardial ischaemia.

Aortic dissection

There were 3 deaths from aortic dissections in ruptured aortic aneurysms. All dissections were Type A (ascending aorta); 1 occurred at greater than 30 weeks gestation and the other 2 at term. The women who died were aged between 26 and 36. In 1 of the cases, the pathologist did not comment on the cause of the aneurysm. In another, the pathologist commented on the possibility of an underlying connective tissue disorder such as Marfan's syndrome. For the third case, the autopsy report was not available. During 2006–2010, there were 6 maternal deaths from ruptured splenic artery aneurysms, which are reported in 'Section 4.2 Non-obstetric haemorrhage', and 1 death of a woman with Barlow's syndrome (valvular disease, which is common but very rarely associated with Marfan's syndrome). It is noteworthy that women with underlying connective tissue disease are at risk of aortic dissection in pregnancy, as are those with bicuspid aortic valve. In addition, pregnant women who had previous normal pregnancies may also suffer this complication. The UK *Saving mothers' lives: Reviewing maternal deaths to make motherhood safer, 2006–2008* report recommends that women with severe chest or abdominal pain requiring opiate analgesia must be investigated with appropriate imaging such as computed tomography chest scan, magnetic resonance imaging, transthoracic or transoesophageal echocardiogram (CMACE 2011).

Other deaths

There was 1 death from cardiac failure as a sequela of RHD. There was 1 death from infective endocarditis and 1 from the sequelae of Takayasu arteritis. The 2 deaths of undetermined cause 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.

Summary

Cardiac disease represented the largest cause of indirect maternal deaths between 2006 and 2010 in Australia and accounted for 15% of maternal deaths overall and 26% of indirect deaths. This proportion will likely rise given the increasing cardiovascular risk factors including smoking, increasing maternal age, obesity, diabetes and hypertension. This may result in an increase in women with acquired cardiac disease such as IHD embarking on pregnancy, as well as the increasing number of women with known congenital heart disease embarking on pregnancies. The true burden of pregnancy-related cardiovascular morbidity and mortality in Australia has not been fully characterised, with some of the current research suggesting under-reporting.

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 (RCOG 2011a). Future research should be aimed at facilitating improvements in the recognition, prevention and treatment of cardiac disorders and providing the evidence base for effective planning of maternity services in Australia.

4.2 Non-obstetric haemorrhage

Good practice guidance

- Ruptured splenic artery aneurysm (SAA) 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 (Selo-Ojeme & Welch 2003).
- Neurological symptoms in pregnant women suggest an urgent review and cerebral imaging if indicated (CMACE 2011).

Severe non-obstetric haemorrhage related maternal morbidity

Splenic artery aneurysm (SAA) is a rare condition and the published literature mainly consists of single case reports and literature reviews. The research discussed in this report is limited in its statistical power. There have been no major studies on SAA and the prevalence is unknown and difficult to determine because most cases are asymptomatic. One study found that splenic artery aneurysms were found incidentally on 0.78% of angiograms (Selo-Ojeme & Welch 2003).

It is known that SAA is more frequent in women, with up to 58% of cases occurring in women of child-bearing age and up to 95% during pregnancy (Ha et al. 2009). Although rupture can occur at any time during pregnancy and in the immediate postpartum period, most occur in the third trimester (Selo-Ojeme & Welch 2003). Pregnancy leads to increased blood volume, compression of the aorta and iliac vessels from the uterus (which increases proximal blood flow) and hormonal changes, which affect arterial wall structure. These combined effects stress the vessel wall, and the splenic artery is progressively weakened by successive pregnancies, leading to an increased incidence of SAA, and also increased frequency of rupture with increased parity (Ha et al. 2009; Hillemanns et al. 1996; Selo-Ojeme & Welch 2003). Mortality in pregnancy is reported at a disproportionately high rate. In the non-pregnant population, mortality following rupture has been reported to be approximately 25%. Rupture during pregnancy is associated with a maternal mortality rate of 70% and a fetal mortality rate of 90% (Hillemanns et al. 1996).

Deaths from non-obstetric haemorrhage between 2006 and 2010

There were 12 maternal deaths due to non-obstetric haemorrhage between 2006 and 2010, giving an MMR of 0.8 per 100,000 women who gave birth (Table 4.4). For the purposes of this report, non-obstetric haemorrhage is defined as haemorrhage occurring from sites other than the genital tract. Ten of the deaths were classified as indirect maternal deaths, 1 was classified as a direct death and another death required further classification. There were 5 deaths from ruptured splenic artery aneurysm and 7 deaths from intracerebral haemorrhage. In previous reporting periods, there were 5 deaths due to non-genital tract haemorrhage between 2003 and 2005 and 9 deaths between 2000 and 2002 (Table 4.4).

Table 4.4: Deaths from non-obstetric haemorrhage, Australia, 2000–2010

Reporting period	Number	MMR[(a)]
2000–2002	9	1.2
2003–2005	5	0.6
2006–2010[(b)]	12	0.8

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

There were 12 deaths from non-obstetric haemorrhage between 2006 and 2010—five from ruptured splenic artery aneurysm and 7 from intracerebral haemorrhage. There were 2 deaths from cerebral infarcts reported in 'Section 4.10 Deaths due to other causes'. Of the 7 deaths from intracerebral haemorrhage, 1 was due to a spontaneous acute intracranial haemorrhage, 2 were due to spontaneous haemorrhage from an arteriovenous malformation and 4 were due to subarachnoid haemorrhage including 3 from a ruptured Berry aneurysm.

The age group, parity and gestation of the women who died are shown in Table 4.5. The majority of women who died were aged over 30 (10 of 12). Parity ranged between 0 and 4, and 10 of the 12 women who died were more than 20 weeks gestation or postpartum at the time of death.

Table 4.5: Deaths from non-obstetric haemorrhage, by cause, age group and parity, Australia, 2006–2010

	Cause of death		
	Ruptured splenic artery aneurysm	Intracerebral haemorrhage	Total
Age group			
<20	0	0	0
20–24	0	1	1
25–29	1	0	1
30–34	2	3	5
35–39	1	3	4
≥40	1	0	1
Parity			
0	1	1	2
1	2	4	6
2	1	0	1
3	1	1	2
≥4	0	0	0
Not stated	0	1	1
Gestational age group			
Antepartum/Intrapartum			
< 20 weeks	0	1	1
≥20 weeks	1	2	3
Postpartum	3	4	7
Not stated	1	0	1
Total	**5**	**7**	**12**

Ruptured splenic artery aneurysm

The 5 cases of ruptured splenic artery aneurysm that occurred during 2006–2010 are significantly more than the 1 case reported during the 2003–2005 triennium and only 1 reported in the UK during 2006–2008. Splenic artery aneurysm rupture is a rare and life-threatening condition. The majority of cases are asymptomatic until rupture, although 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. Three of the women who died reported a sudden onset of abdominal pain, which was followed by circulatory collapse.

Rupture is often misdiagnosed 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 (Selo-Ojeme & Welch 2003).

Case summary

A multiparous woman in her early 20s collapsed at home at over 30 weeks gestation after complaining of abdominal pain. She was admitted to a regional hospital where an initial diagnosis of AFE was made. On transfer to a tertiary hospital she was found to have a haemoglobin level of 3 g/dL. She suffered a cardiopulmonary arrest and resuscitation was unsuccessful. Autopsy: ruptured splenic artery aneurysm.

In the emergency setting, adequate resuscitation is essential. Management of an SAA or SAA rupture requires surgery. The mortality rate for ruptured splenic artery aneurysm in pregnancy is approximately 70%. A review of reported cases of SAA rupture in pregnancy found that involvement of a general or vascular surgeon was found to be a protective factor for mortality (Ha et al. 2009). There were 5 deaths in 13 patients reported where a general surgeon wasn't involved, compared with no deaths in the 9 patients reported that had involvement of a general surgeon.

Intracerebral haemorrhage

Six of the 7 maternal deaths due to intracerebral haemorrhage between 2006 and 2010 were classified as indirect. For the seventh death, there was insufficient information to classify the death, and it has been included based on the reported cause of death. There were 5 spontaneous acute intracranial haemorrhages, 3 of these from ruptured Berry aneurysms. There were 2 deaths secondary to rupture in an arteriovenous malformation. Age at death ranged between 24 and 38, with a median age of 33. Parity ranged between 0 and 4 (for 1 woman it was unknown) (Table 4.5). One of the women was at less than 20 weeks gestation and 2 were at more than 20 weeks gestation and 4 were postpartum when the haemorrhage occurred. None of the haemorrhages were associated with labour. Three of the women died before giving birth and 4 died postpartum. One woman underwent a caesarean section before the cessation of medical treatment and 1 had a peri-mortem caesarean section. Four of the women died in hospital, 1 died at home and for 1 woman the place of death was unknown. All of the women who were known to have died in hospital died in an ICU.

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.

Case summary

A nulliparous woman at 26 weeks gestation collapsed at home in the bath shortly after physical activity. She had no known history of cerebrovascular disease or hypertension. Autopsy: ruptured Berry aneurysm leading to subarachnoid haemorrhage.

Case summary

A nulliparous woman at 36 weeks gestation presented to hospital conscious and complaining of severe headache. She was noted to be hypertensive. Her conscious state gradually deteriorated and she was transferred by ambulance to a regional hospital where a CT scan revealed intracerebral haemorrhage. A caesarean section was performed and a live born infant delivered. She suffered a cardiac arrest shortly after. Autopsy: ruptured aneurysm in the left basal ganglion.

Case summary

A 32-year-old woman who was in the second trimester of pregnancy developed a severe headache with slurred speech and general weakness. She suffered a cardiac arrest in the ambulance en route to hospital. On arrival at the hospital a CT scan showed intracerebral haemorrhage. She never regained consciousness and was declared brain dead 13 days after her admission. Life support was later withdrawn. Autopsy: haemorrhage in anterior-inferior cerebellar artery.

The UK report, *Saving mothers' lives: Reviewing maternal deaths to make motherhood safer, 2006–2008*, noted 11 deaths from intracerebral haemorrhage between 2006 and 2008. There were 6 cases of sudden collapse or rapid deterioration; 4 of these were asymptomatic. In many instances reported in Australia and in the UK, women present to hospital in pregnancy with potentially serious neurological symptoms. The UK report recommends that 'women with new and potentially serious neurological symptoms in pregnancy must be seen early by a specialist who understands that all imaging modalities can be used in pregnancy if necessary, and the implications of headache and unilateral weakness or numbness' (CMACE 2011).

Summary

There were an unusually high number of deaths due to splenic artery aneurysm reported between 2006 and 2010. Rupture most commonly occurs in multiparous women in the third trimester of pregnancy. Splenic artery rupture 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. Six women died from an intracerebral haemorrhage. The majority of the women who died presented to hospital with neurological symptoms. Women with potentially serious neurological conditions should be investigated in a timely manner and with appropriate imaging.

4.3 Amniotic fluid embolism

Good practice guidance

- The immediate management of women with suspected amniotic fluid embolism (AFE) is prompt cardio-pulmonary 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).
- Autopsy should be advocated in all deaths suspected of being caused by AFE.

Severe amniotic fluid embolism-related maternal morbidity

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. The first national population-based AMOSS study of AFE was undertaken in Australia and New Zealand for the period 2010–2012. Preliminary data from the AMOSS study for 2010–2011were used to estimate an incidence of 4.1 cases per 100,000 women giving birth to a baby of at least 20 weeks gestation or at least 400 grams birthweight (95% CI 2.9–5.6 per 100,000 women giving birth). The AMOSS AFE study had a case fatality of 14%. A study in New South Wales, where one-third of births in Australia occur, found that 35% (7 out of 20 identified cases) of women with AFE died, and in Victoria between 2000 and 2008, 43% (6 out of 14 identified cases) of women with AFE died (Knight et al. 2012).

Although about 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. In Australia, the AMOSS AFE study is ongoing to collect national information on all cases of AFE. All suspected cases should be reported via the AMOSS online reporting system.

Deaths from amniotic fluid embolism between 2006 and 2010

AFE is a rare, but often fatal, condition of pregnancy and occurs when amniotic fluid enters the maternal circulation. Fetal skin cells or meconium in the amniotic fluid cause platelet thrombi to form, blocking the pulmonary vessels (Medforth et al. 2011). In Australia, the death rate from AFE has remained relatively stable over the last 3 triennia (Table 4.6). There were 9 deaths due to AFE between 2006 and 2010, giving an MMR of 0.6 per 100,000 women who gave birth. All of these deaths were classified as direct maternal deaths.

Table 4.6: Direct deaths from AFE, Australia, 2000–2010

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

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year periods were used.

The 9 women who died were aged between 21 and 42, with a median age of 35. Parity ranged between 0 and 3. All of the women who died with known gestational age were over 36 weeks gestation at the time of their death, and 3 women died postpartum. There has been a suggested link between induction of labour and AFE (Roberts et al. 2010). Four of the women who died had an induction of labour and for 1 woman there were no details of the birth event available. All of the women whose labour was induced had prostaglandins for this purpose. Table 4.7 shows the type of labour and type of birth for the women who died from AFE.

Table 4.7: Deaths from amniotic fluid embolism by type of labour and birth, Australia, 2006–2010

Type of labour	Type of birth
Induced	Caesarean section
Induced	Caesarean section
Induced	Caesarean section
Induced	Caesarean section
No labour	Did not give birth
No labour	Caesarean section
Spontaneous	Instrumental vaginal
Spontaneous	Instrumental vaginal
Not stated	Not stated

The diagnosis of AFE is difficult and 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.

Box 4.1: Characteristics of AFE

- 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

Source: NMMAC

Case summary

A 39-year-old woman in her third pregnancy with a past history of 1 caesarean section at 32 weeks was treated with aspirin, prednisone and progestins during this pregnancy. The placenta was known to be encroaching on lower uterine segment and a repeat caesarean section had been booked for 38 weeks. She suffered one episode of vaginal bleeding estimated at 500 mL at 37 weeks, and a small episode of further vaginal bleeding 2 days before death. She collapsed at home 1 day before the booked caesarean section date following a spontaneous rupture of membranes. Resuscitation by the woman's family failed. Autopsy: major placenta praevia (placenta completely covered cervical os) and extensive amniotic fluid embolism.

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 cardio-pulmonary resuscitation.

Diagnosing AFE

All of the 9 women who died of AFE had an autopsy. AFE was confirmed at autopsy in 7 of the cases, all by the presence of fetal squames in the maternal pulmonary circulation. Insufficient information was available in the other cases to determine the grounds on which the diagnosis was made.

It is important that consistent and complete information can be collected on rare disorders such as AFE. Rare diseases require comprehensive and lengthy surveillance (so that enough cases can be collected) to generate sufficient information to guide changes in policy or practice (Kayem et al. 2011). An international review of AFE incidence, risk factors and outcomes found that reported incidence of AFE in comparable countries such as the UK and Australia varied (Knight et al. 2012). It is suggested that these differences in the number of cases are due to variation or inconsistencies in the way cases of AFE are identified and analysed, rather than actual differences in the number of women who develop an AFE (Knight et al. 2012). For example, in the UK, cases of AFE are identified based upon clinical diagnosis with strict exclusion criteria. In Australia, where incidence is much higher, cases

were identified by suspicion with no formal exclusion criteria. The review also found that the available information did not allow an assessment of any potential relationships between management and outcome (Knight et al. 2012).

As discussed in Chapter 9, an inability to make assessments on preventability or the standard of care provided limits the usefulness of any data collected. Recommendations have been published that highlight the need for a single method of identifying or diagnosing AFE (Knight et al. 2012). It is intended that this 'will allow for valid international comparisons and may permit pooling of data to provide more reliable information on associated factors, management and outcomes, thus allowing for development of preventative and treatment strategies to improve outcomes' (Knight et al. 2012), and potentially prevent deaths and serious morbidity. The AMOSS study may contribute to the development of such uniform diagnostic definitions.

Summary

AFE, the most common cause of direct maternal death in Australia, remains a poorly understood cause of maternal deaths. The persistence of AFE as a leading 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.

4.4 Thromboembolism

Good practice guidance

- Identification of at-risk women and thromboprophylaxis use saves lives: all women should undergo a documented assessment of risk factors for venous thromboembolism (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 2009).
- Institutions should have guidelines on the management of obesity in pregnancy and women requiring thromboprophylaxis should be placed on doses appropriate to their weight.
- Where the cause of death is not clearly known, autopsy should be advocated to establish the cause of death.

Severe thromboembolism-related maternal morbidity

There is currently 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 finished 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. There were no maternal deaths from the 104 antenatal pulmonary embolism cases in the AMOSS study. This is in keeping with a prospective national case-control study of antenatal pulmonary embolism undertaken through the UKOSS between 2005 and 2006 that reported an incidence of 1.3 cases per 10,000 women giving birth to 1 or more live or stillborn infants at 24 weeks gestation or above. Of the women who had an antenatal pulmonary embolism, 3.5% died (CMACE 2011). Information is available on some risk factors that are associated with an increased risk of VTE in pregnancy. These include obesity, older age, smoking and operative delivery. These risk factors are prevalent in Australia.

The prevalence of morbid obesity has risen dramatically in Australia over recent years. The AMOSS undertook a prospective national population-based cohort study between 1 January and 31 October 2010. Extremely obese pregnant women were defined as BMI > 50 and/or weight over 140 kilograms. The study identified 370 extremely obese women with a prevalence of 2.14 per 1,000 women giving birth (n = 171,289 women giving birth) (Sullivan et al. 2011). In 2010, the proportion of women who smoked during pregnancy was 13.5% nationally. There were 93,157 caesarean sections performed the same year, which equates to 31.6% of all the women who gave birth in Australia in 2010.

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 between 2006 and 2010

There were 9 maternal deaths due to thromboembolism between 2006 and 2010. 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 (usually the deep veins of the leg) to block

another vessel (Medforth et al. 2011). The MMR for thromboembolism for 2006–2010 is 0.6 per 100,000 women who gave birth, which is unchanged from the 2003–2005 triennium (Table 4.8). Pulmonary thromboembolism is a known complication of pregnancy and historically has been a leading direct cause of maternal death in Australia and other developed nations across the world. It appears that this trend is improving, with the proportion of maternal deaths attributable to pulmonary thromboembolism decreasing in comparable countries such as the UK and New Zealand. In the UK, where monitoring of cases of antenatal pulmonary embolism is more reliable than in Australia, this fall is attributed to improved identification of at-risk women and the more widespread use of thromboprophylaxis (CMACE 2011). Since the publication of the guidelines, *Thromboprophylaxis during pregnancy, labour and after normal vaginal delivery* (RCOG 2004), the UK has reported its lowest mortality rate from thromboembolism to date. This suggests that adherence to these guidelines has resulted in improved recognition and management of obstetric patients at risk of VTE and has saved lives.

Table 4.8: Deaths from thromboembolism, Australia, 2000–2010

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

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

There were 9 deaths in Australia from thromboembolism between 2006 and 2010. Data on contributing factors were poorly reported. All of the women died from pulmonary thromboembolism. Eight of the deaths were classified as direct and 1 was classified as indirect. The indirect death occurred in a woman with a retroperitoneal tumour. Table 4.9 is a summary of all maternal deaths in which pulmonary embolism was a principal or contributory cause that have been documented in Australia since maternal death reporting began in 1964. Pulmonary embolism was previously a leading cause of direct maternal death in Australia, ranging from 18% of deaths in 1967–1969 to 9% for 2006–2010. When reviewed in conjunction with the UK research, this 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 4.9: Maternal deaths in which pulmonary embolism was a principal and contributory cause by reporting period, Australia, 1964–2010

Reporting period	During pregnancy	After miscarriage/ termination of pregnancy	After ectopic pregnancy	After vaginal birth	After caesarean section	Total	Total number of deaths	Percentage of total
1964–1966	3	6	0	22	13	44	275	16.0
1967–1969	15	0	0	23	5	43	237	18.1
1970–1972	5	2	1	10	4	22	244	9.0
1973–1975	4	0	0	6	1	11	137	8.0
1976–1978	7	0	0	3	3	13	106	12.2
1979–1981	1	0	0	1	6	8	98	8.1
1982–1984	1	0	0	1	1	4	94	4.2
1985–1987	2	0	0	3	2	7	86	8.1
1988–1990	3	1	0	3	5	12	96	12.5
1991–1993	2	0	1	2	4	8	84	9.5
1994–1996[(a)]	2	0	1	2	4	9	100	9.0
1997–1999	3	0	0	1	2	6	90	6.7
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

(a) The total number of deaths includes 9 deaths where the timing of death was unknown.

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

(c) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

n.a. not applicable

The women who died due to thromboembolism between 2006 and 2010 were aged between 18 and 41, with a median age of 28. Parity ranged between 0 and 4. Seven of the deaths occurred postpartum, 1 in the immediate postpartum period, 1 occurred in the week following birth and 5 died between 7 and 42 days postpartum. There was 1 death with sudden collapse in the second trimester of pregnancy. There was 1 death in the first trimester of pregnancy in a woman with a complex medical and obstetric history. Table 4.10 is a summary of the timing of deaths from pulmonary thromboembolism in relation to pregnancy over previous reporting periods.

Table 4.10: Direct deaths from pulmonary thromboembolism by timing of death, Australia, 1994–2010

Reporting period	Died before giving birth	Died within 24 hours of birth or termination of pregnancy	Death 2–6 days postpartum	Death 7–42 days postpartum	Total
1994–1996	2	1	1	4	8
1997–1999	3	1	1	1	6
2000–2002	1	0	1	1	3
2003–2005[(a)]	n.a.	n.a.	n.a.	n.a.	5
2006–2010[(b)]	2	1	1	5	9

(a) Information not reported for 2003–2005.

(b) 2006–2010 is 5-year period; previously 3-year reporting periods were used.

n.a. not available

The data collected for these women were of variable quality and adequate details of death were only provided for 3 of the 9 women described here. For the other 6 women, it is not known whether any of them experienced respiratory symptoms before the morbid event, because this information was incomplete at the national level. Additionally, details of the use of thromboprophylaxis is not currently collected on the national reporting form used to populate this report, so this information was unavailable for many of the women who died.

Case summary

A nulliparous woman aged under 25 with a BMI >35, known smoker and a previously uncomplicated pregnancy collapsed at home following a spontaneous birth. On arrival to hospital she was found to be asystolic with non-reactive pupils. Resuscitation was unsuccessful. Autopsy: pulmonary thromboembolism.

Risk factors for pulmonary thromboembolism were also inadequately documented, but some information can be drawn from the available data. All of the women who died had an identifiable risk factor. Four of the women who died had 2 or more risk factors for thromboembolism and 3 women had more than 2 risk factors. Four of the 7 women who gave birth had their babies by caesarean section. All of the caesarean sections were undertaken for factors related to maternal or fetal wellbeing. Three of the 9 women were aged over 35. In the 3 women where BMI was known, 2 were morbidly obese (BMI≥40). Of the 8 women where smoking status was known, 5 were smokers. One woman had conceived through assisted reproductive technology and had a multiple pregnancy. One woman had a retroperitoneal malignancy and recent admission to ICU, 1 had pre-eclampsia and 1 had gestational diabetes. Table 4.11 provides information on the known risk factors such as BMI, parity, mode of birth and smoking status.

Table 4.11: Direct deaths from thromboembolism by cause and known risk factors, Australia, 2006–2010

Age group	Parity[a]	Principal cause of death	Mode of birth	BMI[b]	Smoking
25–29	M	Pulmonary embolus	Caesarean section	Not stated	Smoker
≥40	N	Pulmonary embolus	Before giving birth	Not stated	Not stated
25–29	M	Pulmonary embolus	Caesarean section	Normal	Non-smoker
≥40	M	Pulmonary thromboembolism	Non-instrumental vaginal	Not stated	Non-smoker
30–34	M	Pulmonary thromboembolism	Non-instrumental vaginal	Not stated	Smoker
25–29	M	Large pulmonary embolus	Non-instrumental vaginal	Not stated	Smoker
<20	M	Pulmonary thromboembolism from inferior vena cava and pelvic thromboses	Before giving birth	Morbidly obese	Smoker
35–39	GM	Pulmonary embolism	Caesarean section	Morbidly obese	Smoker
25–29	M	Pulmonary embolism	Caesarean section	Not stated	Non-smoker

(a) N = nullipara; M = multipara; GM = grand multipara.

(b) BMI = body mass index.

Risk assessment

In the UK, publication of the 3 RCOG guidelines on thromboprophylaxis in pregnancy—the 1995 RCOG guideline on thromboprophylaxis after caesarean section (RCOG 1995); the 2004 RCOG thromboprophylaxis guideline (RCOG 2004), and the updated guideline that includes weight-specific advice on thromboprophylaxis in pregnancy (RCOG 1995, 2009)—have been associated with a significant decline in pulmonary embolism deaths in pregnancy (CMACE 2011). All women should undergo a documented assessment of risk factors for thromboembolism in early pregnancy or before pregnancy. Women are at risk of 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.

Over 2 in every 1,000 women giving birth in Australia are extremely morbidly obese (Sullivan et al. 2011). 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. Table 4.12 describes risk factors for thromboembolism in pregnancy.

Table 4.12: Risk factors for venous thromboembolism in pregnancy

Time frame	Factors
Pre-existing	Previous venous thromboembolism
	Thrombophilia—heritable:
	Antithrombin deficiency
	Protein C deficiency
	Protein S deficiency
	Factor V Leiden
	Prothrombin gene G20210A
	Thrombophilia—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[(a)], 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 litre) requiring transfusion
	Prolonged labour
	Mid-cavity rotational operative delivery
New-onset/transient	Surgical procedure in pregnancy or puerperium (e.g. evacuation of retained products of conception, appendectomy, postpartum sterilisation)
	Potentially reversible hyperemesis, dehydration
	Ovarian hyperstimulation syndrome
	Systemic infection (requiring antibiotics or admission to hospital), e.g. pneumonia, pyelonephritis,
	postpartum wound infection
	Long-distance travel (> 4 hours)

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

Source: RCOG 2004.

Autopsy

Of the 9 women who died of thromboembolism, 8 had autopsies. In the cases of sudden death, all of these autopsies resulted in the cause of death being identified. In 1 case, the cause of death was diagnosed before death. In the other cases, the cause of death was diagnosed at death on clinical grounds and confirmed at autopsy. 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.

Summary

Thromboembolism still remains a leading cause of maternal death in Australia. Of the women who died, there was a significant number with known risk factors, and in some cases these were multiple risk factors. 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 of pregnant women, because this has been shown to save mothers' lives.

4.5 Obstetric haemorrhage

Good practice guidance

- An antenatal ultrasound should be recommended to all pregnant women in order to determine the placental location. Appropriate recognition, preparation and management of women with placenta praevia or suspected morbidly adherent placentation is crucial, because these conditions are associated with increased risk of catastrophic haemorrhage and maternal mortality (RANZCOG 2011c).
- Active management of the third stage of labour (use of prophylactic oxytocics and controlled cord traction) decreases the risk of postpartum haemorrhage (PPH) and blood transfusion and should be recommended to all women (RANZCOG 2011b).
- Assessment of ongoing blood loss is an essential aspect of postpartum care. Visual estimation of blood loss is notoriously unreliable and often underestimates true blood loss. More accurate measures such as weighing drapes, pads and swabs can also be used. Clinical signs of shock or tachycardia should prompt a thorough assessment of the mother, including an accurate appraisal of blood loss, both concealed and revealed (RANZCOG 2011b).
- Delays in recognising the severity of haemorrhage can lead to morbidity and death.

Severe obstetric haemorrhage-related maternal morbidity

There are no national data on massive obstetric haemorrhage requiring rapid blood transfusion in pregnancy. However, based on earlier studies, it has been estimated that adjusted rates for PPHs during the birth admission increased from 8.3% in 1994 to 10.7% in 2002, with a sixfold increase of transfusion following birth (1.9% to 11.7%) (Cameron et al. 2006). This suggests that PPH is increasing in frequency and severity in Australia. A new AMOSS study will provide data concerning massive obstetric haemorrhage events requiring rapid blood transfusion, including information on the women, clinical features, transfusion requirements and complications. An AMOSS study on peripartum hysterectomy was completed in 2012 in Australia and New Zealand. Preliminary analysis from 2010–2011 estimated the incidence of peripartum hysterectomy to control haemorrhage to be 6.0 per 10,000 women giving birth to a baby of at least 20 weeks gestation or at least 400 grams birthweight (95% CI 5.5–6.5). The earlier UKOSS study undertaken between February 2005 and February 2006 estimated the incidence of peripartum hysterectomy to control haemorrhage to be 4.1 per 10,000 women giving birth to 1 or more live or stillborn infants at 24 weeks gestation or above (95% CI 3.6–4.5) (Knight et al. 2008). Less than 1% of the women who had hysterectomies died. A similar finding was found in the AMOSS study. Thirty-nine per cent of the women had a morbidly adherent placenta, and the main documented risk factor was previous caesarean delivery (adjusted odds ratio 3.52, 95% CI 2.35–5.26) (CMACE 2011). In 2010, there were 93,157 caesarean sections performed in Australia, which was 31.6% of all births (Li et al. 2012).

Deaths from obstetric haemorrhage between 2006 and 2010

Obstetric haemorrhage remains a major cause of mortality in Australia and worldwide. It can be defined as bleeding from the genital tract with an estimated blood loss of > 1,000 mL or a blood loss which causes clinical signs of shock (Medforth et al. 2011). 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 4.2 Non-obstetric haemorrhage'. There were 8 deaths due to obstetric haemorrhage between 2006 and 2010, giving an MMR of 0.6 per 100,000 women who gave birth. Seven 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. Between 1997 and 2005, obstetric haemorrhage was the second most common direct cause of maternal mortality in Australia (Sullivan et al. 2007). For this reporting period, it is the third most common cause of direct maternal deaths, behind amniotic fluid embolism and thromboembolism. Table 4.13 shows the MMR for deaths due to obstetric haemorrhage for the last 3 reporting periods. Although death rates appear to be relatively stable, obstetric haemorrhage is the leading cause of severe maternal morbidity in many developed countries and evidence suggests that the number of cases of obstetric haemorrhage is increasing. A recent population-based study in New South Wales found that the incidence of severe maternal morbidity is increasing by 4% each year, with nearly all of the increase due to the increasing occurrence of obstetric haemorrhage (Roberts et al. 2009).

Table 4.13: Deaths from obstetric haemorrhage, Australia, 2000–2010

Reporting period	Number	MMR[(a)]
2000–2002	9	1.2
2003–2005	4	0.5
2006–2010[(b)]	8	0.6

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

There were 8 deaths due to obstetric haemorrhage. There were 4 due to postpartum haemorrhage and 4 due to antepartum haemorrhage. Four of the 8 women had at least 1 previous caesarean section. Parity ranged between 1 and 7. The median age at death was 33. Table 4.14 shows details of the women who died from obstetric haemorrhage, including age group, parity, BMI and mode of birth in 2006–2010.

Table 4.14: Death from obstetric haemorrhage by age and parity, BMI, mode of birth, Australia, 2006–2010

Age group	Principal cause of death	Contributing cause of death	Parity[a]	BMI[b]	Mode of birth
30–34	Obstetric haemorrhage	Ischaemic heart disease	GM	Not stated	Caesarean section
≥ 40	Massive intra and postpartum haemorrhage	Spontaneous uterine rupture; grand multiparity	GM	Obese	Instrumental vaginal
25–29	Postpartum haemorrhage	Multi-system organ failure; coagulopathy	M	Not stated	Caesarean section
35–39	Postpartum haemorrhage	None	M	Not stated	Caesarean section
30–34	Postpartum haemorrhage	None	M	Obese	Caesarean section
25–29	Haemorrhage: placenta accreta	None	M	Morbidly obese	Caesarean section
25–29	Placental laceration and haemorrhage	Motor vehicle accident and blunt trauma	M	Not stated	Before giving birth
35–39	Placenta percreta	Placenta praevia	GM	Obese	Caesarean section

(a) M = multipara; GM = grand multipara

(b) BMI = body mass index

Of the 8 women who died, 1 had an undiagnosed placenta praevia, 3 had a confirmed placenta accreta or percreta and 2 women died following uterine rupture. One woman died from placental laceration as the result of a car accident and 1 from a postpartum haemorrhage of unspecified cause.

Antepartum haemorrhage

One of the reported women died near term due to placental laceration following blunt trauma to the abdomen sustained in a motor vehicle accident. The other 3 women who died due to an antepartum haemorrhage were all of high parity (4 or more) and 2 had a history of 3 or more previous caesarean sections. One woman required a subtotal hysterectomy, 1 had embolisation of the internal iliac arteries and for the other, the surgical history was not provided.

Case summary

A woman in her early 30s with 5 previous pregnancies and 4 previous caesarean sections presented to hospital at 28 weeks gestation with an antepartum haemorrhage. Four previous pregnancy ultrasounds had not identified that the placenta was praevia. An emergency caesarean section was performed and there was heavy intraoperative bleeding due to placenta praevia accreta. A subtotal hysterectomy was undertaken and was followed by a cardiac arrest. She was successfully resuscitated and transferred to a tertiary hospital. A second arrest occurred during transfer. On arrival, further intervention including embolisation of the internal iliac arteries was unsuccessful and she died from multi-organ failure.

Postpartum haemorrhage

All 4 women who died from postpartum haemorrhage (PPH) were of parity greater than 2. One of the women who died gave birth by caesarean section because of a known placenta praevia, 1 was found to have a placenta percreta at caesarean section, and 1 presented to the hospital following uterine rupture. Both women with percreta and uterine rupture had a history of 2 previous caesarean sections. The fourth woman had an unspecified PPH following a normal vaginal birth.

Definitions of PPH vary, but the one used by the World Health Organization is 'blood loss of 500 mL or more during or following birth, or any amount of blood loss post-partum that causes haemodynamic instability' (Lalonde et al. 2006). It can be difficult to predict the occurrence of bleeding and, once this occurs, the situation can change rapidly with women deteriorating quickly.

Case summary

A woman with a history of 2 previous caesarean sections underwent an elective caesarean section at term. Approximately 10 minutes after the birth of the baby there was a fall in blood pressure and rise in heart rate. Heavy bleeding from the placental bed was observed and a manual removal of the placenta attempted. The placenta was found to be morbidly adhered to the uterine wall. Manual removal continued and cross-matched blood was ordered. The uterus began to bleed profusely with a drop in blood pressure, which responded to vasopressors. The uterus was exteriorised and with manual compression the bleeding settled. The abdomen was closed. Thirty minutes later in recovery light flow of vaginal blood loss was noted. Doctors administered misoprostol, undertook bimanual compression of the uterus and an intra-uterine balloon insertion. The bleeding appeared to slow. There was a total estimated blood loss of 3 L in a woman of small stature. The woman suffered a cardiac arrest in recovery. Resuscitation was successful and she was returned to theatre for a hysterectomy. After the hysterectomy she was transferred to ICU with multiple organ failure, likely secondary to ischaemia suffered during the cardiac arrest. Shortly after, treatment was withdrawn.

According to Welsh et al. (2008), while 'certain factors for obstetric haemorrhage can be identified in the antenatal period, for the most part when it occurs it is unpredictable, sudden and often catastrophic and may result in serious morbidity or death'. It is understood that delay in recognising the severity of haemorrhage and delay in referring for appropriate treatment are contributing factors to maternal death in the UK (Knight et al. 2009). Similarly, a United States (US) study found that 'human and service provider factors' were responsible for women progressing along the severe maternal morbidity–mortality continuum, contributing to women having more severe disease (Geller et al. 2004).

A Cochrane review showed that active management of the third stage, when compared with physiological management, decreases the risk of PPH and blood transfusion (Prendiville et al. 2003). Active management includes the administration of prophylactic oxytocics and controlled cord traction (RANZCOG 2011b).

Placenta accreta

Morbid adherence of the placenta to the uterine wall is a potentially life-threatening condition. The first national population-based AMOSS study of placenta accreta was undertaken in Australia and New Zealand for the period 2010–2012 and has recently finished data collection. Preliminary results for 2010–2011 demonstrate an incidence of 4.2 cases per 10,000 women giving birth to a baby of at least 20 weeks gestation or at least 400 grams birthweight. Less than 1% of the women who had a placenta accreta died. The AMOSS study will report on complications and outcomes. Morbidly adherent placentation can be difficult to diagnose, but may be suspected when there is a placenta praevia in a woman with a history of caesarean section or other uterine surgery (Armstrong et al. 2004; Miller et al. 1997). With the rising caesarean section rate and increasing maternal age, the incidence of placenta accreta has significantly increased (Miller et al. 1997). The Royal Australian and New Zealand College of Obstetrics and Gynaecology (RANZCOG) has released the following statement on the management of placenta accreta.

Good practice guidance regarding 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.
- 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 that for uncomplicated elective caesarean births or uncomplicated placenta praevia.

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.

OR

(continued)

Good practice guidance regarding placenta accrete (cont.)

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.

- Retrospective studies of pregnancy following conservative management of placenta accreta have reported reasonably good fertility rates and pregnancy outcomes but with an increased rate of recurrent placenta accreta (17–29%).
- Consideration of ureteric stenting should be made particularly when there is a suspicion of placenta percreta.
- Interventional radiology can be life-saving and uterine-sparing for the treatment of massive postpartum haemorrhage. It can be useful in the management of haemorrhage from abnormal placentation after delivery. The role of radiological placement of balloon catheters before delivery in placenta accreta requires further evaluation.

Source: RANZCOG 2011b.

Summary

Obstetric haemorrhage remains a key cause of maternal mortality and severe morbidity. Identification of placentae 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.

4.6 Hypertensive disorders of pregnancy

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 of a service capability level suitable to manage high-risk pregnancies.
- The management of women with pre-eclampsia between gestational ages of 24 and 32 weeks should be undertaken in those centres of an appropriate service capability level with corresponding experience and expertise (SOMANZ 2008).
- The major cause of death in women with hypertension in pregnancy is intra-cerebral 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.

Severe hypertensive-related maternal morbidity

Eclampsia is a rare complication of pregnancy and birth and the associated incidence of severe morbidity is unknown in Australia. Preliminary findings from the 2010–2011 AMOSS eclampsia study identified an Australia and New Zealand incidence of eclampsia of 2.2 cases per 10,000 women giving birth to a baby of at least 20 weeks gestation or at least 400 grams birthweight. These findings were similar to an earlier UKOSS eclampsia study, which identified a UK incidence of 2.7 cases per 10,000 births. UK data estimate a case fatality rate from eclampsia to be 3.1% (CMACE 2011) . There were no maternal deaths in the AMOSS eclampsia study.

The UK's Confidential Enquiries into Maternal Deaths persistently show substandard care in a significant percentage of deaths (CMACE 2011). Information as to the standard of care in Australia has not been routinely collected and is outside the scope of this report. However, internationally there has been a demonstrated reduction in severe maternal morbidity due to improved treatment of pre-eclampsia and it is known that timely identification and treatment can save women's lives.

The extent to which Australasian clinicians have adopted the treatment recommendations for eclampsia since publication of the major international trials is unknown. The Society of Obstetric Medicine of Australia and New Zealand (SOMANZ) publishes national guidelines for the diagnosis and management of pre-eclampsia and eclampsia, and it recommends that 'each Unit should develop protocols for the management of hypertension and regularly monitor and audit their outcomes' (SOMANZ 2008).

Deaths from hypertensive disorders of pregnancy in 2006–2010

Hypertension in pregnancy affects up to 10% of pregnancies (AIHW 2012b), making it one of the most common pregnancy complications and a leading cause of maternal death around the world for many years (Sullivan et al. 2007). There a number of definitions relating to hypertensive disorders of pregnancy, depending on the underlying cause. The 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 (SOMANZ

2008). There were 6 maternal deaths related to hypertensive disorders of pregnancy between 2006 and 2010.

Hypertension in pregnancy may be due to a number of conditions: pre-eclampsia and eclampsia are the most common causes and are potentially harmful conditions to both mother and baby. All of the deaths caused by hypertensive disorders of pregnancy between 2006 and 2010 were due to pre-eclampsia or eclampsia. All deaths were classified as direct.

The MMR during 2006–2010 for hypertensive disorders of pregnancy was 0.4 per 100,000 women who gave birth compared with 0.8 in 2003–2005 (Table 4.15). Although these figures do show a potential fall in the rate of deaths from hypertensive disorders of pregnancy, such statistics should be interpreted with caution due to the small numbers of maternal deaths.

Table 4.15: Deaths from hypertensive disorders, Australia, 2000–2010

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

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

All 6 maternal deaths related to hypertensive disorders of pregnancy between 2006 and 2010 were due to sequelae of pre-eclampsia or eclampsia. Intracerebral haemorrhage was the most commonly reported cause of death (4 women), although the majority suffered multiple complications and organ failure. One woman died as a result of a hepatic rupture and for another woman the cause of death was reported as 'eclampsia'.

The women who died were aged between 17 and 41, with a median age of 34. Parity ranged between 0 and 2. All of the women who died were at greater than 37 weeks gestation. Five presented with symptoms of fitting or pre-eclampsia in the antenatal period, and 1 presented postpartum following an uncomplicated birth by elective caesarean section. All 6 women had given birth before their death: 4 by caesarean section, 1 by vaginal birth after induced labour and 1 by vaginal birth after spontaneous labour. All women died between 2 and 26 days postpartum. Table 4.16 details deaths from hypertensive disorders of pregnancy by cause in Australia from 1997 to 2010.

Table 4.16: Deaths from hypertensive disorders of pregnancy, by cause, Australia, 1997–2010

Cause of death	1997–1999	2000–2002	2003–2005	2006–2010[(a)]
Hypertension	..	1	..	..
Cerebral				
Intracranial haemorrhage	1	..	3	4
Subarachnoid haemorrhage	1	..	1	..
Infarct	1	..	..	..
Pre-eclampsia		2	..	..
Eclampsia	1	1	..	1
Cardiac				
Arrhythmia	1	..	..	..
Hepatic				
Rupture	..	..	..	1
Other	1	1	1	..
Total	**6**	**5**	**5**	**6**

2006–2010 is a 5-year period; previously 3-year reporting periods were used.

.. not applicable

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 ICU before their deaths.

Women who develop organ failure require intensive monitoring and medical management, either within a high dependency or intensive care setting. The SOMANZ recommends that the management of women with pre-eclampsia between gestational ages of 24 and 32 weeks should be restricted to those centres with appropriate experience and expertise (SOMANZ 2008).

Pre-eclampsia and eclampsia

Case summary

A nulliparous woman with a booking blood pressure of 105/65 mmHg presented to hospital at 37 weeks gestation with minimal facial oedema and a mild headache. Urinalysis was normal and she was discharged home with a follow-up midwifery home visit the next day. She next presented in spontaneous labour at term. In labour, investigations revealed proteinuria +++ and blood pressures of 130/85–90 mmHg. No further documentation. She was found unconscious at home by her husband 2 days postpartum. A CT scan showed cerebellar haemorrhage and acute hydrocephalous. She died on the day of her collapse. Cause of death: Intracerebral haemorrhage.

It is essential that the significance of hypertension in pregnancy is recognised early. Systolic blood pressure greater than or equal to 140 mmHg and/or diastolic blood pressure greater than or equal to 90 mmHg (Korotkoff 5) requires referral to a specialist and multidisciplinary

team involvement. As in this case summary, a woman with a low booking blood pressure (105/65) and signs of pre-eclampsia (proteinuria +++) may be at substantial risk, even with borderline elevated blood pressures (130/85–90). 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.

Box 4.2: Identification of pre-eclampsia

- 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 minimum, urine testing should 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.
- Systolic blood pressure greater than or equal to 140 mmHg and/or diastolic blood pressure greater than or equal to 90 mmHg (Korotkoff 5) requires referral to an obstetric specialist.
- 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.
- Treatment should be considered at lower blood pressures in women who have low blood pressure at booking visits.
- Continued postnatal observation is necessary.

Source: SOMANZ 2008.

Summary

Early recognition and appropriate management of pre-eclampsia saves women's lives. 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.

4.7 Sepsis

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.

Source: NMMAC

Severe sepsis-related maternal morbidity

There is currently limited available information on sepsis in pregnancy. In the UK, a prospective UKOSS study on all severe infection in pregnancy has commenced, which is intended to assist in the development of management guidelines.

Deaths from sepsis between 2006 and 2010

The diagnosis of septic shock during pregnancy, labour or the puerperium may depend on careful observation and be associated with a range of clinical symptoms, and can be defined as collapse due to failure of the woman's circulatory system (Medforth et al. 2011). Overall, there were 10 maternal deaths due to sepsis between 2006 and 2010, giving an MMR of 0.7 maternal deaths per 100,000 women who gave birth. This compares with an MMR of 0.6 deaths per 100,000 women due to sepsis in women who gave birth between 2003 and 2005 (Table 4.17). In the UK, sepsis was the leading cause of direct maternal death for the 2006–2008 triennium, and has risen from 0.85 deaths per 100,000 women giving birth to 1 or more live or stillborn infants at 24 weeks gestation or above in 2003–2005 to 1.13 deaths in 2006–2008 (CMACE 2011). In Australia, for the 2003–2005 triennium, there was 1 direct maternal death due to sepsis. For 2006–2010, there were 5 direct deaths due to sepsis. The 10 deaths, including 3 deaths due to H1N1 influenza infection, have been included here and reported separately in 'Section 4.8 Influenza in pregnancy'.

Table 4.17: Deaths from sepsis, Australia, 2000–2010

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

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

Deaths due to sepsis can be grouped or classified in a number of ways. For this report, they 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 4.18 shows the number of direct and indirect maternal deaths due to sepsis and the cause of these deaths including the organisms identified from 2000 to 2010.

Table 4.18: Deaths from sepsis, Australia, 2000–2010

Reporting period	Number of deaths		Principal causes	Contributing cause	Organisms
	Direct	Indirect			
2000–2002	5	10	Pneumonia Meningitis Epidural abscess Group A beta haemolytic streptococcus Intra-abdominal sepsis following caesarean section Influenza Septicaemia	Asthma Thromboembolism Pre-eclampsia Adult respiratory distress syndrome Multi-organ failure	*E. coli* Group A beta haemolytic streptococcus *Staphylococcus aureus* *Herpes simplex* Malaria *Cryptococcus neoformans* *Streptococcus pneumoniae* *Pseudomonas aeruginosa*
2003–2005	1	4	Unknown	Unknown	Unknown
2006–2010[(a)]	5	5	H1N1 influenza Meningitis Pneumonia Puerperal sepsis/chorioamnionitis Intra-abdominal sepsis Group A streptococcal septicaemia Cholecystitis	Congenital heart disease Psychosocial factors	*Pneumococcus* *E. coli* H1N1 influenza A Group A beta haemolytic streptococcus Gram negative organism

(a) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

Group A beta haemolytic streptococcus (GAS), also known as *Streptococcus pyogenes*, is the most common pathogen associated with maternal mortality (Nicoll et al. 2012). In Australia, there were 4 deaths due to GAS between 2006 and 2010, and 3 between 2000 and 2002. Between 2005 and 2008, 50% of direct maternal deaths due to sepsis in the UK were caused by GAS infection.

There were 5 direct maternal deaths due to sepsis. These women died from the following causes: endometritis, chorioamnionitis, postpartum puerperal sepsis, cholecystitis and pneumonia. There were 4 indirect deaths and 1 unclassified death due to sepsis. The 4 indirect deaths included 3 from H1N1 influenza and 1 from pneumococcal meningitis infection. Table 4.19 shows the causes of direct and indirect maternal death from sepsis, any contributing factors, organisms identified and the age group of the women who died between 2006 and 2010.

Table 4.19: Deaths from sepsis by cause, Australia, 2006–2010

Age group	Principal cause of death	Contributing cause of death	Comments/organism
Direct deaths			
≥40	Endometritis	None	Group A beta haemolytic streptococcal septicaemia
35–39	Chorioamnionitis	None	Unknown
20–24	Toxic shock-like syndrome, Acute cholecystitis	None	Group A beta haemolytic streptococcus and *Staphylococcus aureus* in caesarean section wound. No blood culture results reported
20–24	Lobar pneumonia	*E. coli*	*E. coli*
35–39	Puerperal sepsis	Unknown	Group A streptococcus sepsis
Indirect deaths			
35–39	H1N1 influenza	Congenital heart disease	Influenza A
≥40	Respiratory failure due to H1N1 influenza	None	Influenza A
20–24	Complications of H1N1 influenza	None	Influenza A
35–39	Pneumococcal meningitis	None	
Not stated	Sepsis	None	Group A streptococcus

The age at death ranged from 20 to 42 with a median age of 38. The parity ranged between 0 and 4. Eight of the women who died were postpartum at the time of their death, 1 died during labour and 1 died near term before giving birth. Three of the women were smokers, 3 women did not smoke, and for the remaining women smoking status was unknown. Two women had a BMI over 35, 1 had a BMI less than 30, and for the others BMI was not recorded. Table 4.20 shows deaths from sepsis by smoking status, BMI, country of birth and remoteness of usual residence.

Table 4.20: Deaths from sepsis, by smoking, BMI and country of birth, Australia, 2006–2010

Age group	Principal cause of death	Contributing cause of death	Smoking	BMI[(a)]	Country of birth	Remote-ness
35–39	H1N1 influenza	Congenital heart disease	Not stated	Not stated	Australia	Not stated
20–24	Lobar pneumonia	*E. coli*	Not stated	Not stated	Not stated	Not stated
20–24	Complications of H1N1 influenza	None	Non-smoker	Not stated	Australia	Major cities
35–39	Pneumococcal meningitis	None	Smoker	Not stated	Australia	Major cities
Not stated	Puerperal sepsis	None	Not stated	Not stated	Not stated	Not stated
≥40	Respiratory failure due to H1N1 influenza	None	Non-smoker	Obese	Timor Leste	Outer regional
≥40	Group A streptococcal septicaemia	None	Not stated	Obese	Australia	Not stated
35–39	Chorioamnionitis	None	Smoker	Not stated	Australia	Inner regional
20–24	Sepsis	None	Smoker	Over-weight	Australia	Inner regional
35–39	Group A streptococcus sepsis	Unknown	Non-smoker	Not stated	Australia	Major cities

(a) BMI = body mass index.

Obstetric infections

Most obstetric infections occur postpartum and may relate to genital tract infection, mastitis, thrombophlebitis, episiotomy and perineal tear infections, caesarean section wound infection, gastric acid aspiration or post-general anaesthesia pneumonia. Antepartum infections include chorioamnionitis, which may follow prolonged premature rupture of membranes (PPROM) and prolonged labour. Endometritis is a spectrum of endometrial, myometrial and parametrial infections. Three of the women who died between 2006 and 2010 died from obstetric-related infections. Two of these women died from postpartum GAS uterine infection. One developed septicaemia following Gram negative infection in retained placental tissue after a second trimester miscarriage. All of these deaths were classified as direct maternal deaths.

Case summary

A multiparous woman aged over 35 developed vomiting and diarrhoea 10 days following spontaneous vaginal birth of a live born infant. The same day she attended her GP and was documented to have been 'treated' and returned home (the details of treatment are unknown). On day 11 she presented to a health-care centre with vomiting, diarrhoea and hypothermia. On day 12 she was brought to a health centre unconscious with an unrecordable blood pressure. Resuscitation attempts failed and she died the same day. Autopsy: postpartum—puerperal sepsis; streptococcus group A septicaemia.

For all of the women who died from obstetric-related infections, the course of events described showed a rapid deterioration from mild onset of symptoms to death within hours or days. Sepsis can present at any time before, during or following giving birth and it is important to recognise and treat it early. Mothers often present with vague symptoms and signs.

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. Seven women died as a result of non-obstetric related (non-genital tract sepsis) infections. Six of these deaths were classified as indirect maternal deaths: 3 deaths were from H1N1 influenza; 1 from pneumococcal meningitis; 1 from subdural empyema and purulent meningitis with Group A beta haemolytic streptococcal sinusitis; and 1 from cholecystitis following complicated recovery from a caesarean section. One death was unable to be classified.

Two deaths from non-obstetric related infection were classified as direct maternal deaths: 1 death from pneumonia was complex in nature and related to other obstetric and psychosocial factors; another from a toxic shock-like syndrome where the pathogenesis of disease could not be accurately established but was possibly due to acute cholecystitis. As with obstetric-related infection, early investigation of non-specific symptoms in pregnant and early-postnatal women is necessary to exclude serious infection.

Group A beta haemolytic streptococcus

There were 4 deaths identified as due to GAS infection, accounting for 36% 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 Box 4.3.

Box 4.3: Clinical signs of GAS sepsis

- pyrexia, but normal temperature does not exclude sepsis
- hypothermia may be a sign of sepsis
- diarrhoea is a common presenting symptom of women with pelvic sepsis
- tachycardia
- fetal distress or fetal death without placental abruption may be a presenting symptom of sepsis and should always be considered
- abdominal pain
- tachypnoea
- vaginal discharge/abnormal lochia
- blanching erythema.

(continued)

Box 4.3 (cont.): Clinical signs of GAS sepsis

Management of severe sepsis

- Start antibiotics within 1 hour.
- Take blood cultures, vaginal swabs, urine and any other relevant tissue or discharge cultures. If prolonged premature rupture of membranes (PPROM), take amniotic fluid culture.
- Take a throat swab if any history of sore throat in patient or family members.
- Senior obstetric clinician involvement as soon as possible and have a low threshold for admission to high dependency unit or intensive care unit and for involvement of an infectious disease specialist.
- Fluid challenge cautiously due to the risk of pulmonary oedema.

Source: Nicoll et al. 2012

Serious maternal morbidity from acquired infection during pregnancy is rare and consequently awareness among health professionals and pregnant women of the potential severity of infection is low (Nicoll et al. 2012). The Australian national maternal death reporting system does not support a commentary on the standard of care provided in individual cases. However, in the UK, where these types of assessments are made, 'failure to recognise severity' is identified as a contributing factor in a high proportion of cases (CMACE 2011). A high index of suspicion is required to the successful identification of GAS infection.

Risk factors for GAS infection are hard to define. The UK *Saving mothers' lives: Reviewing maternal deaths to make motherhood safer, 2006–2008* report has shown a correlation between GAS infection and seasonal flu between December and March and concurrent upper respiratory tract infection (CMACE 2011). Evidence has shown that in developed countries there is an association with obesity, invasive antenatal and intrapartum procedures, premature rupture of membranes, retained placental tissue and medical comorbidities such as diabetes (Nicoll et al. 2012; Sriskandan 2011). Globally, possible reasons for the observed increase in deaths due to sepsis, and in particular GAS infection, include decreased awareness by clinicians of maternal morbidity and mortality associated with obstetric infection, a hyper-virulent strain of GAS, and an increase in vulnerable populations (Sriskandan 2011). The UK *Saving mothers' lives: Reviewing maternal deaths to make motherhood safer, 2006–2008* report advocates education of women regarding perineal hygiene and hand-washing in the period following childbirth as a public health intervention (CMACE 2011).

Data collection

The current Australian maternal death data collection does not provide enough information to contribute towards an evidence base for GAS or other rare obstetric infections. It cannot inform guidelines on management of pregnancy-associated infection because clinical details including results of laboratory testing, clinical observations and relevant comorbidities are not consistently reported. This report relied heavily on second-hand clinical summary information and coroners' data. In a number of cases, the clinical details and course of events were difficult to determine. The National Maternal Death Reporting (NMDR) form intended for implementation in 2015 will collect more detailed information on microbiology results, infection markers and pre-existing disease. It is anticipated that this will improve the

capacity to accurately establish the cause of death in individual cases and to compare cases at the national level. It should be advocated that all women who die due to infection during pregnancy or in the postpartum period be referred for autopsy to accurately establish the cause of death. The UK Royal College of Pathologists (RCPATH) maternal death autopsy guidelines recommend that 'on admission to the mortuary take blood cultures (aerobic and anaerobic) from a sterile upper body site on all cases, unless another cause of death is already evident' (RCPATH 2010).

Summary

Overall, there were 10 maternal deaths due to sepsis between 2006 and 2010, giving an MMR of 0.7 per 100,000 women who gave birth. This compares favourably to the UK where sepsis was the leading cause of direct maternal death for the 2006–2008 triennium and had risen from 0.85 deaths in 2003–2005 to 1.13 deaths per 100,000 women giving birth to 1 or more live or stillborn infants at 24 weeks gestation or above in 2006–2008 (CMACE 2011). Group A beta haemolytic streptococcus was the most common 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.

4.8 Influenza in pregnancy

Good practice guidance

- 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. Current recommendations are that pregnant women should be vaccinated (RANZCOG 2011a).
- The risk of transmission of novel H1N1 through breast milk is unknown. Use of antiviral medication for H1N1 treatment or chemoprophylaxis is safe for use in breastfeeding women (RACS 2011).
- The use of extracorporeal membrane oxygenation for severe adult respiratory distress syndrome in pregnant and postpartum women was associated with a 66% survival rate (Logan & Price 2011; NZIC Influenza Investigators & AMOSS 2010).
- Intensive management for maternal hypoxia, including caesarean section and extracorporeal membrane oxygenation, led to better than expected outcomes (ANZIC Influenza Investigators & AMOSS 2010).

Severe influenza-related maternal morbidity

During 2009, AMOSS and the Australian and New Zealand Intensive Care Society (ANZICS) undertook a collaborative study of H1N1 influenza in pregnant women leading to ICU admission in Australia and New Zealand. 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. For women who developed critical illness, there were poorer outcomes, including the death of the mother or baby (ANZIC Influenza Investigators & AMOSS 2010).

Compared with non-pregnant women of child-bearing age, pregnant women with a gestation of greater than 20 weeks or more had a 13-fold greater risk of admission to an ICU as a result of the 2009 H1N1 infection (relative risk 13.2). The relative risk for postpartum women was 6.4 and for women with gestation of less than 20 weeks the relative risk was 2.4 (ANZIC Influenza Investigators & AMOSS 2010). In 2009, in Australia and New Zealand, 57 women who were pregnant or in the postpartum period were found to have a confirmed diagnosis of H1N1 influenza, and were subsequently admitted to an ICU. Six women (11%) died of H1N1 influenza in Australia and New Zealand (ANZIC Influenza Investigators & AMOSS 2010). A UK comparison study identified a maternal death rate of 6.9 deaths due to H1N1 infection per 100,000 women giving birth to 1 or more live or stillborn infants at 24 weeks gestation or above (95% CI 2.6–15.1) (Knight et al. 2011).

The AMOSS/ANZICS study was repeated in 2010 during the flu season (June to December) to also examine medical and obstetric management and maternal and infant outcomes related to critical illness following influenza A in pregnancy. It studied the impact of immunisation on the incidence and severity of influenza A in Australia and New Zealand. Preliminary analysis of the Australian data identified only 1 woman (from 36 cases) who was immunised for influenza A (NPESU 2012).

Deaths from influenza between 2006 and 2010

In previous Australian maternal death reports, all deaths due to infection were reported in the same chapter. For this report, deaths due to influenza virus and deaths due to other infections are reported in separate sections. Maternal deaths due to H1N1 influenza and the impact of the 2009 pandemic on the Australian obstetric population will be discussed in this chapter. Maternal deaths from other infections including obstetric and non-obstetric infection (such as puerperal sepsis or pneumonia) are reported in 'Section 4.7 Sepsis'. There were 3 reported deaths due to H1N1 influenza virus: all occurred during the 2009 H1N1 influenza pandemic.

There were 3 reported deaths from H1N1 influenza in 2009–2010. The women who died were aged from their early 20s to early 40s. Parity ranged between 0 and 3. BMI was unknown for all women. Both of the women whose smoking status was known were non-smokers. One of the women who died had a background of significant congenital heart disease (corrected Tetralogy of Fallot); there were no reported comorbidities for the other 2 women. All deaths were classified as indirect.

The collaborative AMOSS/ANZICS study identified 6 maternal deaths in Australia and New Zealand during the 2009 H1N1 pandemic (ANZIC Influenza Investigators & AMOSS 2010); 3 of these deaths occurred in Australia and were identified through the national maternal death reporting system.

Some clinical symptoms of H1N1 influenza are included in Box 4.4.

Box 4.4: Clinical symptoms of H1N1 influenza

Patients typically present with symptoms of acute respiratory illness including:

- cough
- sore throat
- rhinorrhoea
- fever
- headache
- fatigue
- body aches
- vomiting
- diarrhoea.

Clinical presentation can be complicated by development of a secondary bacterial infection (such as pneumonia).

Symptoms commonly develop within 1 week of exposure, and patients are contagious for approximately 8 days thereafter (Novel Swine-Origin Influenza A (H1N1) Virus Investigation Team 2009).

For the 2009–2010 H1N1 pandemic, it was established that pregnancy is a risk factor for critical illness, leading to maternal morbidity and mortality (ANZIC Influenza Investigators & AMOSS 2010). Following the 2009–2010 pandemic, the national H1N1 vaccination program is known to have contributed to better than expected impact of influenza on the Australian population in 2010 (Commonwealth of Australia 2011). It is not known whether

any of the women discussed in this report were vaccinated, although the AMOSS/ANZICS study reported that none of the women in the study had been vaccinated, despite established recommendations that pregnant women should be vaccinated. No Aboriginal or Torres Strait Islander women are reported in this chapter. However, international studies have shown that indigenous women and women with pre-existing morbidity had a higher risk of critical illness or death (Knight et al. 2011; ANZIC Influenza Investigators & AMOSS 2010). The ANZICS study also identified obesity as a risk factor for critical illness due to H1N1 influenza during pregnancy or postpartum. A key observation from the study was the need for emergency caesarean section because the mother could not be ventilated (and most did well). It is an important finding that preterm delivery of a baby can be of major benefit to mother and safe for the baby in women with influenza. These findings contribute significantly with respect to appropriate planning of a public health response to influenza and any future pandemics (Knight et al. 2011).

Summary

A global pandemic of H1N1 influenza occurred during this 2006–2010 reporting period. It is known that pregnancy is a risk factor for critical illness following infection and that pregnant or postpartum women suffered higher rates of morbidity and mortality than non-pregnant women. In Australia and New Zealand, 11% of pregnant or postpartum women who were admitted to an ICU with H1N1 influenza died (ANZIC Influenza Investigators & AMOSS 2010).

4.9 Early pregnancy deaths

Good practice guidance

- An early pregnancy ultrasound that fails to identify an intrauterine sac in the presence of a positive serum human chorionic gonadotropin (hCG) titre should stimulate active exclusion of tubal pregnancy (NICE 2012).
- The first clinical sign of an ectopic pregnancy may be a catastrophic collapse.
- 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.

Severe early pregnancy maternal morbidity

Information on early pregnancy loss is difficult to capture because information on these pregnancies is not routinely collected in the perinatal or hospital administrative data collections. At the national level, the National Perinatal Data Collection contains information on births of at least 20 weeks gestation (or greater than 400 grams birthweight) only.

There is no national data collection on the conditions relating to termination of pregnancy. The Royal Australian and New Zealand College of Obstetricians and Gynaecologists 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). In Australia, legislation regarding termination of pregnancy varies across jurisdictions.

Early pregnancy deaths between 2006 and 2010

For the purpose of this report, an early pregnancy death is defined as a maternal death during the first 14 weeks of pregnancy. Fifteen deaths occurred in the first 14 weeks of pregnancy between 2006 and 2010. Eleven of these deaths are reported and counted in other chapters. These deaths included 5 deaths related to psychosocial morbidity, including 3 suicides, 1 homicide and 1 drug overdose. There were 2 deaths from cardiac disease: 1 due to ischaemic heart disease and 1 in a woman with dilated cardiomyopathy that was unclassifiable. There was 1 death from thromboembolism in a woman with an early IVF pregnancy and 1 due to intracerebral haemorrhage. There were 2 further deaths at less than 14 weeks gestation also reported in 'Section 4.10 Deaths due to other causes' where the cause of death could not be determined.

Three women died following an ectopic pregnancy and 1 died following a termination of pregnancy. These 4 women will be reported in this chapter. Table 4.21 shows the deaths in early pregnancy by cause over the previous 3 reporting periods.

Table 4.21: Deaths in early pregnancy by cause, Australia, 2000–2010

Cause of death	2000–02	2003–05	2006–10[a]
Ectopic pregnancy	1	1	3
Psychosocial	0	2	5
Cardiac	1	2	2
Non-genital tract haemorrhage	1	0	1
Thrombosis and thromboembolism	0	0	1
Epilepsy	0	1	0
Other	1	0	3
Total	**4**	**6**[b]	**15**

(a) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

(b) 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.

The MMR for all deaths occurring in the first 14 weeks of pregnancy (15) is 1.0 per 100,000 women who gave birth. The MMR for early pregnancy deaths not reported elsewhere (4) is 0.3 per 100,000 women who gave birth. Table 4.22 shows the MMR from early pregnancy deaths between 2000 and 2010 and earlier reporting periods.

Table 4.22: Deaths from early pregnancy loss, Australia, 2000–2010

	Number	MMR[a]
2000–2002	4	0.5
2003–2005	6	0.8
2006–2010[b]	15	1.0

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

Three women died following an ectopic pregnancy and 1 following a termination of pregnancy. The median age of the women who died was 30. Parity was unknown in 1 case. All of the other women had previously given birth. Two of the women died from rupture of an ectopic pregnancy and 1 died from complications of the associated laparoscopic surgery. Insufficient information was available at the national level to accurately establish the circumstances of the fourth death and the cause of death was recorded as 'intractable cerebral hypertension' following a termination of pregnancy. In the UK, 6 women died from ruptured ectopic pregnancies between 2006 and 2008 and overall, care was considered to be substandard in 54% of cases of early pregnancy death (CMACE 2011). Commentary on the standard of care provided is not undertaken at the national level in Australia.

Two of 3 women reported had a sudden and catastrophic collapse before a diagnosis of ectopic pregnancy being made. The third woman presented to her GP, and later the hospital, with increasingly severe abdominal pain. The cases reported here and a number of cases reported in the UK demonstrate that, in cases of ectopic pregnancy, the pregnancy is often unknown to the woman and her family before the catastrophic collapse, or she may be very ill when first contact is made with medical services. Due to the small number of deaths,

details of cases cannot be reported here. However, a number of learning points were identified on expert clinical review and are included in the good practice guidance at the beginning of this section.

Summary

Although ectopic pregnancies are rare, they are potentially fatal. Women who do not know they are pregnant may present to medical services with a catastrophic collapse. An early pregnancy ultrasound that fails to identify an intrauterine sac in the presence of a positive serum human chorionic gonadotropin (hCG) titre should stimulate active exclusion of tubal pregnancy; the presence of a small intrauterine sac does not exclude ectopic pregnancy.

4.10 Deaths due to other causes

Good practice guidance

- Women with epilepsy should be provided with advice regarding the risks of the use of baths.
- Pregnant women with symptoms and/or signs suggestive of potentially serious conditions should undergo appropriate investigations.

Source: NMMAC

There were 13 maternal deaths due to 'other' causes between 2006 and 2010 that have not been reported in other chapters, giving an MMR of 0.9 per 100,000 women who gave birth (Table 4.23). This included 12 indirect maternal deaths. One death was deemed unclassifiable by the NMMAC as insufficient information was available.

Table 4.23: Deaths from other causes, Australia, 2000–2010

	Number	MMR[(a)]
2000–2002	12	1.6
2003–2005	10	1.3
2006–2010[(b)]	13	0.9

(a) Deaths per 100,000 women who gave birth.

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

There were 3 deaths from epilepsy, 2 deaths from cancer and 1 in a woman with a phaeochromocytoma. Two women died following a cerebral infarction. In 3 cases, the cause of death was undetermined and 2 women died of other miscellaneous causes. Table 4.24 shows causes of death and classification of deaths from 'other' causes between 2006 and 2010.

Table 4.24: Maternal deaths by other causes and classification, Australia, 2006–2010

Age group	Principal cause of death	Contributing cause of death	Gestational age	Type of death
30–34	Dilated cardiomyopathy	None	14	Unclassified
20–24	Hypoxic ischaemic brain Injury	Epilepsy	28	Indirect
30–34	Intra-abdominal haemorrhage due to ruptured liver tumour	None	38	Indirect
25–29	Stroke; midbrain infarction and haemorrhagic transformation	None	40	Indirect
20–24	Cardiorespiratory arrest—uncertain origin	None	12	Indirect
35–39	Drowning	Epilepsy	Unknown	Indirect
20–24	Drowning	Epilepsy	40	Indirect
35–39	Hodgkin's lymphoma	None	31	Indirect
<20	Brain stem infarction	Basilar artery thrombosis	40	Indirect
20–24	Undetermined	None	32	Indirect
≥40	Undetermined	Mastitis, obesity, sleep apnoea	6	Indirect
25–29	Phaeochromocytoma	Unknown	Unknown	Indirect
35–39	Acute renal failure resulting from postpartum coagulation defects and acquired haemolytic anaemia	Unknown	35	Unclassified

Epilepsy

Three women died from epilepsy: all were classified as indirect maternal deaths. Two of the women died while pregnant and 1 in the postpartum period. All of the women were known to have epilepsy and all were on anticonvulsant therapy. Two of the women died from drowning in the bath and 1 presented in the second trimester with intractable seizures.

Case summary

A multiparous woman with a known history of epilepsy was being closely monitored during her pregnancy. She was found unconscious in shallow water in the bathtub at home. She was transferred to a regional hospital where she was pronounced dead shortly after arrival. Autopsy: Carbamazapine levels were found to be within therapeutic range.

The most recent UK *Saving mothers' lives: Reviewing maternal deaths to make motherhood safer, 2006–2008* report found that 14 women had died of epilepsy during pregnancy or the puerperium. One of these women also died while bathing. The bathing deaths of women with epilepsy demonstrates the importance of women with epilepsy being advised regarding the risks of the use of baths (CMACE 2011).

Cerebral infarction

One woman died of basilar artery thrombosis and brain stem infarction, and another from a cerebral infarction diagnosed on imaging and no autopsy was performed to establish the cause. Both of these deaths were classified as indirect maternal deaths.

The risk factors for basilar artery thrombosis are the same as those seen generally in stroke and the prognosis is poor. The guidelines endorsed by the Royal Australian and New Zealand College of Obstetricians and Gynaecologists (McLintock et al. 2012) and the NHMRC (NHMRC 2009) on the use of anticoagulation in pregnancy and the puerperium are summarised in Box 4.5.

Box 4.5: Anticoagulation in pregnancy and the puerperium

- Therapeutic doses of low molecular weight heparins (LMWH) may be used for the management of acute thrombotic events in pregnancy, unless the shorter half-life of intravenous unfractionated heparin (UH) and predictable reversibility by protamine are important.
- Treatment should be continued up until the birth of the baby and into the puerperium.
- Pregnant women who have had an acute thrombotic event should give birth under the care of a specialist maternity team.
- In the case of recent thrombosis, the birth of the baby should be planned and the time during which anticoagulation therapy is ceased around the time of birth should be minimised.
- Therapeutic doses of LMWH contraindicate the use of regional anaesthesia, and a switch to intravenous UH before birth is due may allow greater flexibility in this regard.
- Prophylactic doses of LMWH can be used to reduce the risk of recurrent thromboembolic events in pregnancy. The regimen used will depend on the previous history, the family history and the presence of risk factors, including the genetic and acquired causes of thrombophilia.
- Women with mechanical heart valves are at high risk during pregnancy and require therapeutic anticoagulation throughout pregnancy under the direction of experienced cardiological and haematological specialists (Hague et al. 2001).

Cancer in pregnancy

Cancer is a leading cause of death of women during reproductive years, although the number of pregnancy-associated cancers remains low. A New South Wales study identified 499 cancers that were diagnosed during pregnancy between 1994 and 2008, and 1,299 cancers that were diagnosed during the first year after pregnancy (Lee et al. 2012). This gave a crude incidence for pregnancy-associated cancers (defined as a diagnosis of cancer during pregnancy or within 12 months of giving birth) of 191.5 per 100,000 women giving birth to 1 or more live or stillborn infants at 24 weeks gestation or above ($p < 0.001$) (Lee et al. 2012). The most common pregnancy-associated cancers identified were melanoma (33.3%) and breast cancer (21.0%). In 2013, the AMOSS commenced the first national Australian study on gestational breast cancer.

Two women reported here died from cancer during pregnancy and 1 from a tumour of the right adrenal gland (phaeochromocytoma). One of the women was diagnosed with a relapse of cancer, having been in remission before becoming pregnant. One woman had undiagnosed cancer before her death and she died from intra-abdominal bleeding due to a ruptured liver tumour in the antenatal period. There was insufficient information available to establish the circumstances surrounding the death of the third woman. These deaths were classified as indirect maternal deaths.

Although pregnancy-associated cancers remain rare, it is an important clinical point to note that pregnant women should undergo appropriate investigations for potentially serious conditions. Studies have shown that women and their health-care providers may incorrectly attribute cancer-related symptoms to the physiologic changes of pregnancy and that there is reluctance to perform radiographs or invasive procedures during pregnancy (Smith et al. 2003). These factors may lead to delayed diagnoses of cancer during pregnancy. Evidence has shown that less aggressive tumours are more likely to remain undetected until after the woman has given birth (Smith et al. 2003). The New South Wales cancer in pregnancy study concluded that 'pregnancy-associated cancers have increased, and this increase is only partially explained by increasing maternal age. Pregnancy increases women's interaction with health services and the possibility for diagnosis, but may also influence tumour growth' (Lee et al. 2012).

Deaths from undetermined causes

There were 3 indirect maternal deaths where the cause of death could not be determined. Of these 3 deaths, 2 of the women had an autopsy examination, but the other was not referred to the coroner and the reason for this was not documented at the national level. One woman died from respiratory causes but the exact cause of death could not be determined at autopsy examination. Another woman died antenatally from an undetermined cause after complaining of swelling of the hands and feet but remained normotensive and the cause was not determined at autopsy examination. One woman who was being treated for mastitis, and was known to have multiple comorbidities, collapsed at home and died postpartum.

Summary

'Other' causes of maternal death included epilepsy, cerebral infarction and cancer. The cause of death was undetermined in a number of cases because an autopsy was not performed or was inadequate. Although it is accepted that the death of a woman in association with pregnancy is a very difficult occurrence for all involved, it is important that health professionals always seek consent for specialist pathologist autopsy.

Pregnant women who present with symptoms of serious disease should be fully investigated and relevant clinical specialists consulted.

5 Deaths related to psychosocial morbidity

Good practice guidance

- The antenatal period presents an opportunity to monitor women's psychosocial wellbeing and provide access to appropriate mental health services.
- Antenatal psychosocial screening has been introduced throughout Australia as part of the National Perinatal Depression Initiative 2008–2013.
- Antenatal and postnatal screening programs, with clear referral guidelines and treatment of significant maternal psychiatric morbidity should be routine practice in maternity services, general practice and child and family health services (Austin et al. 2011).

5.1 Severe psychosocial maternal morbidity

The most common mental health problem related to pregnancy is depression. Research shows that the period prevalence (over the 9-month gestation) for major depression is 12.7%, while the period prevalence for major depression is 7.1% in the first 3 months postpartum (Gaynes et al. 2005). The National Perinatal Depression Initiative (NPDI) 2008–2013 is an Australia-wide initiative that has a specific focus on psychiatric illness in pregnancy and the postpartum period. The NPDI identifies maternal mental health and wellbeing as an essential part of a holistic approach to maternity health care. For the first time in Australia, guidelines have been developed and implemented for the detection and treatment of depression and related conditions during pregnancy and up to the first year after birth. The NPDI, underpinned by the *Australian Clinical practice guidelines for depression and related disorders-anxiety, bipolar disorder and puerperal psychosis- in the perinatal period* (Austin et al. 2011), aims 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.

Deaths from psychosocial morbidity between 2006 and 2010

For this report, the term 'psychosocial morbidity' describes deaths in which a psychiatric condition contributed to the cause of death, and encompasses the wider issues of domestic violence and substance misuse. There were 13 maternal deaths from causes related to psychosocial morbidity between 2006 and 2010. Psychosocial morbidity was the second leading cause of indirect maternal death in Australia, behind cardiac causes. The MMR due to psychosocial morbidity for 2006 to 2010 is 0.9 deaths per 100,000 women who gave birth, compared with 1.2 deaths per 100,000 women who gave birth in 2003–2005 (Table 5.1). Previous Australian maternal death reports have shown similar findings with 'psychiatric deaths' (the term used in previous Australian maternal death reports) reported as the leading cause of death in the previous 3 triennia (Table 5.1). The very small number of deaths increases volatility and limits the interpretation of the data, so caution should be used when interpreting these results.

Table 5.1: Deaths related to psychosocial morbidity, ratio per 100,000 women who gave birth, Australia, 2000–2010

Reporting period	Number	MMR[(a)]
2000–2002	9	1.2
2003–2005	9	1.2
2006–2010[(a)]	13	0.9

(a) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

In the UK, a data linkage study, which is a reliable method of obtaining information on the number of maternal deaths and their cause, identified suicide as the leading cause of maternal morbidity and mortality for the time period studied (CMACE 2011). A New South Wales-based data linkage study reported similar findings, with a large proportion of the deaths identified (32%) due to psychosocial-related morbidity (Cliffe et al. 2008). The serious and, in some cases life-threatening, consequences of mental health illness associated with the perinatal period have been afforded increasing prominence in the area of maternal morbidity and mortality research over recent years, and in this report. A significant proportion of maternal deaths occur among women with a previous psychiatric history (Austin et al. 2007) and 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). The antenatal period is a time when many women will have contact with health-care services, which presents an important opportunity to evaluate and monitor psychosocial wellbeing and provide access to appropriate mental health services. Although these deaths can be viewed as not strictly due to 'obstetric causes' they are a part of the spectrum of maternal morbidity and a significant cause of mortality in the perinatal period. If the aim of examining and reporting maternal deaths is to make improvements in maternity care that could lead to prevention of maternal deaths and to provide information that can be used to improve maternity services, then it is essential that deaths of women by suicide or assault in the perinatal period are included in systems of review. It is essential that maternity services are able to effectively identify and provide services to women at risk of harm from themselves or others. It is essential that opportunities to prevent the death of vulnerable women are not lost.

There were 13 women who died from causes related to psychosocial morbidity between 2006 and 2010: 9 of these women committed suicide; 2 were murdered by their partners; and 2 were known substance users who overdosed on illicit drugs with unknown intent.

Table 5.2: Indirect maternal deaths due to psychosocial morbidity by cause, Australia, 2000–2010

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

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

(b) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

There were 4 further deaths related to psychosocial morbidity that were classified as incidental. Of the incidental deaths, 3 women were murdered and 1 died of an overdose in early pregnancy; all of these cases were deemed unrelated to the pregnancy by the local STMMC. There was another death related to psychosocial morbidity that is reported elsewhere: a woman died from complications of labour after failing to attend maternity services during the antenatal period or at birth and was classified as an indirect death due to infection.

Of the 9 women who committed suicide, 7 were by violent means including 5 who committed suicide by hanging. The method of suicide for 1 woman was not documented and 1 was an overdose of illicit drugs. The women who died were aged between 19 and 40 with a median age of 32. Seven of the women died while they were pregnant, including all 3 who were victims of partners. Six women died in the postnatal period and the pregnancy status was not reported for 1 woman. Table 5.3 gives a summary of the women who died from causes associated with psychosocial morbidity in Australia between 1994 and 2010, and in the UK between 2000 and 2002. The 2006–2010 data support previous findings that a significant proportion of maternal deaths occur among women with a previous psychiatric history, or among those with current contact with mental health services.

Table 5.3: Profiles of maternal deaths associated with psychiatric causes in Australia and the UK (adapted from Austin et al. 2007)

	Australia 2006–2010 (n = 13)	Australia 1994–2002 (n = 26)	UK 2000–2002 (n = 60)
Age < 25	4 (31%)	7 (27%)	11/58 (16%)
Ethnic/Indigenous status	Not reported	At least 3 (12%) Indigenous	7/60 (12%) ethnic minorities
Suicide by violent means	6 (46%)	17 (65%)	17/26 (65%)[(a)]
Antenatal death	8 (62%)	17 (65%)	14/60 (23%)
Prior psychiatric illness	8 (62%)	6 (23%)	34/56 (61%)
Perinatal psychiatric episode	4 (31%)	13 (50%)	37/60 (62%)
Receiving treatment perinatally	3 (23%)	9 (35%)	37/60 (62%)
Contact with a psychiatric service perinatally	4 (31%)	8 (31%)	23/60 (38%)
Psychiatric in-patient care perinatally	3 (23%)	6 (23%)	10/60 (17%)
Perinatal risk detection	Of the 8 women with a previous or current psychiatric disorder, 3 (38%) were reported at the national level as in contact with mental health services	Of the 19 women with a previous or current psychiatric disorder, 9 (47%) were in contact with mental health services	Of the 34 women with a previous psychiatric disorder, 17 (50%) had been identified as 'at risk'; 10/17 had a management plan in place

Note: Details were not available for 2 of the 28 suicide deaths.

Of the 13 women who died between 2006 and 2010, 8 had a documented psychiatric history, 8 were known substance users and4 had contact with mental health services during the perinatal period. Austin et al. (2007) suggest 'that these deaths, in particular, may have been avoided if there had been adequate monitoring of the women's mental health status'.

Case summary

A 30-year-old nulliparous woman with a history of depression and borderline personality disorder revealed feelings of anxiety, suicidal ideation and an episode of attempted self-harm to maternity staff during the antenatal period. Although she was referred for mental health care, she failed to attend any follow-up appointments. She went into spontaneous labour at term and gave birth to a healthy infant. During the early postpartum period family members raised concerns with maternity staff over her difficulty parenting the baby. Two days later she committed suicide by hanging.

Case summary

A 24-year-old nulliparous woman experienced a neonatal death. Medical records reported no known general practitioner. A mental health history was not obtained but a known history of 'recreational drug use' was recorded. The woman was found deceased at home 32 days postpartum. Autopsy: mixed drug toxicity.

Collecting information on maternal deaths due to psychosocial morbidity

At present, the national maternal death data collection consists of limited information on psychosocial wellbeing. In 2013–14, a new national maternal death reporting form was piloted: the National Maternal Death Reporting (NMDR) form. The NMDR form is the result of a thorough process of consultation with relevant experts, both nationally and internationally. The NMDR form will collect more detailed information on psychosocial wellbeing, including details of antenatal and postnatal mental health screening, psychiatric history and previous contact with psychiatric or child protection services.

Data linkage, as previously demonstrated in Cliffe et al. 2008 and Thornton et al. 2013, allows more accurate detection of all psychosocial-related maternal deaths, including late maternal deaths, which are particularly relevant to this group of women, given that the greatly increased rate of serious psychiatric morbidity extends into the first few months postpartum (Austin et al. 2011; Munk-Olsen 2006; Thornton et al. 2013) .

Classifying maternal deaths due to psychosocial morbidity

In Australia, each maternal death undergoes a through process of review and investigation in the form of a confidential death enquiry. As part of the confidential death enquiry, there is the opportunity to examine the circumstances surrounding each death on an individual basis and determine previous psychosocial morbidity. As discussed in 'Chapter 2 Definitions, classifications and methods', for national reporting purposes, Australia has classified deaths among women with a pre-existing psychiatric illness or a psychiatric illness that developed during pregnancy and was not due to direct obstetric causes as indirect. Deaths deemed unrelated to the pregnancy due to 'external causes' have been classified as incidental. This classification system was introduced in the 1997–1999 triennium and the classification for psychosocial deaths that occurred between 2006 and 2010 remained unchanged from that triennial report.

In general, the Australian classification system is intended to determine the causes and potential preventability of these deaths, with the aims of improving maternity mental health services and reducing maternal deaths.

Summary

Psychosocial morbidity is a leading cause of maternal death in Australia. 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 implementation of the NPDI, which for the first time provides guidelines for the management of psychiatric illnesses in the perinatal period, are timely initiatives in preventing maternal deaths related to psychosocial morbidity. A more detailed national maternal death reporting form represents the potential for significant change and improved reporting in Australia. Improved reporting of these non-obstetric causes of maternal death could provide the evidence base required for further policy and service implementation for women with mental health morbidity.

6 Incidental deaths

Incidental maternal deaths are deaths from causes unrelated to pregnancy that happen to occur in pregnancy or the puerperium. Internationally, cases of such incidental deaths are included in maternal mortality reporting, although only direct, indirect and unclassifiable maternal deaths are counted for statistical purposes. In addition to the 99 maternal deaths reported to the NPESU between 2006 and 2010, there were 26 incidental maternal deaths (Table 6.1).

Table 6.1: Causes of incidental maternal deaths, Australia, 2006–2010

Cause of death	Number
Medical causes	11
Motor vehicle accident	7
Homicide	3
Accidental injury	2
Undetermined	2
Overdose	1
Total	**26**

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, intracerebral haemorrhage and probable cardiac arrhythmia. Deaths resulting from motor vehicle accidents were the most common single cause, accounting for 7 of the 26 incidental maternal deaths, followed by 3 deaths due to homicide. These are additional to the 2 indirect deaths due to homicide reported in 'Chapter 5 Deaths related to psychosocial morbidity', where the deaths were able to be attributed to known partner violence.

6.1 Accidental injury and motor vehicle accident

The Injury and Prevention Research Unit, New Zealand provided a statement with regards to the prevention of accidental and motor vehicle injury in pregnancy. Motor vehicle accidents during pregnancy are the leading cause of traumatic fetal mortality and serious maternal injury morbidity and mortality in the US and presumably in other car-centric societies such as Australia. However, fetal death and injury due to maternal injury is a largely invisible problem and has not been enumerated in Australia. The problem remains hidden and under-reported because of the way fetal trauma is coded in vital statistics and the lack of pregnancy status recorded in crash and other injury surveillance systems. Linking crash data to fetal death and infant birth records is 1 proven way to get a better understanding of the problem, though no states do this on an ongoing basis. In addition to better tracking of the problem, a combination of prevention efforts is needed to deal with the issue including: increased occupant protection through high levels of proper maternal seatbelt use; less maternal driving to suit different lifestyles; lower driving speeds; and avoiding or limiting being in a vehicle during risky situations (poor roads, night, bad weather, impaired or distracted drivers).

Summary

All maternal deaths occurring in pregnancy or the puerperium should be reviewed by a STMMC. 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.

7 Aboriginal and Torres Strait Islander women

Good practice guidance

Aboriginal and Torres Strait Islander women:

- remain at 3 times the risk of maternal death as non-Indigenous women
- have a greater burden of maternal mortality from chronic conditions
- have sepsis as the most common specific cause of death in this reporting period and when deaths over a longer time period were considered
- may not all have been identified among women who died. It is important to record accurately Aboriginal and Torres Strait Islander status in all data collections.

Pregnancy and birth pose a greater risk for Aboriginal and Torres Strait Islander women than for non-Indigenous women. There were 14 Aboriginal and Torres Strait Islander women who died during their pregnancy, labour or in the postnatal period between 2006 and 2010. Of these, 9 were maternal deaths, 4 were due to incidental causes and 1 was unclassifiable. The MMR for the 5 years 2006 to 2010 was more than 3 times higher for Aboriginal and Torres Strait Islander women than for the 75 non-Indigenous women (where Indigenous status was known), with MMRs of 16.4 and 5.4 deaths, respectively, per 100,000 women who gave birth. The very small number of deaths increases volatility and limits the interpretation of the data. Caution should be used when interpreting these results.

7.1 Indigenous women who died between 2006 and 2010

The 9 maternal deaths among Aboriginal and Torres Strait Islander women in the current reporting period comprised of 5 direct maternal deaths and 4 indirect maternal deaths. Table 7.1 presents a summary of maternal deaths in Aboriginal and Torres Strait Islander women between 2006 and 2010.

Table 7.1: Maternal deaths among Aboriginal and Torres Strait Islander women, Australia, 2006–2010

Age group	Cause of death category	Parity group[(a)]
Direct		
<20	Hypertensive disorder	M
30–34	Obstetric haemorrhage	GM
20–24	Sepsis	M
35–39	Sepsis	M
≥40	Sepsis	GM
Indirect		
20–24	Suicide	Not stated
20–24	Cardiac condition	M
30–34	Cardiac condition	Not stated
35–39	Other cause	Not stated

(a) M = multipara; GM = grand multipara.

The median age of the Aboriginal and Torres Strait Islander women and other Australian women who died was 32. In contrast, the median age of all Aboriginal and Torres Strait Islander women who gave birth between 2006 and 2010 was 24, compared with 30 for other Australian women. All 6 women for whom parity was known were parous, with 2 grand multipara(4 or more previous births).

Trends in maternal mortality by Indigenous status

The 9 maternal deaths of Aboriginal and Torres Strait Islander women that occurred during 2006–2010 are fewer than the peak of 12 deaths reported during 2000–2002 (Table 7.2). There has been a tendency towards lower MMRs for Aboriginal and Torres Strait Islander women compared with other Australian women since reporting of Indigenous-specific MMR began in 1991 (Table 7.2). Past reports have included women where Indigenous status was not reported. These are collectively referred to as 'Other Australian women'. Although, there are more deaths in the current 5-year reporting period, which is 2 years (67%) longer than for previous reports, the rates of maternal mortality are lower for both Aboriginal and Torres Strait Islander women and other Australian women.

Table 7.2: Trends in maternal mortality in Aboriginal and Torres Strait Islander women and other Australian women, 1991 to 2010

	Aboriginal or Torres Strait Islander women			Other Australian women[a]			
	Maternal deaths			Maternal deaths			
Period	Direct	Indirect	MMR[b]	Direct	Indirect	MMR[b]	Relative MMR[c]
1991–93	1	4	23.2	26	17	5.8	4.0
1994–96	3	1	17.4	43	19	8.3	2.1
1997–99	1	5	23.5	33	23	7.7	3.1
2000–02	4	8	45.8	28	44	10.0	4.6
2003–05	2	4	21.7	27	32	8.0	2.7
2006–10[d]	5	4	16.4	35	52	6.2	2.6

(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/or Torres Strait Islander women or other women who gave birth is the sum of numbers reported in the *Australia's mothers and babies* series for the years referenced.

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

(d) 2006–2010 is a 5-year period; previously 3-year reporting periods were used.

Fluctuation in the MMRs has been more marked for Aboriginal and Torres Strait Islander women than for other women. This reflects both the rarity of maternal death and the smaller population of Aboriginal and Torres Strait Islander women. Apart from the 2000–2002 triennium, MMRs for Aboriginal and Torres Strait Islander women have been of a similar order in all time periods. Higher numbers of indirect maternal deaths were reported for both Aboriginal and Torres Strait Islander and other women in the 2000–2002 triennium compared with other reporting periods. The numbers of maternal deaths among Aboriginal and Torres Strait Islander women, or indeed for other women, is too small to detect statistically significant differences over time, even when reporting periods are combined.

To compare the causes of death between Aboriginal and Torres Strait Islander women and other Australian women, the causes of maternal death reported between 1997 and 2010 have been classified to categories of maternal death used in the current report (Table 7.3). Sepsis (21% of maternal deaths), cardiac conditions (18% of maternal deaths) and psychosocial conditions (18% of maternal deaths) were the leading cause categories among Aboriginal and Torres Strait Islander women. In contrast the most common specific causes of death for other Australian women in this period were hypertensive disorders and non-obstetric haemorrhage (15.3% of maternal deaths), followed by cardiac conditions (15.0% of maternal deaths) and amniotic fluid embolism (12.0% of maternal deaths). 'Other specified cause' comprise a varied group of conditions. Hypertensive disorders and non-obstetric haemorrhage were combined as these conditions may co-exist.

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 Table 7.3, 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. The risk of maternal death from sepsis was more than eightfold higher among Aboriginal and Torres Strait Islander women compared with other Australian women over this time period. Higher risks of maternal death from cardiac conditions, psychosocial conditions, and hypertensive disorders and non-obstetric haemorrhage combined are also seen among Aboriginal and Torres Strait Islander women compared with other women.

Table 7.3: Cause of maternal death among Aboriginal and Torres Strait Islander women and other Australian women, 1997 to 2010

	Aboriginal or Torres Strait Islander women			Other Australian women[a]			
	Maternal deaths			Maternal deaths			
Cause of maternal death	Number	%	CS-MMR[b]	Number	%	CS-MMR[b]	Relative CS-MMR[c]
Sepsis	7	21.2	44.5	23	8.8	5.6	8.6
Cardiac condition	6	18.2	38.1	41	15.0	9.5	4.0
Psychosocial condition	6	18.2	38.1	30	10.9	6.9	5.5
Hypertensive disorders and non-obstetric haemorrhage	5	15.2	31.8	42	15.3	9.7	3.3
Other specified cause	4	12.1	25.4	58	21.2	13.4	1.9
Obstetric haemorrhage	3	9.1	19.1	25	9.1	5.8	3.3
Amniotic fluid embolism	1	3.0	6.4	33	12.0	7.6	0.8
Thrombosis and thromboembolism	1	3.0	6.4	21	7.7	4.9	1.3
Total	**33**	**100.0**	**209.7**	**273**	**100.0**	**63.4**	**3.3**

(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 CS-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.

Pre-existing and non-obstetric conditions are more common causes of maternal death for Aboriginal and Torres Strait Islander women than for other women. This is consistent with generally poorer health among Aboriginal and Torres Strait Islander women compared with the general population of women. 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, especially rheumatic heart 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.

Remoteness as a risk factor for maternal death

There was no substantial difference in maternal mortality between Aboriginal and Torres Strait Islander women resident in *Major cities* or *Inner regional* areas (15.4 per 100,000 women who gave birth) and those living in *Outer regional, Remote* or *Very remote* locations (13.8 per 100,000 women who gave birth). Nor was there a trend evident. In contrast, maternal mortality increased with increasing remoteness among non-Indigenous women from 3.7 per 100,000 women who gave birth and were resident in *Major cities* to 4.9 per 100,000 women who gave birth and were resident in *Remote* and *Very remote* areas.

In 2006–2010, 27% of Aboriginal and Torres Strait Islander women and 2% of non-Indigenous women who gave birth lived in a *Remote* or a *Very remote* area, while 27% and 72%, respectively, lived in *Major cities*. Small numbers limit interpretation and detailed reporting of remoteness area for Aboriginal and Torres Strait Islander women.

Access to health services and health outcomes are generally poorer in rural and remote areas relative to metropolitan areas (Department of Health and Aged Care 2003). Access to health care and chronic ill health may be issues for Aboriginal and Torres Strait Islander women living in urban areas, as well as those living in remote settings. Potential information bias regarding place of usual residence exists for women who are temporarily relocated to attend hospitals in metropolitan areas in the later stages of their pregnancy until they give birth.

Taking control of maternity care

The threefold higher risk of maternal death faced by Aboriginal and Torres Strait Islander women compared with other women in Australia is 1 of a range of differential perinatal outcomes that communities, health services and health authorities are seeking to eliminate. In the National Maternity Services Plan, attention is focused on expanding the provision of culturally competent maternity services for Aboriginal and Torres Strait Islander women (Australian Health Ministers' Conference 2011). Cultural competence has been defined as a set of congruent behaviours, attitudes and policies that focuses on the capacity to improve health and wellbeing by integrating culture into the delivery of health services (NHMRC 2006).

Culturally competent Aboriginal and Torres Strait Islander maternity care integrates respect for, and recognition of, cultural diversity, partnership with Aboriginal and Torres Strait Islander communities and Aboriginal and Torres Strait Islander workforce into services with continuity of care and carer models, community-appropriate infrastructure, guidelines, communications, cultural education programs, evaluation tools and consumer engagement in clinical governance (Kruske 2011). These principles are exemplified in the 3 examples in Box 7.1 from the growing number of programs across Australia.

Box 7.1: Examples of Aboriginal and Torres Strait Islander culturally competent maternity services

- The Anangu Bibi Family Birthing Program was founded following consultation with senior Aboriginal women in South Australia and set up in partnership with Aboriginal communities in Whyalla and Port Augusta. Aboriginal maternal and infant care workers take the lead role, working in partnership with midwives backed by general practitioners in an intercultural partnership and skill exchange to provide care during pregnancy, childbirth and in the postnatal period for Aboriginal mothers and families (Stamp et al. 2008).
- Mawarnkarra Aboriginal Health Service developed a program that incorporates relevant cultural beliefs in the health education program for pregnant women and their families in response to gaps in service provision identified by the health team and community elders (McHugh & Hornbuckle 2011).
- Congress Alukura is a long-standing Aboriginal community-controlled health service in Alice Springs that provides culturally appropriate antenatal, intrapartum and postnatal care by a team that includes a full-time general practitioner, midwives, women's health nurse, Aboriginal liaison officer, educators and traditional grandmothers (Kruske 2011).

Audit tools (Reibel & Walker 2010) and indicators (Kruske 2011) of cultural competence in maternity services are being developed and tested so that the extent and contribution of culturally competent maternity services can be evaluated (Australian Health Ministers' Conference 2011). This is, however, only 1 facet, and services are encouraged to develop an organisational culture that values learning and continuous quality improvement across all areas of practice and service delivery (McHugh & Hornbuckle 2011).

Identifying Aboriginal and Torres Strait Islander women

Aboriginal or 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 16 women who died during pregnancy or within 42 days of giving birth, including 12 direct or indirect maternal deaths, representing 13% of maternal deaths. This is higher than the previous triennium 2003–2005 when 6 (8%) of the maternal deaths had no data reported on Indigenous status (Sullivan et al. 2007). This reflects in part the provisional nature of some of the data provided for this report.

An Aboriginal or 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. The third criterion for Aboriginality, namely that she is accepted by her community, is not included for pragmatic reasons. 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 or 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 2012a). 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

Aboriginal and Torres Strait Islander women are 3 times more likely to die during their pregnancy or the puerperium than 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. Sepsis, cardiac and psychosocial conditions were the leading cause categories of deaths among Aboriginal and Torres Strait Islander women between 2006 and 2010. 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.

The sociocultural, geographic and health service environments for many Aboriginal and Torres Strait Islander women are different to other Australian women. There are successful examples of culturally appropriate Aboriginal and Torres Strait Islander community maternity care programs that have been shown to improve the health of Aboriginal and Torres Strait Islander mothers and their babies. It is critical that Aboriginal and Torres Strait Islander status is adequately reported in key health data sets, so that essential information can be collected and used to inform research, with the ultimate purpose of improving the health of all Australian mothers.

8 Coronial review

Good practice guidance

- Maternal deaths should be reported to the coroner and where the cause of death is not clearly known autopsy should be advocated to establish the cause of death.
- Guidelines for how to perform a maternal death autopsy are available from The Royal College of Pathologists, *Guidelines on autopsy practice scenario 5: Maternal death* (RCPATH 2010).
- Jurisdictions are advised to develop documents to support families and clinicians during the process of consent for autopsy.
- The role of the coroner and reporting requirements are not standardised across jurisdictions.

This is the first *Maternal Deaths in Australia* report to include a specific chapter on the role of the coroner. The NMMAC was concerned about the number of deaths that it reviewed that were not examined by autopsy despite there being some uncertainty regarding the cause of death and, in some cases, not being appropriately referred to a coroner; this concern led to inclusion of this chapter.

In Australia, the primary method of review for all maternal deaths is confidential enquiry. However, there are several models of reporting and investigation into maternal deaths other than confidential enquiry. Examples of other models of investigation include investigation by the hospitals in which the death occurs, such as by root cause analyses, and investigation by the coroner. These other enquiries can provide valuable information on individual cases to be used at confidential enquiry. Autopsies may be essential in accurately establishing the cause of death in some cases, and coronial review can establish valuable insights into the circumstances of particular deaths. Between 2006 and 2010, 80 of the 99 (80.1%) direct and indirect maternal deaths were referred to the coroner. There were autopsies for 72 (72.7%) of all cases (Table 8.1).

Table 8.1: Maternal deaths by referral to coroner, by type of death and autopsy, Australia, 2006–2010

Type of death	Maternal deaths	Referred to the coroner	Autopsy
Direct	39	33	30
Indirect	57	45	40
Maternal deaths not further classified	3	2	2
Total	**99**	**80**	**72**

8.1 The role of the coroner

Each state and territory has its own Coroners Act, which governs the powers and duties of the coroner. Accordingly, the specific duties and responsibilities of the coroner vary by jurisdiction (National Coronial Information System). In general, the role of the coroner is to investigate the circumstances surrounding a 'reportable death'. At the conclusion of every

investigation, it is the task of the coroner to prepare a written finding to establish wherever possible the following:

- identity of the deceased
- circumstances surrounding the death
- cause of death
- particulars needed to register the death.

The coronial process is not adversarial and is not intended to determine whether any person is guilty of any offence, but rather to investigate and discover facts (Turnbull 2010). As part of the coronial process, an autopsy may be performed to help explain the cause of death. Once a pathologist has all the results of the tests, a detailed report is prepared for the coroner, which outlines medical findings and conclusions (National Coronial Information System). The coroner takes this information into account when making a finding. In some circumstances, an inquest may be held. An inquest is a court hearing conducted by the coroner, in which the circumstances surrounding a death are examined. It is important to note that most deaths do not require an inquest. In Western Australia, an inquest or public hearing is only held in about 3% of cases (Turnbull 2010).

Is a maternal death a reportable death?

Coronial legislation varies by jurisdiction and, in turn, what constitutes a 'reportable death' varies by jurisdiction. A review of the relevant legislation demonstrates that generally legislation mandates that:

- all reportable deaths are reported to the coroner
- health professionals must provide all available information to the coroner's office
- the coroner's role is to determine what happened, as well as to assign a cause of death.

Across jurisdictions in general, a reportable death is a:

- death that follows an injury or accident (not explicitly stated in New South Wales)
- violent or unnatural death
- death of which the cause is unknown
- death which was unexpected
- death in custody
- death that has not been certified by a medical practitioner
- death of a person who was detained or recently detained in mental health services (Victoria, New South Wales, South Australia, Queensland, Western Australia and Northern Territory, but not Australian Capital Territory or Tasmania).

In some jurisdictions, health-care-related deaths are more specifically included:

1. A death following anaesthetic (South Australia, Tasmania, Western Australia and Northern Territory)
2. A health-care-facility-related death:
    - Queensland: 'healthcare related death'
    - Northern Territory: 'a death following a medical procedure where the death is or may be causally related to the medical procedure'

- New South Wales: 'the person died where the person's death was not a reasonably expected outcome of a health-related procedure'
- Australian Capital Territory: 'a death within 72 hours of an operation of a medical, surgical, dental or like nature, or an invasive medical or diagnostic procedure'
- Victoria: 'a death following a medical procedure where the death is or may be causally related to the medical procedure'.

In April 2004, Australian Health Ministers agreed to all public hospitals reporting all sentinel events and that all states and territories would contribute to a national report on sentinel events (AIHW & ACSQHC 2007). Sentinel events are reported by the Productivity Commission in their annual *Report on government services*. Most cases of maternal death are likely to fall within the criteria for a reportable death. In the UK, the Royal Colleges of Obstetricians and Gynaecologists and of Pathologists both recommend that 'an autopsy be performed on as many maternal deaths as possible to learn from the results' (CMACE 2011). In Australia, the Royal College of Pathologists of Australasia is supportive of all maternal deaths being investigated by an autopsy, whether authorised by the coroner or not. Guidelines for how to perform a maternal death autopsy are available from The Royal College of Pathologists, *Guidelines on autopsy practice scenario 5: Maternal death* (RCPATH 2010). It is important to note that if the case is reportable when death is declared (which includes when brain death is determined), the body becomes property of the coroner and it is an offence to perform any procedure on, or to interfere with, the body without permission from the coroner.

Sentinel event reporting

The national list of sentinel events, revised by the Australian Health Ministers' Advisory Council (AHMAC) and the Standing Committee on Health (SCoH) in 2009 is as follows. A maternal death is the seventh sentinel event:

1. procedures involving the wrong patient or body part resulting in death or major permanent loss of function
2. suicide of a patient in an inpatient unit
3. retained instruments or other material after surgery requiring re-operation or further surgical procedure
4. intravascular gas embolism resulting in death or neurological damage
5. haemolytic blood transfusion reaction resulting from ABO incompatibility
6. medication error leading to the death of patient reasonably believed to be due to incorrect administration of drugs
7. maternal death or serious morbidity associated with labour or delivery
8. infant discharged to the wrong family.

A survey of jurisdictional reporting practices

In April 2012, the AIHW NPESU undertook a survey in each jurisdiction. The survey was completed by the Department of Health in each jurisdiction and aimed to establish which

methods of maternal death enquiry are used by each jurisdiction. A component of the survey focused on the role of the coroner and aimed to establish:

- jurisdictional legislation or policy that mandates or recommends maternal deaths are reported to the coroner
- any non-formalised reporting processes involved in coronial review of maternal deaths.

No survey responses were received from the Australian Capital Territory and the Northern Territory. Table 8.2 summarises the jurisdictional reporting practices by identifying the relevant legislation, showing if there is mandatory reporting of maternal deaths to the coroner and highlighting any reported relationships between the Department of Health and the coroner's office.

Table 8.2: Coronial legislation and existing reporting relationships by jurisdiction

State	Coroner's legislation	Does this policy mandate referral of maternal deaths?	Existing reporting structures/current relationship
NSW	*Coroners Act 2009*	No	The Department of Forensic Medicine at Glebe reports maternal deaths to the Ministry of Health on a voluntary basis.
Qld	*Coroners Act 2003*	No	The Chairpersons of gazetted state-wide quality assurance committees have an informal relationship with the State Coroner, and the chairperson of the Queensland Maternal and Perinatal Quality Council has met formally with the State Coroners in 2013 and 2014. The *Public Health Act 2005* was revised in early 2014 to mandate reporting of maternal deaths to the Department (the Maternal Death Statistics Collection).
Vic	*Coroners Act 2008*	Yes	Notified automatically through coronial e-Medical Deposition Form (check box asking if pregnant in past 12 months).
SA	*Coroners Act 2003*	Yes	Coroner's records are able to be accessed, excepting those where a criminal investigation is underway.
Tas	*Coroners Act 1995*	Yes	All maternal deaths to be reported to the coroner.
WA	*Coroners Act 1996*	No	The WA Health Coronial Liaison Unit was established in 2005 to improve communication between WA Health and the Office of the State Coroner
ACT	*Coroners Act 1997*	–	–
NT	*Coroners Act 2011*	–	–

Each jurisdiction has a Coroners Act, which legislates for the role of the coroner. Jurisdictions reported differing practices with regards to maternal death review. Victoria and Tasmania have a mandatory reporting requirement for maternal deaths. Reporting of a maternal death to the coroner is not mandatory in New South Wales, Western Australia and Queensland. Some jurisdictions have established reporting relationships with the coroner's office. For example, in New South Wales, the Department of Forensic Medicine, where all maternal death autopsies are undertaken, report maternal deaths to the Ministry of Health on a voluntary basis.

The number of referrals to the coroner and the number of autopsies carried out varied in each jurisdiction between 2006 and 2010. The proportion of autopsies performed varied between 40% in Northern Territory to 100% in Western Australia (Table 8.3).

Table 8.3: Maternal deaths by referral to coroner, autopsy, state and territory of death, Australia, 2006–2010

State and territory	Maternal deaths	Referred to the coroner		Autopsy	
		Number	%	Number	%
NSW and ACT	24	22	91.7	20	83.3
Vic	30	23	76.7	16	53.3
Qld	24	20	83.3	20	83.3
WA	8	8	100.0	8	100.0
SA	6	[(a)]5	83.3	5	83.3
Tas	2	0	0.0	1	50.0
NT	5	2	40.0	2	40.0
Total	**99**	**80**	**80.8**	**72**	**72.7**

(a) Includes 1 woman who had pathology review only with histology of the uterus, spleen and placenta.

Summary

Most cases of maternal death are likely to fall within the criteria for a reportable death. Reporting practices vary by jurisdiction, as do the number of autopsies undertaken. Maternal deaths should be reported to the coroner and the majority of cases should undergo autopsy.

9 Quality of maternal death reviews in Australia

The current Australian maternal death reporting system involves several tiers of reporting/review as outlined in Chapter 2. The organisational structure, roles and responsibilities of State and Territory Maternal Mortality Committees (STMMCs) 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 National Maternal Death Report Data Set, used to populate this report, reflect these inconsistencies.

This chapter outlines the variations in the process of data collection and supply across states. Information used in this chapter was obtained from a national survey distributed to the Department of Health in each state and territory in July 2012. The aims of the survey were: to determine the most common sources of maternal death notification; identify legislation relevant to maternal deaths in each state and territory; and to establish which mechanisms of review other than confidential enquiry are routinely used. Survey responses were received from New South Wales, Victoria, Queensland, South Australia, Western Australia and Tasmania, with the majority completing all questions.

9.1 Sources of maternal death notification

Methods of maternal death notification vary across states and territories. Information from the survey responses is detailed here, noting that no information was received from the Australian Capital Territory and Northern Territory.

In New South Wales, maternal deaths are notified through a number of methods such as: direct notification by hospitals; voluntary reporting by the local Department of Forensic Medicine; and dedicated searches of New South Wales admitted patient data such as the New South Wales Perinatal Data Collection and the National Coronial Information System. Additionally, the number of deaths for each year is assessed against ABS mortality data.

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 Forms 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 for 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).

Tasmania Health Department are notified of maternal deaths through the following sources: health statistics; the Register of Births, Deaths and Marriages; and by local clinicians who are members of the state STMMC (Tasmanian Council of Obstetric and Paediatric Mortality and Morbidity Maternal Mortality), as well as the local hospital Morbidity and Mortality Committees.

Other jurisdictions have more informal processes of review. South Australia Health 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 is not used as a source of notification to the STMMC in South Australia. Additionally, hospital separation discharge codes are reviewed to identify maternal deaths. No information was provided by Western Australia on the sources of maternal death notification.

Relevant legislation pertaining to the reporting of maternal deaths is shown in Table 9.1. Only Victoria, Queensland and Western Australia reported a mandatory reporting requirement for maternal deaths.

Table 9.1: Jurisdictional legislation pertaining to maternal deaths notification, Australia, 2012

State and territory	Legislation
New South Wales	*Public Health Act 1982*, section 23
Victoria	*Public Health and Wellbeing Act 2008*
Queensland	*Public Health Act 2005* (revision)
Western Australia	*Health Act 1911*, Part XIII, section 336
Tasmania	*Obstetric and Paediatric Mortality and Morbidity Act 1994*

The supply and sharing of information

As outlined in Chapter 2, a standard set of information is requested from each state and territory STMMC and compiled into the National Maternal Death Report Data Set with expert input from the NMMAC. For this report, data were supplied to the NPESU using the National Maternal Death Reporting (NMDR) form 2006–2010: a standardised data collection form distributed to each state and territory health department. A subcommittee of the National Maternal Mortality Advisory Committee Report Working Group (NMMAC–RWG) (Appendix B) was established to develop this data collection form. The NMDR form 2006–2010 was developed based upon the existing national maternal death reporting form, the New Zealand Perinatal and Maternal Mortality Review Committee (PMMRC) maternal death reporting form and the UK's maternal death surveillance form. A number of concerns were raised by the RWG over the availability of data for the period 2006–2010. The RWG noted there were likely to be administrative and logistical barriers to the collection of the data and expressed significant concerns over the retrospective collection of data and the burden on the jurisdictional health services. On the advice of the RWG and NMMAC, it was agreed the proposed NMDR form 2006–2010 would be shortened to enhance usability and maximise likely data completion. As a result, the NMDR form 2006–2010 used to populate the National Maternal Death Report Data Set collects limited information on risk factors, clinical pathways and management of severe maternal morbidity.

For this report, and in previous reporting periods (Sullivan et al. 2007), there were inconsistencies in the data supplied, which in part reflect issues relating to legislative barriers to the sharing of data and with timeliness of the process of review. For the current report, several jurisdictions did not undertake a clinical review of the deaths before supplying data, and other jurisdictions were unable to provide information obtained at clinical review or confidential enquiry for compilation into the National Maternal Death Report Data Set. Data provided by Western Australia has been subject to legislative privacy

restrictions and limited information was provided. Data as collected by the STMMC were not provided and data were sourced from perinatal and hospital administrative data collections. Classification of death as decided by the STMMC was subsequently supplied in 2013. During the development of the report, the New South Wales Maternal and Perinatal Committee was in a period of suspension due to legislative committee restructuring and a number of cases were provided as not yet reviewed by the committee. In some instances, this resulted in very limited available information.

Supply of data was variable, with data not available for all deaths. Data for 2006–2010 deaths were not received until late 2012 with a further resupply of data in 2013. Not all deaths at a jurisdictional level had been notified, reviewed and classified at the time of the data request for the report. Three deaths were excluded because not enough information was available to determine whether these deaths could be classified as maternal deaths. The publication time for the report has varied and is detailed in Table 9.2. The 5-year reporting period for this report was used to mitigate this delay in publishing data.

Table 9.2: Timeliness of publication of *Maternal deaths in Australia* reports

Maternal mortality reporting period	Year of publication
1997–1999	2004
2000–2002	2006
2003–2005	2008
2006–2010	2014

The delay in publication time potentially compromises the immediate clinical relevance of data because maternal health care continues to evolve. The development of a nationally agreed process of review of maternal deaths, an agreement for the responsible sharing of data at the committee level and implementation of the proposed NMDR form 2014 are required to improve the quality and utility of the maternal deaths data collection.

Methods of review other than confidential enquiry

State and territory-based confidential enquiry is the primary method of review for all maternal deaths. Across Australia, there is a variety of reporting systems other than maternal death confidential enquiry that focus on patient deaths. These include the coronial system, the sentinel event program and patient safety incident reporting systems. All of these enquiries can be used to add value to the confidential enquiry. The coronial system was discussed in 'Chapter 8 Coronial review'.

A national list of core sentinel events was agreed with all jurisdictions at the Australian Health Ministers' Conference in 2004: a maternal death is the seventh sentinel event (AIHW 2007). A sentinel event report was published by the AIHW, in conjunction with the Safety and Quality in Health Care Council in 2007 (AIHW 2007). To date, there have been no subsequent publications.

Patient safety incident reporting and investigation is now required in all health-care jurisdictions in Australia (ACSQHC 2009). The legislative and policy basis for this requirement varies between states and territories, as do the mechanisms in place for reporting (ACSQHC 2009). Broadly, the requirements in each jurisdiction mandate health-care practitioners to report patient safety incidents. They mandate the use of a standardised

risk-adjustment tool to classify the severity of the incident reported (generally a 'Severity Assessment Code (SAC)'), and specified actions for the investigation of the most severe patient safety incidents, usually through root cause analysis (RCA). Maternal death is classified as the highest severity of incident. Table 9.3 names the relevant policy and processes of review by state and territory. Although the states and territories consistently reported policy regarding incident reporting systems, they reported inconsistency in the utilisation of RCAs in investigating maternal deaths. Queensland Health estimates that less than 50% of maternal deaths undergo RCA. Victoria reported that they are unable to identify maternal deaths cases in the incident reporting system before 2010, and South Australia reported 'unknown' for the proportion of maternal deaths undergoing RCA.

Table 9.3: Maternal death incident reporting system policy and review processes by state and territory, Australia, 2012

	New South Wales	Victoria	Queensland	South Australia	Tasmania
Maternal deaths incident reporting system policy	Policy Directive on Incident Management NSW Health	Victorian Health Incident Management Policy	Clinical Incident Management Policy	SA Health Incident Management Policy	DHHS Incident Reporting and Management
Responsible body	Clinical Excellence Commission	Quality and Safety and Patient Experience Branch of Department of Health	Patient Safety and Quality Improvement Service, Queensland Health	Safety and Quality Unit, SA Health	Tasmanian Council of Obstetric and Paediatric Mortality and Morbidity Maternal Mortality

Maternal death review in the United Kingdom and New Zealand

The UK confidential enquiry process is considered internationally as the gold standard and the 2010 *Saving mothers' lives: Reviewing maternal deaths to make motherhood safer, 2006–2008* reports the following process of review (CMACE 2011). Confidential enquiries are carried out regionally, with a central coordination office overseeing the process. Notification usually occurs through a clinician involved in the case and then to a regional officer who follows up with a request for more detailed surveillance data. Each case undergoes a 2-stage review: 1 at the regional level and1 at the central level. National reporting is undertaken by the central office every 3 years.

In New Zealand, a subgroup of the ministerially convened PMMRC, the Maternal Mortality Review Working Group (MMRWG), undertakes review of all direct and indirect maternal deaths (PMMRC 2007). On notification of a death, the national coordinator issues a nationally standardised maternal deaths reporting form to a local coordinator who is then responsible for gathering necessary clinical information from those involved in the case. Each maternal death is then reviewed by designated members of the MMRWG, who presents a summary of a case and findings to the working group (PMMRC 2012). The MMRWG reviews each case in detail including assessing the presence of contributory factors and potential avoidability.

In New Zealand, local coordinators are requested to notify all maternal deaths. Deaths are also identified through the coroner and media reports. At the end of each year, known deaths are cross-referenced with the mortality collection of the Births, Deaths and Marriages Registry to ensure collection is complete. Since July 2007, there has been a mandatory reporting requirement for all maternal deaths to the coroner (PMMRC 2012).

The current Australian system of review does not have the same level of centralisation and continuity of reporting that occurs in the UK and New Zealand. In Australia, a secondary report-specific data set collected up to 7 years after a death has occurred is used to undertake national reporting. Assessments of potential avoidability are not undertaken consistently at a jurisdictional level. At the national level, only summary data on the maternal deaths is provided, which limits this type of assessment. The timeliness of reporting and lack of transfer of information between committees do not permit this type of national review. Overall, these factors limit the capacity for meaningful comparison of cases. The lack of a nationally standardised process of data collection and review has a significant impact on the quality and utility of the data collected in Australia.

Future reporting of maternal deaths

The NMMAC has advised that the NMDR form 2006–2010 will be used to collect information about maternal deaths occurring in 2011 and 2012. The use of the NMDR form 2006–2010 is in response to the NMMAC's concern regarding the timeliness of maternal death data collection, as well as consideration of the burden of retrospective data collection on jurisdictional health services.

Pilot National Maternal Death Reporting form

The National Maternal Death Reporting (NMDR) form is intended for implementation in 2015. The NMDR form has been developed by the NMMAC–RWG and has been based on the National Maternity Council's draft form provided to the NMMAC in September 2011. The form has undergone several rounds of review by relevant national and international experts. The aim of this process of review has been to ensure that the national data collection tool is up to date, comprehensive and reflects the availability of information at the state and territory level. Although the form is intended for use at the national level, it may be used at the local level if the states and territories determine. Piloting commenced in South Australia and Queensland in 2013.

Overall, this form will collect more detailed information on the underlying health status of women who die, the risk factors associated, and the details of labour and birth events. It will limit the capacity for variability in data provision and is in line with current international and national data development initiatives. The aim has been to present a form that will improve the quality and utility of the data collection that can ultimately be used in the development of policy, clinical guidelines and educational resources.

Summary

The care pregnant women in Australia receive is among some of the best in the world and the existing process of review is an example of good practice as well as in compliance with international standards. However, there are inconsistencies in the process of maternal death review and in turn there is:

- inconsistency in the quality of data collected
- under-utilisation of other patient death enquiry systems
- delay in the process of confidential enquiry

- legislative inconsistency and barriers to sharing data between states, territories and federally.

The WHO suggests that, in order to enhance patient safety, health-care services need an 'increased ability to learn from mistakes, through better reporting systems, skilful investigation of incidents and responsible sharing of data' (WHO 2002). In order to achieve this in Australia, it is necessary to work in collaboration with state and territories to implement policy at a national level that aims to improve and standardise data collection. A mandatory reporting requirement for notification of maternal deaths and an agreement on the responsible sharing of data at the national committee level would support this.

Appendix A National Maternal Mortality Advisory Committee membership

Dr Fadwa Al-Yaman	Head, Social and Indigenous Group, Australian Institute of Health and Welfare
Professor Marie-Paule Austin	The Royal Australian and New Zealand College of Psychiatrists
Dr Peter Chapman: proxy for Professor Jeremy Oats 22/2/2012–28/5/2012	Representative for Maternity Services Inter-jurisdictional Committee
A/Professor Amanda Dennis	Chair, Tasmanian Council of Obstetric and Paediatric Mortality and Morbidity, Maternal Mortality Subcommittee
Professor Jodie M Dodd	Chair, South Australian Maternal and Neonatal Clinical Network
Ms Kate Dyer	A second representative from the Australian College of Midwives with expertise in maternal mortality and high-risk pregnancy
Professor David Ellwood	Chair, Australian Capital Territory Maternal Perinatal Data Collection
Professor Cynthia Farquhar	Chair, Perinatal and Maternal Mortality Review Committee New Zealand
Professor Michael Humphrey	Chair, Queensland Maternal and Perinatal Quality Council
Dr Jenny Hunt	Representative for the National Aboriginal Community Controlled Health Organisations (NACCHO)
Ms Rebecca Jenkinson	Consumer representative, The Maternity Coalition
A/Professor Steven Katz	Associate Professor, Australian and New Zealand College of Anaesthetists
Professor Yee Khong	The Royal College of Pathologists of Australasia
Ms Ann Kinnear	Executive Officer, Australian College of Midwives
Ms Rachael Lockey	Midwifery Co-Director Integrated Maternity Services, Northern Territory Department of Health and Families
Dr Karin Lust	Council Member, Society of Obstetric Medicine Australia and New Zealand

Dr Nhi Nguyen	The College of Intensive Care Medicine
Professor Jeremy Oats	Victorian Consultative Council on Obstetric and Paediatric Mortality and Morbidity; Representative for Maternity Services Inter-jurisdictional Committee
Professor Michael Permezel: proxy for Professor Jeremy Oats 22/2/2012–28/5/2012	Victorian Consultative Council on Obstetric and Paediatric Mortality and Morbidity
A/Professor John Smoleniec	New South Wales Perinatal and Maternal Mortality Committee
Professor Elizabeth Sullivan (Chair)	Director, National Perinatal Epidemiology and Statistics Unit
Clinical A/Professor Barry Walters	The Royal Australian and New Zealand College of Obstetrics and Gynaecology and Western Australian Perinatal and Infant Mortality Committee

Appendix B National Maternal Mortality Advisory Committee–Report Working Group membership

Professor Cynthia Farquhar	Chair, Perinatal and Maternal Mortality Review Committee, New Zealand
Professor Michael Humphrey	Chair, Queensland Maternal and Perinatal Quality Council
Ms Ann Kinnear	Executive Officer, Australian College of Midwives
Dr Karin Lust	Council member, Society of Obstetric Medicine Australia and New Zealand
Professor Michael Permezel: proxy for Professor Jeremy Oats	Victorian Consultative Council on Obstetric and Paediatric Mortality and Morbidity Chair, Victorian Consultative Council on Obstetric and Paediatric Mortality and Morbidity and Maternity Services Inter-jurisdictional Committee
A/Professor John Smoleniec	New South Wales Perinatal and Maternal Mortality Committee
Professor Elizabeth Sullivan	Director, National Perinatal Epidemiology and Statistics Unit

Appendix C National Maternal Mortality Advisory Committee–Clinical Classifications Working Group membership

Professor Marie-Paule Austin	The Royal Australian and New Zealand College of Psychiatrists
Professor David Ellwood	Chair, Australian Capital Territory Maternal Perinatal Data Collection
Professor Cynthia Farquhar	Chair, Perinatal and Maternal Mortality Review Committee New Zealand
Professor Michael Humphrey	Chair, Queensland Maternal and Perinatal Quality Council
Professor Jeremy Oats	Victorian Consultative Council on Obstetric and Paediatric Mortality and Morbidity; Representative for Maternity Services Inter-jurisdictional Committee
A/Professor John Smoleniec	New South Wales Perinatal and Maternal Mortality Committee
Professor Elizabeth Sullivan (Chair)	Director, National Perinatal Epidemiology and Statistics Unit
Clinical A/Professor Barry Walters	The Royal Australian and New Zealand College of Obstetrics and Gynaecology and Western Australian Perinatal and Infant Mortality Committee

Appendix D Data quality statement National Maternal Death Report Data Set for 2006-2010

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 2006 and 2010.
- Data sources, supply and quality varied 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 2010.
- Data collection for some jurisdictions was 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 is a set of national research data 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 2006 and 2010. 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 National Maternal Death Report Data Set include data collected retrospectively and specifically by some states and territories to produce the maternal deaths report for 2006–2010. 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 (STMMCs) 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 National Maternal Death Report Data Set, 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; The Consultative Council on Obstetric and Paediatric Mortality and Morbidity HREC; Queensland Health HREC; Department of Health Western Australia HREC; 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; 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 AIHW. The AIHW is Australia's national agency for health and welfare statistics and information. The role of the AIHW is to provide information on Australia's health and welfare, through statistics and data development that inform discussion and decisions on policy and services.

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 an independent statutory authority established in 1987, governed by a management Board, and accountable to the Australian Parliament through the Health and Ageing 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 AIHW 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 Maternal Death Reporting Data Set 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 AIHW, and within 3 years of the time frame for including maternal deaths of 31 December 2010.

Accessibility

The NPESU provides a variety of products that draw upon the National Maternal Death Report Data Set including the *Maternal deaths in Australia* report series

Data is also used in a number of other AIHW products including *Australia's health* and the *Australia's mothers and babies* series. Data is 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 National Maternal Death Report Data Set reflects these variations. In all cases, the best available information was used to form the National Maternal Death Report Data Set. Data provided by Western Australia has been subject to legislative privacy restrictions and limited information was initially provided to 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. 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 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 here:

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 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, but to date this process has never informed the Maternal Mortality Committee of a maternal death the Maternal Mortality Committee was not already aware of. Similarly, sentinel event reporting has not identified a new maternal death to the Maternal Mortality Committee.

Tasmania Health department are notified of maternal deaths through the following sources: health statistics, the Register of Births, Deaths and Marriages and local clinicians who are members of Tasmanian Council of Obstetric and Paediatric Mortality and 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 undertook a process of maternal death ascertainment and review specifically to supply data to the National Maternal Death Report Data Set.

Relevance

The National Maternal Death Report Data Set is a specification for data compiled primarily from state and territory maternal death data collections, or where not available, other data sources. Data was 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 2006 and 2010. Information was collected from each state and territory health department through the completion of a standardised data collection form: the National Maternal Death Reporting (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, <http://meteor.aihw.gov.au/content/index.phtml/itemId/181162 >. 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, as well as 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.

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 before 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.

Before 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 National Maternal Death Report Data Set is a one-off data set collected specifically for use in *Maternal Deaths in Australia 2006–2010*. 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.

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 E National Aboriginal Perinatal Reference Group membership

State or territory	NACCHO state affiliate organisation	Person nominated
NSW	Aboriginal Health and Medical Research Council of NSW (AH&MRC)	Jennifer Hunt
Vic	Victorian Aboriginal Community Controlled Health Organisation (VACCHO)	Wendy Bissinger
Qld	Queensland Aboriginal and Islander Health Council (QAIHC)	Kate Panaretto
WA	Western Australia Aboriginal Health Council	Daniel McAullay
SA	Aboriginal Health Council of South Australia Inc.	Karen Atkinson
ACT	Winnunga Nimmityjah Aboriginal Health Service (AHS)	Emma Adams
NT	Aboriginal Medical Services Alliance Northern Territory (AMSANT)	To be advised

Note: The Tasmanian affiliate declined the invitation to nominate a representative. A representative from Northern Territory has not yet been nominated.

Glossary

Aboriginal or 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.

acute myocardial infarction (AMI): Term still commonly used to mean a heart attack, but more correctly refers only to those heart attacks that have caused some death of heart muscle.

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 (that is, 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.

admission: An admission to hospital. In this report, the term **hospitalisation** is used to describe an episode of hospital care that starts with the formal admission process and ends with the formal **separation** process. In this report, the number of separations has been taken as the number of admissions; hence, admission rate is the same as separation rate.

amniotic fluid embolism (AFE): Amniotic fluid embolism is 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 heart beat—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.

episiotomy: An incision of the perineum and vagina to enlarge the vulval orifice.

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.

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

phaeochromocytoma: A small vascular tumour of the inner region (medulla) of the adrenal gland.

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.

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

This report, *Maternal deaths in Australia 2006–2010*, is part of a series. The earlier editions and any published subsequently can be downloaded for free from the Perinatal and Reproductive Epidemiology Research Unit (PRERU) website <www.preru.unsw.edu.au/preruweb.nsf>, or from the AIHW website <www.aihw.gov.au/publications/>. The websites also include information on ordering printed copies.

The following publications might also be of interest:

- AIHW 2014. Foundations for enhanced maternity data collection and reporting in Australia: National Maternity Data Development Project Stage 1. Cat. no. PER 60. Canberra: AIHW.
- CMACE (Centre for Maternal and Child Enquiries) 2011. Saving mothers' lives: reviewing maternal deaths to make motherhood safer: 2006–2008. BJOG: An International Journal of Obstetrics and Gynaecology 118:1–203.
- Li Z, Zeki R, Hilder L & Sullivan E 2012. Australia's mothers and babies 2010. Canberra: AIHW National Perinatal Epidemiology and Statistics Unit.

List of tables

List of figures

Maternal deaths in Australia 2006–2010 is the 15th report on women who die during pregnancy and childbirth. Although maternal deaths are rare in Australia, they are catastrophic events when they do occur and require monitoring and investigation. The report includes information about the women, pregnancy, and cause of death as well as good practice guidance points for clinicians to inform practice improvement.