Stillbirths 5

Stillbirths: the way forward in high-income countries

Vicki Flenady, Philippa Middleton, Gordon C Smith, Wes Duke, Jan Jaap Erwich, T Yee Khong, Jim Neilson, Majid Ezzati, Laura Koopmans, David Ellwood, Ruth Fretts, J Frederik Frøen, for The Lancet*'s Stillbirths Series steering committee**

Stillbirth rates in high-income countries declined dramatically from about 1940, but this decline has slowed or stalled over recent times. The present variation in stillbirth rates across and within high-income countries indicates that further reduction in stillbirth is possible. Large disparities (linked to disadvantage such as poverty) in stillbirth rates need to be addressed by providing more educational opportunities and improving living conditions for women. Placental pathologies and infection associated with preterm birth are linked to a substantial proportion of stillbirths. The proportion of unexplained stillbirths associated with under investigation continues to impede efforts in stillbirth prevention. Overweight, obesity, and smoking are important modifiable risk factors for stillbirth, and advanced maternal age is also an increasingly prevalent risk factor. Intensified efforts are needed to ameliorate the effects of these factors on stillbirth rates. Culturally appropriate preconception care and quality antenatal care that is accessible to all women has the potential to reduce stillbirth rates in high-income countries. Implementation of national perinatal mortality audit programmes aimed at improving the quality of care could substantially reduce stillbirths. Better data on numbers and causes of stillbirth are needed, and international consensus on definition and classification related to stillbirth is a priority. All parents should be offered a thorough investigation including a high-quality autopsy and placental histopathology. Parent organisations are powerful change agents and could have an important role in raising awareness to prevent stillbirth. Future research must focus on screening and interventions to reduce antepartum stillbirth as a result of placental dysfunction. Identification of ways to reduce maternal overweight and obesity is a high priority for high-income countries.

Lancet 2011; 377: 1703–17

Published Online
April 14, 2011
DOI:10.1016/S0140-6736(11)60064-0

See Comment pages 1635 and 1636

See Comment *Lancet* 2011; 377: 1291, 1386, 1471, and 1550

This is the fifth in a Series of six papers about stillbirths

*Members listed at end of paper

Mater Medical Research Institute, South Brisbane, QLD, Australia (V Flenady MMedSc, L Koopmans BPsych)**; University of Queensland, Brisbane, QLD, Australia** (V Flenady)**; International Stillbirth Alliance, Baltimore, MD, USA** (V Flenady) **University of Adelaide, Adelaide, SA, Australia** (P Middleton MPH)**; Department of Obstetrics and Gynaecology, Cambridge University, Cambridge, UK** (Prof G C Smith MD)**; Centers for**

Introduction

In high-income countries, there is an expectation that every pregnancy will end with the birth of a healthy baby. Yet about one baby out of every 200 (who reaches 22 weeks' gestation or more) is stillborn. Public perception is that stillbirths are a thing of the past, but these are not rare events. The effect of a stillbirth on parents is devastating and long term: to many of these parents the death of their baby before birth is no less a death than is the death of any other child. As highlighted in the first paper of *The Lancet*'s Stillbirths Series,[1] families are often left with intense grief and damaging psychological and social problems for many years.

Although improvements in maternity care resulted in a dramatic reduction in stillbirth in high-income countries beginning in the 1940s, more recently, the decline has slowed or halted.[2] Examination of recent trends in stillbirth rates by gestational age in the USA shows some improvements in late gestation stillbirth (28 weeks or more)[3] but little reduction in the early gestational age stillbirth (figure 1).

A closer look at trends in late gestation stillbirth rates across 12 high-income countries over the past 20 years reveals substantial reductions in most of these countries. Norway and the Netherlands have shown the largest reductions (50% and 40%, respectively) during this time. Norway now has the lowest rate at 2·2 stillbirths per 1000 births and the UK the highest at 3·8 stillbirths per 1000 births across these high-income countries. Although differences in rates can relate to population characteristics, practices, and policies around registration and reporting[4] (including termination of pregnancy)[5] rather than quality of care, these findings suggest that further reductions in stillbirth rates are possible in many high-income countries (figure 2, see webappendix p 1 for data sources).

Key messages

- The variation in stillbirth rates clearly shows that further reduction in stillbirth is possible in high-income countries.
- Women from disadvantaged backgrounds continue to experience stillbirth rates far in excess of non-disadvantaged women in high-income countries and an increased focus on appropriate programmes is needed to address this disparity.
- Maternal overweight and obesity, and smoking are the most important potentially modifiable risk factors for stillbirth in high-income country settings. Implementation of preconception care for all women could reduce these risk factors. Smoking cessation programmes in pregnancy are effective and should be implemented as part of routine care.
- Factors relating to suboptimum professional care contribute to a substantial proportion of stillbirths. Implementation of perinatal mortality audit at the national level is an important step towards addressing quality of care.
- Data for stillbirth are inadequate. A thorough investigation of stillbirth is essential. This includes placental histopathology for all stillbirths and parents being given the option of a high-quality autopsy. Consensus on definition and classification is needed.
- Antepartum stillbirth related to placental dysfunction and very preterm birth are major contributors to stillbirth in high-income countries. Further research is needed on underlying mechanisms to aid early detection and effective management of women at increased risk.

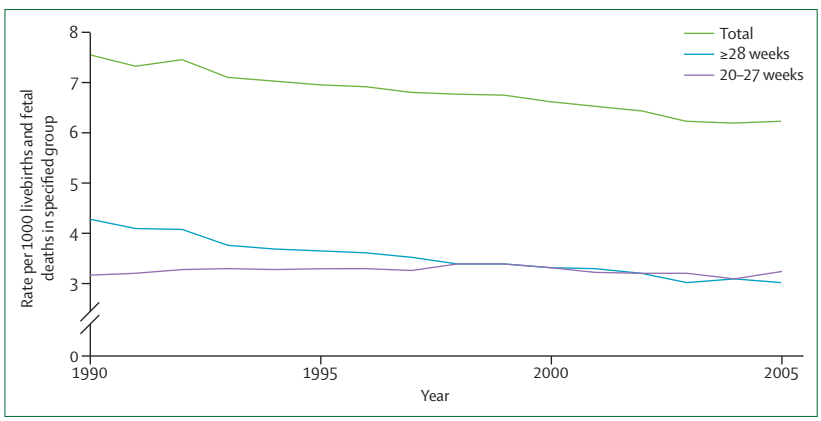

Figure 1: **Stillbirth rates by period of gestation in the USA, 1990–2005**
Reproduced from MacDorman and Kirmeyer.[3]

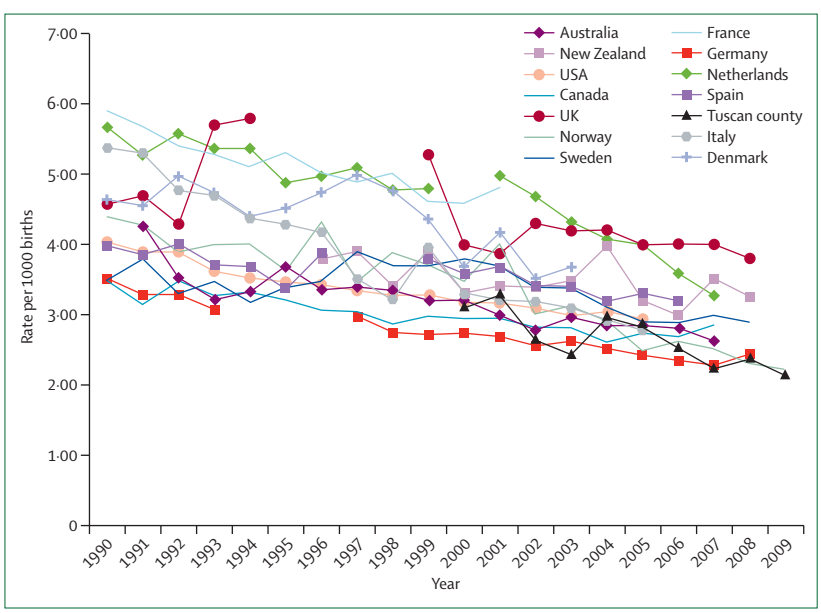

Figure 2: **Trends in stillbirth rates at 28 weeks' or more gestation in selected high-income countries, 1990–2008**

Disease Control and Prevention, National Center on Birth Defects and Developmental Disabilities, Atlanta, GA, USA (W Duke MD); **Department of Obstetrics, University of Groningen and Foundation Perinatal Audit in the Netherlands (PAN), Utrecht, Netherlands** (J J Erwich); **SA Pathology, Women's and Children's Hospital, Adelaide, SA, Australia** (Prof T Y Khong MD); **Cochrane Pregnancy and Childbirth Group, University of Liverpool, Liverpool, UK** (Prof J Neilson MD); **MRC-HPA Centre for Environment and Health, Department of Epidemiology and Biostatistics,**

In the fifth paper of *The Lancet*'s Stillbirths Series, we present priority areas for stillbirth prevention, and interventions and research to address these priorities in high-income countries. We use 500 g or more, or 22 weeks' gestation or more, to define stillbirth, unless otherwise stated.

Priority areas in reducing stillbirth in high-income countries

Future improvements in prevention of stillbirth must target specific causes, risk factors, and vulnerable groups. To identify priorities for stillbirth prevention, we drew on an article published alongside the Stillbirths Series,[6] which presents important risk factors for stillbirth and, additionally, we undertook a detailed analysis of causes and associated disorders for stillbirths through application of one classification system to stillbirths across six high-income countries.

Risk factors

Ethnic origin and socioeconomic status

However disparity is assessed, links with stillbirth and other adverse birth and longer term outcomes are starkly evident in high-income countries. Inuit-inhabited areas of Canada have stillbirth rates nearly three times higher than the rest of Canada.[7] Indigenous Australian women have almost twice the risk of non-indigenous women[8] as do African-American women in the USA when compared with white women.[9–11] In the Netherlands, a 30–80% increased risk of stillbirth was shown for minority populations, which make up 15% of the total population.[12] A review in Nordic countries reported a link between stillbirth and social differences, with most of the 35 studies showing a relative risk of stillbirth between 1·4 and 1·9 for the groups with greatest deprivation.[13] Reports from the UK[14,15] and New Zealand[16] show a similar picture.

The reasons for these disparities differ between countries and regions. Bryant and colleagues[17] described determinants of disparity in obstetric outcomes as having their roots in maternal behaviours, genetics, the physical and social environments, and access to and quality of health care. Some groups, such as American-Alaskan women and Australian and Canadian indigenous women, have high rates of no antenatal care, which is associated with three times the stillbirth risk.[18] Late attendance for antenatal care, also associated with increased risk, can explain some of the disparity in stillbirth rates in high-income countries.[12] Lack of access to care is one of the factors contributing to higher stillbirth rates in remote and rural areas.[7,19,20]

Low educational attainment (less than year 10) is associated with almost twice the odds of stillbirth.[6] However, links with other factors are complex. One US report showed that, although education conferred a 30% reduction in stillbirth risk for white women who had more than 12 years of education, there was only a 9% reduction seen for black women and a 4% reduction for Hispanic women with similar levels of education.[21] High smoking rates are a major contributor to stillbirths in some disadvantaged populations. In Indigenous Australian and Canadian First Nations women, smoking contributes to about 20% of stillbirths compared with 4–7% overall in high-income countries.[6]

Other maternal characteristics

The most important, potentially modifiable risk factors for stillbirth are maternal overweight and obesity before pregnancy (body-mass index [BMI] ≥25 kg/m²), and smoking during pregnancy.[6] Obesity is one of the leading factors contributing to the overall burden of disease worldwide.[22] With up to 58% of women of childbearing age either overweight or obese,[23] the number of attributable stillbirths across high-income countries is in the vicinity of 8064 each year.[6]

Maternal age of more than 35 years is also an important factor that is associated with a 65% increase in the odds

of stillbirth and could be responsible for almost 4226 stillbirths in high-income countries each year.[6] Maternal age is somewhat modifiable through increased awareness of the associated risk and family planning. Smoking in pregnancy (usually based on smoking status in early pregnancy) is associated with a 36% increase in the odds of stillbirth, accounting for around 2852 stillbirths each year in high-income countries (figure 3).[6]

The adverse effect of maternal alcohol intake on the developing fetus is well accepted. Although prevalence data are limited, about 50% of women consume alcohol during pregnancy.[24–26] With an estimated increase in the odds of stillbirth of 40%,[27] alcohol consumption might be accountable for a substantial number of stillbirths in high-income countries. Illicit drug use is associated with a doubling of the risk of stillbirth, and, although data are limited, use during pregnancy might be about 2%.[6]

Pregnancy and medical risk factors

Primiparity is an important risk factor for stillbirth, contributing to about 15% of stillbirths in high-income countries.[6] The increasing prevalence of women with a combination of important risk factors such as primiparity, maternal age of more than 35 years, and high BMI could potentially lead to an increase in stillbirth rates. The risk of fetal death rises with advancing gestational age,[28] increasing from one in 2000 women remaining pregnant per week at 37 weeks to one in 500 at 42 weeks, and to one in 200 by 43 weeks.[29] The increased risk of stillbirth in later gestations is higher for women of advanced age.[30]

With steadily increasing rates and well established increased risk of stillbirth, multiple pregnancy and the use of assisted reproductive technology are important factors in high-income countries.[6] Although the contribution at the population level is small (around 1%), women with a previous stillbirth have an almost three-times increased risk of stillbirth in a subsequent pregnancy.[6] Previous caesarean section has also been associated with an increased risk of stillbirth. Meta-analysis[6] of six studies showed a 20% increase in the odds of stillbirth. Although confounding due to the reasons for caesarean section cannot be excluded, this finding is concerning and requires further investigations, particularly in view of the increasing rates of births with caesarean section.

Causes and contributing disorders

Further prevention of stillbirths in high-income countries must target specific causes of death and the clinical scenarios in which they occur. However, accurate data on causes is hampered by inadequate post-mortem investigation protocols and differences in approaches in classification, as demonstrated by the wide variation in the reported proportion of unexplained stillbirths of 10–70%.[31,32] Reports of causes are often rudimentary, hard to compare, and without description of the often complex clinical scenarios involved. We collaborated with groups across six high-income countries in classifying cohorts of stillbirths and neonatal deaths using the Causes of Death and Associated Conditions (CODAC) classification (panel 1).[33] Many classification systems have been developed and various systems seem to have valuable features.[31,34–37] CODAC did best in retaining information about stillbirth in an assessment by the International Stillbirth Alliance,[31] and was therefore chosen for this analysis. Another benefit of the CODAC system is that for every stillbirth case, three levels of codes are allowed, which enables reporting for each case by groups of disorders or scenarios rather than attributing death to a single event or disorder. In this cohort of 915 perinatal deaths, including 617 stillbirths of 22 weeks' gestation or 500 g or more (66% ≥28 weeks or ≥1000 g), autopsy and placental examinations were done in 45% and 73% of cases, respectively. Results are presented in figure 4.

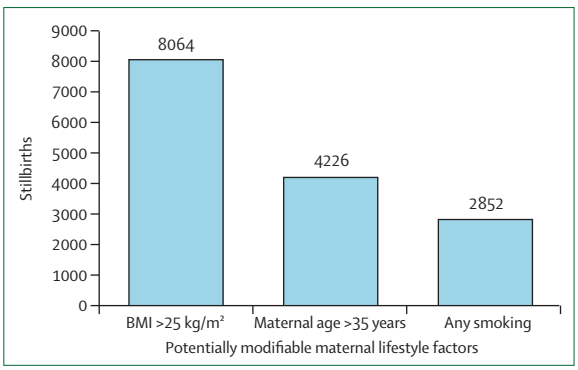

Figure 3: **Estimated number of stillbirths per annum attributed to common potentially modifiable factors in high-income countries**
Adapted from Flenady and colleagues.[6] BMI=body-mass index.

Panel 1: Methods for classification of stillbirths and neonatal deaths

Consecutive series of stillbirths and neonatal deaths (defined as 22 weeks' gestation at birth or 500 g birthweight) date of birth were included from every participating study team from seven regions as follows: Groningen University, Netherlands; Queensland Maternal Perinatal Quality Council, Queensland, Australia; Norwegian Institute of Public Health, Norway; CDC Georgia, USA; Brown University, Providence, USA; Alberta Perinatal Health Program, Canada; and Centre for Maternal and Child Enquiries, UK. Terminations of pregnancy and neonatal deaths after 7 days of life were excluded. With the Causes of Death and Associated Conditions system, cases were classified according to usual practices within each region and submitted in a de-identified format for analysis. Descriptive analysis was done in SPSS of causes and associated disorders for stillbirths and neonatal deaths separately. Subgroup analysis was undertaken by gestation of less than 28 weeks and 28 weeks or more.

School of Public Health, Imperial College, London, UK (Prof M Ezzati PhD)**; Canberra Hospital and Australian National University Medical School, Canberra, ACT, Australia** (Prof D Ellwood MD)**; Harvard Vanguard Medical Associates, Wellesley, MA, USA** (R Fretts MD)**; and Division of Epidemiology, Norwegian Institute of Public Health, Oslo, Norway** (J F Frøen MD)

Correspondence to:
Vicki Flenady, Mater Medical Research Institute, Mater Health Services, Raymond Terrace, South Brisbane, QLD 4101, Australia
Vicki.Flenady@mmri.mater.org.au

See Online for webappendix

Cause of death		Contributing as COD or associated condition		
Level I categories	%	%	%	Level II subcategories
Infection	12	14	9	Unspecified
			2	Group-B streptococci
Intrapartum	3	5	2	Extreme prematurity
			2	Asphyxia of unknown cause
Congenital anomalies	6	11	2	Unspecified
			3	Cardiovascular and lymphatic vessels
			2	Triploidies
Fetal	4	7	5	Unspecified
Cord	9	17	2	Knots
			5	Loops
			2	Abnormal insertion
			2	Focal anomaly
			3	Generalised anomaly
			2	Infection or inflammation
Placenta	29	59	11	Infection or inflammation
			14	Abruption or retroplacental haematoma
			13	Infarctions and thrombi
			8	Circulatory disorders–other non-abruptions
			2	Transfusion or feto-maternal haemorrhage
			4	Small for gestation placenta
			4	Villous or vascular maldevelopment
Maternal	7	24	2	Unspecified or other
			10	Hypertensive disorder
			2	Cervix insufficiency
			2	Haematology–other
			6	Diabetes
			2	Autoimmune–other
Unknown	30	30	6	Lacking examinations or documentation
			10	With no autopsy
			6	Despite autopsy and placental PAD
			5	Despite full evaluation
Associated perinatal	NA	26	11	Small for gestational age
			2	Oligohydramnios
			5	PPROM
			2	Multiples
			2	Antepartum haemorrhage
			4	Suboptimal care
Associated maternal	NA	10	3	Smoking
			4	Maternal BMI ≥30 kg/m²
			2	Obstetric history

Scenarios

Figure 4: **Causes and contributing factors for stillbirth in high-income countries**
The line connectors represent the clinical scenarios of combined factors found in more than 1% of cases. The thickness of the line represents frequency. The slimmest and thickest lines represent 1% and 6%, respectively. COD=cause of death. PAD=provisional anatomic diagnosis. PPROM=preterm premature rupture of membranes. BMI=body-mass index. NA=not applicable.

Placental pathology

Placental pathologies accounted for one in four deaths across all gestational ages, and were contributory or causal in more than half of cases. Infarctions and thrombi were reported to be causal or to contribute in 13% of stillbirths; the corresponding figure for placental abruptions was 14%. These data are consistent with an estimated population-attributable risk (PAR) of abruption for stillbirth of 15%.[6] Obstetric disorders with placental origins such as abruptions, infarctions, and small for gestation placentas are part of a large group of clinical scenarios associated with maternal hypertension, smoking, small for gestational age (SGA), and multiple pregnancy. Several studies confirm placental pathology as an important source of information in most stillbirths,[31,38] replacing the former so-called unexplained group.[38] However, caution is needed not to over-interpret placental findings because causality is often unclear.[39,40]

Fetal maternal haemorrhage, reported in published studies to cause 5–14% of stillbirths,[41] was only detected in 2% of cases. Because screening for this disorder is not done routinely, the true incidence of substantial fetal maternal haemorrhage is probably underestimated.[42] Fetal growth restriction owing to placental insufficiency is identified in about 40–60% of stillbirths, also in otherwise unexplained stillbirths.[43] Classification in CODAC does not allow SGA to be coded as a cause of death, but, even so, this disorder was a contributing factor in 11% of stillbirths.

Infection

The second largest contributor in our CODAC analysis was infection, causing 12% of stillbirths—a finding similar to that from other reports.[44] However, the contribution of infection is probably underestimated due to lack of investigation. Infection-related stillbirth is more frequent in pregnancies at early gestations.[44] In our cohort, infections contributed to 6% of stillbirths at 28 weeks' gestation or more and to 15% of stillbirths at less than 28 weeks in most cases in scenarios of chorioamnionitis and preterm prelabour rupture of membranes (PPROM), often leading to intrapartum deaths. Common bacteria and viruses implicated in stillbirth in high-income-country settings are parvovirus B19, group-B streptococcus, *Listeria*, *Escherichia coli*, enteroviruses, cytomegalovirus, and influenza virus.[44] The fact that most infectious stillbirths were classified as unspecified in our cohort shows the potential for improvement in identification of the infectious agents in stillbirths.

Umbilical cord abnormalities and cord accidents

Umbilical cord abnormalities and cord accidents can cause or contribute to fetal death.[40,45] However, since many cord incidents, including true cord knots and nuchal cords, are also common in livebirths, this diagnosis should be made with caution.[46] In our Series, 9% of stillbirths were deemed to be caused by cord complications and were considered contributory in a further 8%.

Medical and pregnancy disorders

Whereas 7% of stillbirths were caused by maternal medical disorders, these were contributing factors in 24% of cases. The most frequent conditions were hypertensive disorders and diabetes. The estimated

	Strategies
Improvement of general health of women before, during, and after pregnancy	Culturally appropriate preconception care for women throughout reproductive years to ensure adequate folic acid intake, optimum weight and diet, cessation of smoking, education about the harms of alcohol, and risk reduction for women with substance use
Detection and management of women at increased risk	Culturally appropriate accessible routine antenatal care; early ultrasound assessment of gestational age
Diabetes or overweight and obesity	Screening and individualised pregnancy care plan, including dietician counselling (exercise and diet) and post-partum weight management; routine weighing at first antenatal visit
Smoking, alcohol, and illicit drug use	Screening and intervention
Screening for placental insufficiency or FGR and hypertension	Screening for risk factor; increased awareness and timely evaluation of women reporting decreased fetal movements; doppler for high-risk pregnancies; monitoring and treatment with low-dose aspirin for those at risk
Multiple pregnancy	Single embryo transfer for in-vitro fertilisation
Post-term pregnancy	Induction after 41 weeks' gestation
Raising awareness	Parent organisations as change champions; raising public awareness
Improvement of information and standards of maternity care	Implementation of national perinatal mortality audit programmes that incorporate evidence-based clinical guidelines Improve data access with systems to more effectively use routinely collected data; consensus on a minimum dataset for monitoring pregnancy outcomes on a large scale; education for maternity care providers to improve vital statistics data Implement international classifications system to enable comparisons within and across countries Implement high-quality stillbirth investigations protocol, including placental histopathology for all stillbirths Ensure access to the option of a high-quality autopsy for all parents after a stillbirth

FGR=fetal growth restriction.

Table 1: **Interventions and strategies to address priority areas for stillbirth prevention**

PAR for pre-existing hypertension across a selection of high-income countries ranges from about 7% to 14% and for pre-existing diabetes from about 3% to 5%, indicating the important contribution these disorders continue to make to stillbirth in modern high-income-country settings.[6] Although pre-eclampsia is associated with a 60% increased risk of stillbirth in modern obstetric settings, it has a low PAR (3%) based on a prevalence of 5%.[6]

Intrapartum deaths

Only 3% of stillbirths were caused by intrapartum events, with most deaths occurring in extremely preterm infants. Overall, 9% of stillbirths occurred intrapartum, but the causes had antepartum origin for most.

Congenital abnormalities

Congenital anomalies were identified as causal in 6% of stillbirths and as contributing to the death in another 5%. This finding is consistent with other reports showing that 6–12% of stillbirths are associated with anomalies.[41,45] However, this might be an underestimate because of lack of testing and poor test sensitivity.

Unexplained

Although 30% of stillbirths remained without a known cause, this outcome was largely associated with failure to do the appropriate investigations. Only 5% of stillbirths were classified as unexplained despite full assessment (including autopsy and placental investigations) according to local guidelines.

Suboptimal care

Studies in high-income countries have shown that suboptimal care is associated with about 10–60% of stillbirths and neonatal deaths.[47–62] The main factors relate to delayed recognition of emerging clinical disorders, and, if noted, an inadequate or delayed response (webappendix pp 2–6). Failure to use updated best practice protocols and non-compliance with existing protocols has an important role, as does poor communication between staff. For the woman herself, suboptimal care factors include inadequate antenatal care attendance, inadequate diabetes management, and smoking. Although intrapartum stillbirths now make up a small proportion of late gestation stillbirths in high-income countries,[63] concerns have been raised regarding the contribution of suboptimal care in these cases.[16]

Interventions to reduce stillbirth in high-income countries

Interventions to prevent stillbirth have been recently reviewed[64–68] and are summarised in the third paper of this Series.[69] On the basis of these findings, we present interventions and strategies to address the priority areas identified in the first paper of this Series.[1] These interventions fall into three main strategic areas: improvement of health and wellbeing of women before, during, and after pregnancy; detection and management of women at risk during pregnancy; and improvement of information and standards of maternity care (table 1).

Improvement of health and wellbeing of women before, during, and after pregnancy

The stillbirth rate is an important measure of the quality of maternity care but also of women's general health. Preconception care is increasingly recommended as an effective intervention to improve the general health and wellbeing of women across the reproductive lifespan, specifically an adequate diet and exercise, optimum folic acid intake, and smoking and alcohol cessation.[70] This care grows in importance with increasing prevalence of risk factors in modern societies, such as advanced maternal age, diabetes, and obesity. Although strong evidence for preconception care to improve pregnancy outcome is currently not available, since many risk factors have very early origins, preconception care could reduce stillbirth through reduction of such factors.

With regard to disadvantaged women, employment and education are central to improving outcomes for these women. Further, some risk factors are known to be associated with socioeconomic disadvantage, including smoking, overweight, and obesity, and low education. For this reason, regular attendance for antenatal care is particularly important for disadvantaged women. However, organisational, personal, and financial factors can be important barriers to antenatal care attendance.[71] These include transportation problems, not knowing where to access care, having a poor understanding of or attaching a low value to care, ambivalence or fear about the pregnancy, and high levels of stress. One study[72] concluded that "poverty may be the overriding factor preventing access to care; obstacles appear to be deeply rooted in the experience of being poor, disadvantaged and vulnerable". Therefore, providing appropriate maternity services for such women remains an important challenge.

Detection and management of women at increased risk

Routine antenatal care

Quality antenatal care, including identification of those for whom additional care is needed, through screening for risk factors, should be accessible to all women. Early ultrasound determination of gestation (10–12 weeks' gestation) to provide an accurate baseline for continuing fetal surveillance allows optimum timing of early delivery if required and reduces the rate of induction of labour for suspected post-dates pregnancy.[73]

Overweight and obesity

Recent guidelines from the US Institute of Medicine[74] and the UK National Institute for Health and Clinical Excellence (NICE)[75] provide comprehensive recommendations for healthy weight management before, during, and after pregnancy. Although there is some indication that excessive gestational weight gain can be reduced through lifestyle interventions,[76] a review by Dodd and colleagues[77] highlights the present lack of evidence for effective antenatal interventions to improve pregnancy outcomes for these women. Several studies addressing obesity in pregnancy are underway and their findings will further clarify how to help women of reproductive age achieve and maintain healthy weight.[77] Weighing all women at the first antenatal visit assists in risk assessment and allows women to be informed of their recommended weight gain, which can increase the likelihood of correct weight gain.[74,78,79]

Diabetes

Outcomes for women with diabetes have improved in high-income settings, but there is clear evidence of a need for further practice improvement.[80] Although high-quality evidence is not available,[81] provision of quality preconception care for women with pre-existing diabetes could assist in avoiding unplanned pregnancy and ensuring optimum weight, glycaemic control, and folic acid intake before conception.[82] Women, particularly those of childbearing age, with risk factors based on history and present weight should be screened for diabetes. Weight management, monitoring, and intervention to achieve optimum glycaemic control throughout pregnancy is crucial to ensuring best possible outcomes for women with diabetes.

Smoking and alcohol

High-level evidence showing the benefits of smoking cessation interventions in pregnancy has been available

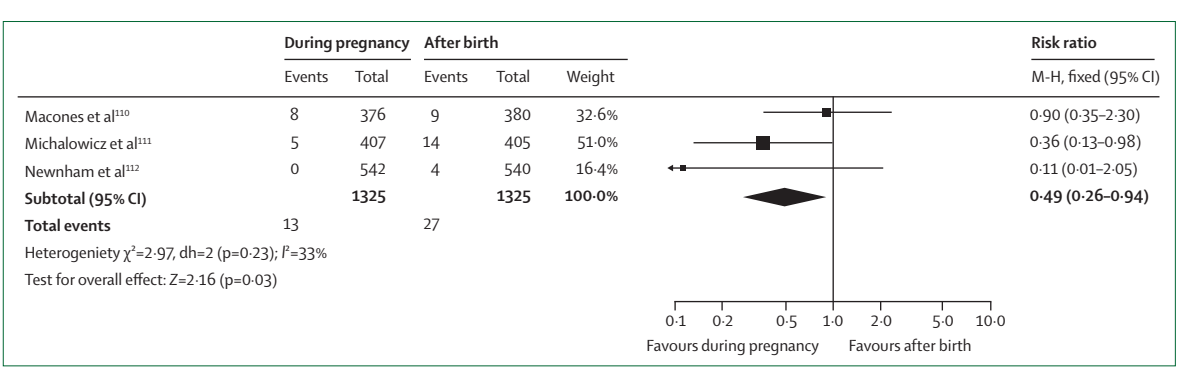

Figure 5: **Effect of periodontal treatment in pregnancy on stillbirth**
M-H=Mantel-Haenszel. One trial also included late miscarriage.

for some time;[83] however, implementation remains suboptimal in many settings. NICE guidelines[84] that recommend a comprehensive approach to detection and intervention for women who smoke may help to address this gap. Because alcohol use in pregnancy is often linked with use of other drugs and smoking, joint targeting of these behaviours might help. Health promotion[85,86] and psychological and educational interventions[87] have been associated with positive maternal behavioural change, including lower rates of binge drinking. Women should be advised about the harms of smoking and alcohol intake and be aware that no safe level of alcohol consumption has been established.[70]

Placental insufficiency and fetal growth restriction

Prevention of stillbirth associated with placental insufficiency, which is often associated with fetal growth restriction,[88] is dependent on detection of women at risk and appropriate timing of birth. The evidence for antepartum testing to detect pregnancies at risk has been extensively reviewed[68] and reveals the paucity of data on which to guide practice. Abdominal palpation to identify fetal growth restriction, although a standard part of antenatal care, results in a substantial proportion of missed cases.[89] The use of serial fundal height measurement with a tape measure can improve detection of fetal growth restriction. However, evidence of benefit is lacking.[90] Customised growth charts improve prediction of morbidity and mortality in newborn babies;[91,92] however, further research is needed to establish the risk and benefits of their use as a screening method in the antenatal period.[93]

Maternal perception of decreased fetal movements is associated with fetal growth restriction and stillbirth.[94] Although formal counting by use of kick charts cannot be recommended,[95–98] there is some indication that increased vigilance by both care providers and women about decreased fetal movements might reduce the risk of stillbirth.[96–98] Planned early delivery, based on the presence of risk factors, is increasingly used to avert late gestation stillbirth. However, this intervention needs to be weighed against the risks associated with intervening at a given gestational age[64] and risks related to unintended, late preterm birth (34–36 weeks).[99]

Hypertension

Impaired placentation can cause some of the most important obstetric complications such as pre-eclampsia and intrauterine growth restriction,[88] and is associated with increased fetal morbidity and mortality. Two high-quality meta-analyses have shown that aspirin reduces the risk of several adverse pregnancy outcomes, including perinatal death.[100,101] These data have prompted NICE in the UK to recommend its use among women at high and moderate risk.[102] However, further research is needed to more clearly define the target population and effect on longer term outcomes.[100] Calcium supplementation reduces the risk of pre-eclampsia,[103,104] although issues remain regarding the target population such as the role of dietary intake and the risk of pre-eclampsia.[102]

The use of fetal and umbilical doppler blood flow measurements in high-risk pregnancies with fetal growth restriction is the only intervention that has been shown, in a systematic review of randomised trials, to prevent stillbirth and neonatal death, and should be included in the management of such pregnancies.[105]

Multiple pregnancy

With a steady increase of multiple births in high-income countries because of increases in rates of assisted reproductive technology and pregnancies in women of advanced maternal age,[106] multiple pregnancy is an important area on which to focus attention. The rate of multiple pregnancy with the use of assisted reproductive technology can be reduced by limitation of the number of embryos transferred.[107] Improvement in routine data collection to include chorionicity will aid efforts to reduce adverse outcome.

Post-term pregnancy

In the Cochrane systematic review on induction for post-term labour,[108] induction (versus expectant management) at or beyond 41 weeks of gestation was associated with a reduction in perinatal mortality, and the review concluded that induction should be offered to all women at or beyond 41 weeks of gestation.

Preterm birth and infection

As many very preterm stillbirths are associated with PPROM and infection, antibiotics could theoretically reduce stillbirth, but they have shown little effect in high-income-country settings.[44,109] However, treatment of periodontal disease during pregnancy might be promising: a

***Panel 2:* Essentials for high-quality perinatal mortality audit**

- Complete registration and comprehensive documentation for each stillbirth
- Allocated motivated multidisciplinary personnel
- Training in audit methodology and communication skills for participants
- An independent chairperson
- Analysis of what went well
- Analysis of what should have been done differently
- Analysis of the substandard care factor (eg, root-cause analysis)
- Definition of improvements in care that need to be made
- Implementation of improvements (with methods such as PDSA cycle)
- Checking that change has occurred
- Keeping the goal in mind: to improve the quality of care

PDSA=Plan-Do-Study-Act.

Panel 3: High-income country research priority methods

With the Child Health and Nutrition Research Initiative (CHNRI) method described in the second paper of this Series,[63] research question lists were developed relating to discovery, epidemiology and development, and delivery in high-income countries. These lists consisted of 32, 50, and 53 questions, respectively.

Scorers included key researchers in the relevant field of stillbirth prevention, identified through Medline searches of first authors in recent stillbirth publications and hand searching of conference proceeding at annual International Stillbirth Alliance conferences from 1996 to 2009 for keynote and invited speakers. Snowball sampling was used to recruit other key researchers and clinicians in the field as scorers. There were 21 scorers each for the epidemiology and development and delivery lists. Discovery scores were provided by six scorers.

Research priority scores were calculated across five criteria for each list and standard CHNRI value weightings were applied. The criteria used for scoring the delivery and discovery lists included answerability, efficacy, deliverability, burden reduction, and equity. For the epidemiology and development list, answerability, attractiveness, feasibility, relevance, and equity were used. Average expert agreement was also calculated per question.

reduction in stillbirth (RR 0·49, 95% CI 0·26–0·94) was shown in meta-analysis of three trials[110–112] including 1894 women (PM, personal communication; figure 5). Although of interest, this finding needs to be confirmed in large scale trials.

Improving information and standards of care

Perinatal audit

Perinatal audit has been described as: "The systematic, critical analysis of the quality of perinatal care, including the procedures used for diagnosis and treatment, the use of resources and the resultant outcome and quality of life for women and their babies".[113] Although high-level evidence is not available,[114] a review of before-and-after studies[115] in low-income and middle-income countries showed a 30% reduction in perinatal mortality associated with the introduction of perinatal audit. Studies in high-income countries also indicate benefit (see web-appendix p 7). In Norway, multidisciplinary perinatal audit has been implemented since 1986.[116] Since then, perinatal mortality decreased from 13·8 to 7·7 per 1000 births, and better cooperation between hospitals and the implementation of nationwide protocols have been attributed to the audit. In the UK, nationwide confidential inquiries into stillbirths have shown improvements in obstetric management.[117] In Australia and New Zealand, guidelines on perinatal mortality audit have been developed and disseminated[118] and although uptake was shown to be suboptimum,[119] an active guideline implementation programme in Australia[120] and a national audit in New Zealand[16] have shown improvements.

In the Netherlands, perinatal audit has been implemented in most obstetric units through a joint effort by the government and professional colleges.[121,122] In the USA, several Fetal and Infant Mortality Review (FIMR) programmes have been established to review these deaths and make recommendations for improvements in health care and public health in general. However, these programmes are not uniform in approach and, although many suggestions for improvements in care have been defined, no structured assessment of efficacy has been reported.[123] Perinatal audit can be organised by panels of external experts, who will confidentially analyse anonymous reports and feed back to the care providers involved such as the Centre for Maternal and Child Enquiries in the UK, or by unit-based teams such as in the Netherlands, Australia, and New Zealand. These two approaches both have advantages and disadvantages. The value of the impartiality of the expert panel approach can be offset by the advantages of the unit-based approach, which includes better information about the death, the knowledge of how their care is organised, and where it can be improved most efficiently. Further, clinician ownership of the process can assist in implementation of practice improvements. Irrespective of the model, the presence of a skilled, independent, and accepted chairperson is important to guide the discussion. The essential elements of effective perinatal mortality audit are shown in panel 2.

Investigations for stillbirths

Comprehensive investigation of stillbirths provides essential information for high-quality perinatal mortality audit. Ascertainment of a cause is often challenging because of the complexity of the situation in which the baby dies[124] and the difficulty of clear determination of causation.[34,125] The value of stillbirth investigations has been extensively reviewed.[126] A comprehensive maternal history, comprehensive testing to exclude infection, clinical examination of the baby, macroscopic and histopathological examination of the placenta and umbilical cord, and a full perinatal autopsy are valuable in the work-up of stillbirths and are common components of existing protocols.[127] Amniocentesis is the optimum method to identify infective causes of stillbirth and for cytogenetic studies, particularly when an autopsy cannot be done.

All parents should be offered the option of a high-quality autopsy examination after a stillbirth. In most high-income countries, parental consent is needed. It is difficult to determine whether autopsy rates are changing in those countries because few serial studies emanate from one location,[128] but recent studies point to a fall in perinatal (including stillbirth) autopsy rates.[129–131] The major limiting factor seems to be parental consent,[132] and cultural and religious beliefs resulting from demographic changes in high-income countries might add to the downward pressure on perinatal autopsy rates.[133]

The autopsy is rated to be useful to establish a cause of death or in counselling after a stillbirth in 21–60% of autopsies, although many studies do not provide sufficient information to gauge this critically.[134] For example, the expertise of those doing the autopsy is often not detailed, but the quality of autopsy is better when done by perinatal rather than general anatomic

pathologists.[135–138] The interpretation and reporting of placental pathology can also be variable and is done better by perinatal pathologists.[139,140]

If parents do not consent to an autopsy, other non-invasive tests, such as the babygram (full body radiograph), fetal ultrasound examination, and MRI,[141–145] could assist

	Rank (weighted [unweighted])	RPS (weighted)	RPS (unweighted)	AEA
The effects of periconceptual environment, including nutrition and micronutrient status, on embryonic development	1 (1)	82·2	80·9	0·79
Development of repositories of well phenotyped human samples from stillbirths or other related conditions and matched controls, with clear arrangements for access, and appropriate ethical and other legal permissions in place	2 (2)	82·1	78·0	0·70
Characterising the fetal response to an adverse intrauterine environment to develop improved means of clinical assessment of fetal wellbeing	3 (5)	80·3	74·9	0·68
Defining pathophysiological pathways leading to stillbirth associated with maternal disease, in particular type 1 and type 2 diabetes mellitus	4 (3)	79·3	76·5	0·70
Defining pathophysiological pathways leading to increased rates of growth restriction and decreased rates of pre-eclampsia among smokers	5 (6)	79·0	74·8	0·70
Development of improved statistical, biometric, and bioinformatic technologies for data interpretation and clinical prediction of outcome	6 (4)	76·6	76·3	0·67
The effect of maternal obesity, with or without insulin resistance, on fetal and placental development	7 (7)	74·8	72·5	0·71
The role of normal and abnormal coagulation in normal and abnormal pregnancy	8 (8)	73·7	71·9	0·78
Understanding the fetal or placental function and control of the timing of parturition in post-dates pregnancy	9 (9)	72·7	70·8	0·67
Discovery-based analysis (expression array or high throughput sequencing, proteomics, and metabolomics) of samples from well characterised complicated pregnancies and matched controls	10 (12)	70·9	64·5	0·63

RPS=research priority score. AEA=average expert agreement. All scores are out of 100, apart from AEA which ranged from 0·50 to 0·79.

Table 2: **Top ten research priorities in discovery science**

	Rank (weighted [unweighted])	RPS (weighted)	RPS (unweighted)	AEA
Epidemiological information				
What factors contribute to the excess in stillbirth rates in minority populations?	1 (1)	87·2	82·9	0·72
What maternal lifestyle consumptions (caffeine, alcohol, cannabis) are associated with stillbirth and what are their relation with other relevant disorders and causes of stillbirth?	2 (2)	84·9	80·7	0·67
What care factors relating to health-care professional practice, care setting, and the mother and family are associated with potentially avoidable stillbirth?	4 (3)	83·7	78·3	0·71
How relevant is antenatal detection of fetal growth restriction to the prevention of stillbirth?	4 (5)	83·7	76·8	0·64
What is the contribution of other maternal bacterial infections in pregnancy (eg, group B streptococcal infection, bacterial vaginosis) to stillbirth?	6 (6)	79·4	75·4	0·65
Epidemiological measurement				
What is the optimum investigation protocol for stillbirth to identify causes and relevant conditions in terms of yield, utility, and costs?	3 (3)	84·3	78·3	0·71
What approaches can be used to enhance accuracy of data on stillbirth rates using existing health systems datasets?	7 (7)	78·3	73·4	0·67
What is the optimum model for clinical perinatal mortality audit and how can this be implemented on a population-based scale?	10 (12)	77·2	72·2	0·68
Can a universal shortlist of less than ten categories of cause of stillbirth be used in LMIC and HIC while linking to the present complex systems for stillbirth cause-of-death classification in HIC? Would such a classification system meet the needs for comparability globally and still be useful for surveillance and public health decision making in varying settings?	12 (16)	75·7	69·4	0·61
What factors affect under-reporting of stillbirth in disadvantaged communities and can these be reduced?	15 (17)	74·4	68·9	0·60

RPS=research priority score. AEA=average expert agreement. LMIC=low-income and middle-income countries. HIC=high-income countries. All scores are out of 100, apart from AEA which ranged from 0·44 to 0·72.

Table 3: **Top five research priorities in epidemiological information and top five in epidemiological measurement**

	Rank (weighted [unweighted])	RPS (weighted)	RPS (unweighted)	AEA
How can smoking cessation programmes be most effectively implemented as part of routine antenatal care?	1 (1)	76·5	76·4	0·74
How can perinatal audit and facility quality improvement be most effectively undertaken to reduce stillbirth rates?	2 (2)	74·6	73·5	0·65
In pregnancies with established intrauterine growth restriction, what is the optimum mode and timing of birth to reduce stillbirth and neonatal and infant mortality and severe morbidity?	3 (3)	73·0	73·1	0·68
What is the role of screening in early pregnancy with markers of placental function in reduction of the risk of stillbirth, neonatal and infant death, and major morbidity?	4 (6)	70·8	69·2	0·58
In high-risk pregnancies, does fetal umbilical artery doppler ultrasound reduce the risk of stillbirth, neonatal and infant mortality, and major morbidity?	5 (4)	69·8	69·9	0·61
For women who report decreased fetal movements, what is the optimum management to reduce the risk of stillbirth in term and preterm pregnancies?	6 (7)	69·5	68·9	0·63
What is the role of fetal growth monitoring with growth curves adjusted according to individual characteristics in detection of abnormalities in fetal growth and reduction of stillbirth, neonatal and infant mortality, and morbidity; and which characteristics, if any, result in optimal performance of such an approach?	7 (5)	69·3	69·5	0·61
What characteristics of antenatal care are associated with a reduction in the risk of stillbirth?	8 (10)	67·9	67·4	0·62
For disadvantaged populations, how can access to optimum antepartum and birthing care be improved?	9 (13)	66·5	66·1	0·64
In pregnancies with impaired fetal growth, what regimens of fetal surveillance are associated with a reduction in adverse pregnancy outcome including stillbirth, neonatal and infant mortality, and major morbidity?	10 (11)	66·4	66·8	0·58

RPS=research priority score. AEA=average expert agreement. All scores are out of 100, apart from AEA which ranged from 0·43 to 0·74.

Table 4: **Top ten research priorities in development and delivery**

in establishing a cause of death. Post-mortem needle biopsy, laparoscopic autopsy, and small incision access are less invasive alternatives to a full perinatal autopsy for focused investigation of suspected abnormalities.[118] Nevertheless, little evidence exists for valid alternatives to the autopsy[146] and important findings might be missed if a full autopsy investigation is not undertaken.

Routine data collection and vital statistics

Routine data collection for stillbirths, such as vital statistics data, is notoriously inadequate and collection processes, including definition and classification, vary widely across high-income countries.[4,147] This situation severely compromises stillbirth prevention strategies through limitation of information on important disorders involved, and the ability to identify variance across and within countries. Efforts in awareness and education for maternity care providers to improve accuracy of surveillance data are needed.[147] Inadequate or inconsistent collection of important risk factors such as maternal BMI, smoking, and alcohol intake in routine birth data is a major impediment in stillbirth prevention. Consensus on a classification system and minimum dataset for all births is urgently needed in high-income countries.

Implementation of measures to reduce stillbirth

Translating research into practice

As outlined above, several actions have the potential to reduce stillbirths, but uptake is often low. System barriers (especially time and resources), and barriers at the level of individual women and health professionals can be formidable. Active implementation strategies that address specific barriers to uptake are essential. For example, although brief smoking cessation interventions work, the latest NICE guidance emphasises more intensive strategies such as referral to specialist midwives or smoking cessation advisers, and prompts to review later if women do not take up referrals.[84] On the basis of early work by Tugwell and colleagues,[148] Henderson-Smart and co-workers[149] described an iterative process of evidence-based health care that integrates best available evidence with patients' preferences, clinical expertise, and cost considerations, underpinned by high-quality systematic reviews.[150] Growing evidence suggests that evidence-based health care improves process of care,[151–153] and use and costs of health services.[151] A comprehensive overview of interventions to increase the uptake of best practice is provided in the fourth paper of this Series.[154]

Raising community awareness

Most prospective parents remain unaware that stillbirths are a possibility at all and, specifically, that particular lifestyles increase their own risk of stillbirth. Parent-based organisations and groups argue for increasing public awareness of risk in pregnancy so women can be informed in the choices they make: parents who are unaware that stillbirth is even a possibility will not be alert to warning signs and are less likely to seek medical advice until it is too late. Successful campaigns, such as that around sudden

infant death syndrome,[155] clearly show that parent organisations can be powerful change agents and have an important part to play in stillbirth prevention.

Stillbirth research priorities

Although already many opportunities for improvement exist within present evidence, significant research gaps still need to be addressed. Following the method described in the second paper of this Series,[63] research themes in discovery science, epidemiology, and development and delivery were developed and scored by international working groups and the top ranking issues are summarised here. Panel 3 describes the methods used in this study.

Research priorities in discovery science

Table 2 lists the research priorities in discovery science. The content of the top ten was not strongly affected by the weighting procedure. Early pregnancy environment was highlighted as the top priority, which is consistent with accumulating evidence that complications in late gestation are related to placental development in early pregnancy.[156] Priorities 2, 6, and 10 all related to the development of improved infrastructure for pregnancy research in terms of repositories, analytical methods, and the so-called omic characterisation of normal and abnormal pregnancy.

Research priorities in epidemiology and development and delivery

Results for these two areas were consistent with the findings for discovery research, with a focus on factors that are most likely to affect antepartum stillbirth rates. The two highest ranked epidemiology issues and the top development and delivery issue related to maternal lifestyle and equity factors include: (1) identification of maternal factors that contribute to excess stillbirth rates in minority populations; (2) other lifestyle factors such as alcohol, cannabis, and caffeine intake; (3) ways to foster smoking cessation programmes; and (4) periconceptual intake of folic acid. Other top scoring issues related to detection of fetal growth restriction including use of antenatal customised growth charts, markers of placental function, and decreased fetal movements. Others dealt with ways to improve information such as ascertainment of stillbirth and improved routine data collection, implementation of perinatal audit, and investigation of stillbirth. Identification of important characteristics of antenatal care also ranked among the highest scoring issues, along with risk scoring and cost-effective methods for screening for diabetes in pregnancy (tables 3 and 4).

Conclusions

Many stillbirths in high-income countries are potentially preventable. The disparity associated with disadvantaged populations requires urgent attention through improvement of living standards for women, and provision of culturally appropriate accessible antenatal care. A greater awareness of risk factors for stillbirth is needed at the community, health-care provider, and policy levels.

The absence of quality data on stillbirths is a major impediment to stillbirth prevention. The proportion of unexplained stillbirths associated without adequate investigation remains high in many high-income countries. Improvements in investigation and reporting practices, including consensus of definition and classification systems, is urgently needed. Implementation of perinatal mortality audit at a national level could result in important reductions in stillbirth in high-income countries through improvement of quality of data and standards of maternity care.

However, a substantial proportion of stillbirths lack an obvious maternal risk factor and are thought most likely to portray an incompletely understood abnormality of placental function, which might or might not be associated with impaired growth. Future research should focus on screening and interventions to reduce antepartum stillbirth and stillbirth associated with extremely preterm birth and infection. Identification of ways to reduce maternal overweight and obesity is also a priority for high-income countries. Effective research collaborations are needed to carry out often large-scale research needed to address stillbirth in high-income countries.

Parents have the greatest stake of all in the wellbeing of their baby, and must be part of the drive to reduce stillbirth. Parents and health professionals working collaboratively (in such models as the International Stillbirth Alliance[157]) have a powerful part to play in bringing stillbirth to public attention and pushing for the prioritisation of stillbirth in research and maternity services.

Contributors

VF compiled the report with contributions from all authors. All authors read and approved the final report.

The Lancet's Stillbirths Series steering committee

J Fredrik Frøen, Joy E Lawn, Zulfiqar A Bhutta, Robert Pattinson, Vicki Flenady, Robert L Goldenberg, and Monir Islam.

Declarations

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the US Centers for Disease Control and Prevention. This report also includes data made available by the Australian Institute of Health and Welfare (Canberra, ACT). The authors are responsible for the use made of the data in this report.

Conflicts of interest

We declare that we have no conflicts of interest.

Acknowledgments

We thank the Bill & Melinda Gates Foundation for a grant to support this work to the International Stillbirth Alliance administered by the Mater Medical Research Institute, Brisbane, QLD, Australia. Additionally, we thank the International Stillbirth Alliance and the Norwegian Institute of Public Health for seed funding to support meetings of the steering committee. We thank the following for technical support: Dominique Rossouw, Madeleine Elder, and Elizabeth Flenady for literature searching and reference management, Kristen Gibbons for statistical advice, and Glenda Hawley, Teresa Walsh,

Shelley Wilkinson, and Ann Kingsbury for providing feedback on the report. We thank Janet Scott of Sands UK, Sue Hale of Sands UK and ISA Parent Advisory Committee, and Liz Conway Sands Australia and the ISA Parent Advisory Committee for their comments and contributions to the report. We thank the following for their contributions to the research priority component: Justus Hofmeyr for his assistance with the development of the research priority questions, review of interventions, and comment of drafts of the report; Eckhart Buchmann for development of the initial drafts of all the research questions; Igor Rudan for guidance and support; and Ibinabo Ibiebele for data analysis. We thank all those who scored the stillbirth research priorities: Adrian Charles, Paul Colditz, Linda Dodds, Lelia Duley, Jason Gardosi, Sanne Gordijn, Grace Guyon, Justus Hofmeyr, Alex Heazell, Robyn Kennare, Russell Kirby, Wolfgang Kuenzel, Kassam Mahomed, Luigi Matturri, Elizabeth M McClure, Lesley McCowan, Giorgio Mello, Ayman el Mohandes, Halit Pinar, Ingela Radestad, Uma M Reddy, Birgit Reime, Bob Silver, and Bert Timmer, and members of the GAPPS Basic Biology Working Group: Craig Rubens, Michael Gravett, Gordon Smith, Leslie Myatt, Oslem Equils, Roger Smith, and Sarah England.
We thank the following for collaborating in the classification of stillbirths and neonatal deaths: Kassam Mahomed, Diane Payton, Lucy Cooke, Teresa Walsh, Rohan Laurie of the Queensland Maternal Perinatal Quality Council, Australia; J Frederik Frøen, Norwegian Institute of Public Health, Oslo, Norway; Halit Pinar, Brown University, Providence, USA; Rachel Koshy and Safiah Bahrin, Malaysian Ministry of Health, Malaysia; Laurie Russell and Grace Guyon, Alberta Perinatal Health Program, Edmonton, Canada; Sanne Gordijn, Froukje de Boer, Joke Ravisé, and Fleurisca Korteweg, Groningen University, Netherlands; Anna Springett and Jon Dorling, Centre for Maternal and Child Enquiries, UK. We acknowledge those who assisted with sourcing stillbirth rate and risk factor prevalence data from various countries: Beatrice Blondel, Christine Cans, Anne Ego, Grace Guyon, Jason Gardosi, Nicholas Lack, Anita Lange, Paula Laws, Zhong Cheng Luo, Vicki Masson, Laura Neilson, Claudia Ravaldi (CiaoLapo Onlus Italy), Lynn Sadler, Anna Springett, Olof Stephansson, Alfredo Vannacci (CiaoLapo Onlus Italy), and Russell Wilkins.

References

1 Frøen JF, Cacciatore J, McClure EM, et al, for *The Lancet*'s Stillbirths Series steering committee. Stillbirths: why they matter. *Lancet* 2011; published online April 14. DOI:10.1016/S0140-6736(10)62232-5.
2 Woods R. Long-term trends in fetal mortality: implications for developing countries. *Bull World Health Organ* 2008; **86:** 460–66.
3 MacDorman MF, Kirmeyer S. The challenge of fetal mortality. *NCHS Data Brief* 2009; **16:** 1–8.
4 Gissler M, Mohangoo AD, Blondel B, et al. Perinatal health monitoring in Europe: results from the EURO-PERISTAT project. *Inform Health Soc Care* 2010; **35:** 64–79.
5 Frøen JF, Gordijn SJ, Abdel-Aleem H, et al. Making stillbirths count, making numbers talk—issues in data collection for stillbirths. *BMC Pregnancy Childbirth* 2009; **9:** 58.
6 Flenady V, Koopmans L, Middleton P, et al. Major risk factors for stillbirth in high-income countries: a systematic review and meta-analysis. *Lancet* 2011; published online April 14. DOI:10.1016/S0140-6736(10)62233-7.
7 Luo Z-C, Senecal S, Simonet F, Guimond E, Penney C, Wilkins R. Birth outcomes in the Inuit-inhabited areas of Canada. *CMAJ* 2010; **182:** 235–42.
8 Laws P, Sullivan EA. Australia's mothers and babies 2007. Perinatal statistics series. Sydney: AIHW National Perinatal Statistics Unit, 2009.
9 Bateman BT, Simpson LL. Higher rate of stillbirth at the extremes of reproductive age: a large nationwide sample of deliveries in the United States. *Am J Obstet Gynecol* 2006; **194:** 840–45.
10 Getahun D, Ananth CV, Selvam N, Demissie K. Adverse perinatal outcomes among interracial couples in the United States. *Obstet Gynecol* 2005; **106:** 81–88.
11 Salihu HM, Kinniburgh BA, Aliyu MH, Kirby RS, Alexander GR. Racial disparity in stillbirth among singleton, twin, and triplet gestations in the United States. *Obstet Gynecol* 2004; **104:** 734–40.
12 Ravelli AC, Tromp M, Eskes M, et al. Ethnic differences in stillbirth and early neonatal mortality in the Netherlands. *J Epidemiol Community Health* 2010; published online Aug 18. DOI:10.1136/jech.2009.095406.
13 Jorgensen T, Mortensen LH, Andersen AM. Social inequality in fetal and perinatal mortality in the Nordic countries. *Scand J Public Health* 2008; **36:** 635–49.
14 Stillbirths, infant deaths and social deprivation: West Midlands 1997–2007/8 (chapter 13). In: West Midlands key health data 2008/9. Birmingham: West Midlands Perinatal Institute, 2009.
15 Centre for Maternal and Child Enquiries Perinatal Mortality 2008. UK. London: CMACE, 2010.
16 PMMRC. Perinatal and maternal mortality in New Zealand 2008: fourth report to the Minister of Health July 2009 to June 2010. Wellington: Perinatal and Maternal Mortality Review Committee, Ministry of Health, 2010.
17 Bryant AS, Worjoloh A, Caughey AB, Washington AE. Racial/ethnic disparities in obstetric outcomes and care: prevalence and determinants. *Am J Obstet Gynecol* 2010; **202:** 335–43.
18 Vintzileos AM, Ananth CV, Smulian JC, Scorza WE, Knuppel RA. Prenatal care and black-white fetal death disparity in the United States: heterogeneity by high-risk conditions. *Obstet Gynecol* 2002; **99:** 483–89.
19 Roberts CL, Algert CS. The urban and rural divide for women giving birth in NSW, 1990–1997. *Aust N Z J Public Health* 2000; **24:** 291–97.
20 Robson S, Cameron CA, Roberts CL. Birth outcomes for teenage women in New South Wales, 1998–2003. *Aust N Z J Obstet Gynaecol* 2006; **46:** 305–10.
21 Willinger M, Ko CW, Reddy UM. Racial disparities in stillbirth risk across gestation in the United States. *Am J Obstet Gynecol* 2009; **201:** 469.e1–8.
22 Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ. Selected major risk factors and global and regional burden of disease. *Lancet* 2002; **360:** 1347–60.
23 Finucane MM, Stevens GA, Cowan MJ, et al. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9·1 million participants. *Lancet* 2011; **377:** 557–67.
24 Floyd RL, Decoufle P, Hungerford DW. Alcohol use prior to pregnancy recognition. *Am J Prev Med* 1999; **17:** 101–07.
25 Bolling K, Grant C, Hamlyn B, Thornton A, on behalf of the Information Centre for health and social care and the UK Health Departments. Infant feeding survey, 2005. London: BMRB Social Research, 2007.
26 Verkerk PH, van Noord-Zaadstra BM, Florey CD, de Jonge GA, Verloove-Vanhorick SP. The effect of moderate maternal alcohol consumption on birth weight and gestational age in a low risk population. *Early Hum Dev* 1993; **32:** 121–29.
27 Aliyu MH, Wilson RE, Zoorob R, et al. Alcohol consumption during pregnancy and the risk of early stillbirth among singletons. *Alcohol* 2008; **42:** 369–74.
28 Yudkin PL, Wood L, Redman CWG. Risk of unexplained stillbirth at different gestational ages. *Lancet* 1987; **329:** 1192–94.
29 Smith GC. Life-table analysis of the risk of perinatal death at term and post term in singleton pregnancies. *Am J Obstet Gynecol* 2001; **184:** 489–96.
30 Haavaldsen C, Sarfraz AA, Samuelsen SO, Eskild A. The impact of maternal age on fetal death: does length of gestation matter? *Am J Obstet Gynecol* 2010; **203:** 554.e1–8.
31 Flenady V, Frøen JF, Pinar H, et al. An evaluation of classification systems for stillbirth. *BMC Pregnancy Childbirth* 2009; **9:** 24.
32 Korteweg FJ, Erwich JJ, Folkeringa N, et al. Prevalence of parental thrombophilic defects after fetal death and relation to cause. *Obstet Gynecol* 2010; **116:** 355–64.
33 Frøen JF, Pinar H, Flenady V, et al. Causes of death and associated conditions (Codac): a utilitarian approach to the classification of perinatal deaths. *BMC Pregnancy Childbirth* 2009; **9:** 22.
34 Dudley DJ, Goldenberg R, Conway D, et al. A new system for determining the causes of stillbirth. *Obstet Gynecol* 2010; **116:** 254–60.

35 Chan A, King JF, Flenady V, Haslam RH, Tudehope DI. Classification of perinatal deaths: development of the Australian and New Zealand classifications. *J Paediatr Child Health* 2004; **40:** 340–47.

36 Korteweg FJ, Gordijn SJ, Timmer A, et al. The Tulip classification of perinatal mortality: introduction and multidisciplinary inter-rater agreement. *BJOG* 2006; **113:** 393–401.

37 Gardosi J, Kady SM, McGeown P, Francis A, Tonks A. Classification of stillbirth by relevant condition at death (ReCoDe): population based cohort study. *BMJ* 2005; **331:** 1113–17.

38 Korteweg FJ, Gordijn SJ, Timmer A, Holm JP, Ravise JM, Erwich JJ. A placental cause of intra-uterine fetal death depends on the perinatal mortality classification system used. *Placenta* 2008; **29:** 71–80.

39 Khong TY. The placenta in stillbirth. *Curr Diag Pathol* 2006; **12:** 161–72.

40 Pinar H, Carpenter M. Placenta and umbilical cord abnormalities seen with stillbirth. *Clin Obstet Gynecol* 2010; **53:** 656–72.

41 Silver RM. Fetal death. *Obstet Gynecol* 2007; **109:** 153–67.

42 Wylie BJ, D'Alton ME. Fetomaternal hemorrhage. *Obstet Gynecol* 2010; **115:** 1039–51.

43 Frøen JF, Gardosi JO, Thurmann A, Francis A, Stray-Pedersen B. Restricted fetal growth in sudden intrauterine unexplained death. *Acta Obstet Gynecol Scand* 2004; **83:** 801–07.

44 Goldenberg RL, McClure EM, Saleem S, Reddy UM. Infection-related stillbirths. *Lancet* 2010; **375:** 1482–90.

45 Goldenberg RL, Kirby R, Culhane JF. Stillbirth: a review. *J Matern Fetal Neonatal Med* 2004; **16:** 79–94.

46 Khong TY. Pathology investigations. In: Facchinetti F, Dekker GA, Baronciani D, Saade G, eds. Stillbirth: understanding and management. London: Informa Healthcare, 2009: 91–99.

47 Hawthorne G, Robson S, Ryall EA, Sen D, Roberts SH, Ward Platt MP. Prospective population based survey of outcome of pregnancy in diabetic women: results of the Northern Diabetic Pregnancy Audit, 1994. *BMJ* 1997; **315:** 279–81.

48 De Reu PA, Nijhuis JG, Oosterbaan HP, Eskes TK. Perinatal audit on avoidable mortality in a Dutch rural region: a retrospective study. *Eur J Obstet Gynecol Reprod Biol* 2000; **88:** 65–69.

49 Tan KH, Wyldes MP, Settatree R, Mitchell T. Confidential regional enquiry into mature stillbirths and neonatal deaths—a multi-disciplinary peer panel perspective of the perinatal care of 238 deaths. *Singapore Med J* 1999; **40:** 251–55.

50 Vredevoogd CB, Wolleswinkel-van den Bosch JH, Amelink-Verburg MP, Verloove-Vanhorick SP, Mackenbach JP. Perinatal mortality assessed: results of a regional audit. *Ned Tijdschr Geneeskd* 2001; **145:** 482–87.

51 Krebs L, Langhoff-Roos J, Bodker B. Are intrapartum and neonatal deaths in breech delivery at term potentially avoidable?—a blinded controlled audit. *J Perinat Med* 2002; **30:** 220–24.

52 Wolleswinkel-van den Bosch JH, Vredevoogd CB, Borkent-Polet M, et al. Substandard factors in perinatal care in the Netherlands: a regional audit of perinatal deaths. *Acta Obstet Gynecol Scand* 2002; **81:** 17–24.

53 Holt J, Fagerli I, Holdo B, et al. Audit of neonatal deaths of nonmalformed infants of 34 or more weeks' gestation: unavoidable catastrophic events or suboptimal care? *Acta Obstet Gynecol Scand* 2002; **81:** 899–904.

54 Essen B, Bodker B, Sjoberg NO, et al. Are some perinatal deaths in immigrant groups linked to suboptimal perinatal care services? *BJOG* 2002; **109:** 677–82.

55 Lauenborg J, Mathiesen E, Ovesen P, et al. Audit on stillbirths in women with pregestational type 1 diabetes. *Diabetes Care* 2003; **26:** 1385–89.

56 Richardus JH, Graafmans WC, Bergsjo P, et al. Suboptimal care and perinatal mortality in ten European regions: methodology and evaluation of an international audit. *J Matern Fetal Neonatal Med* 2003; **14:** 267–76.

57 Acolet D, Elbourne D, McIntosh N, et al. Project 27/28: inquiry into quality of neonatal care and its effect on the survival of infants who were born at 27 and 28 weeks in England, Wales, and Northern Ireland. *Pediatrics* 2005; **116:** 1457–65.

58 Saastad E, Vangen S, Frøen JF. Suboptimal care in stillbirths—a retrospective audit study. *Acta Obstet Gynecol Scand* 2007; **86:** 444–50.

59 Alderliesten ME, Stronks K, Bonsel GJ, et al. Design and evaluation of a regional perinatal audit. *Eur J Obstet Gynecol Reprod Biol* 2008; **137:** 141–45.

60 De Lange TE, Budde MP, Heard AR, Tucker G, Kennare R, Dekker GA. Avoidable risk factors in perinatal deaths: a perinatal audit in South Australia. *Aust N Z J Obstet Gynaecol* 2008; **48:** 50–57.

61 De Reu PA, Oosterbaan HP, Smits LJ, et al. Avoidable mortality in small-for-gestational-age children in the Netherlands. *J Perinat Med* 2010; **38:** 311–18.

62 Annual report for the year 2007: Incorporating the 46th survey of perinatal deaths in Victoria. Victoria: Consultative Council on Obstetric and Paediatric Mortality and Morbidity (CCOPMM), 2007.

63 Lawn JE, Blencowe H, Pattinson R, et al, for *The Lancet*'s Stillbirths Series steering committee. Stillbirths: Where? When? Why? How to make the data count? *Lancet* 2011; published online April 14. DOI:10.1016/S0140-6736(10)62187-3.

64 Smith GCS, Fretts RC. Stillbirth. *Lancet* 2007; **370:** 1715–25.

65 Darmstadt GL, Yakoob MY, Haws RA, Menezes EV, Soomro T, Bhutta ZA. Reducing stillbirths: interventions during labour. *BMC Pregnancy Childbirth* 2009; **9** (suppl 1)**:** S6.

66 Yakoob MY, Menezes EV, Soomro T, Haws RA, Darmstadt GL, Bhutta ZA. Reducing stillbirths: behavioural and nutritional interventions before and during pregnancy. *BMC Pregnancy Childbirth* 2009; **9** (suppl 1)**:** S3.

67 Menezes EV, Yakoob MY, Soomro T, Haws RA, Darmstadt GL, Bhutta ZA. Reducing stillbirths: prevention and management of medical disorders and infections during pregnancy. *BMC Pregnancy Childbirth* 2009; **9** (suppl 1)**:** S4.

68 Haws RA, Yakoob MY, Soomro T, Menezes EV, Darmstadt GL, Bhutta ZA. Reducing stillbirths: screening and monitoring during pregnancy and labour. *BMC Pregnancy Childbirth* 2009; **9** (suppl 1)**:** S5.

69 Bhutta ZA, Yakoob MY, Lawn JE, et al, for *The Lancet*'s Stillbirths Series steering committee. Stillbirths: what difference can we make and at what cost? *Lancet* 2011; published online April 14. DOI:10.1016/S0140-6736(10)62050-8.

70 Jack BW, Atrash H, Coonrod DV, Moos MK, O'Donnell J, Johnson K. The clinical content of preconception care: an overview and preparation of this supplement. *Am J Obstet Gynecol* 2008; **199:** S266–79.

71 Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? *J Health Soc Behav* 1995; **36:** 1–10.

72 Harvey SM, Faber KS. Obstacles to prenatal care following implementation of a community-based program to reduce financial barriers. *Fam Plann Perspect* 1993; **25:** 32–36.

73 Whitworth M, Bricker L, Neilson JP, Dowswell T. Ultrasound for fetal assessment in early pregnancy. *Cochrane Database Syst Rev* 2010; **4:** CD007058.

74 Institute of Medicine and National Research Council. Weight gain during pregnancy: reexamining the guidelines. Washington, DC: National Academies Press, 2009.

75 National Institute for Health and Clinical Excellence. NICE clinical guideline 27. Weight management before, during and after pregnancy. London: National Institute for Health and Clinical Excellence, 2010.

76 Streuling I, Beyerlein A, von Kries R. Can gestational weight gain be modified by increasing physical activity and diet counseling? A meta-analysis of interventional trials. *Am J Clin Nutr* 2010; **92:** 678–87.

77 Dodd JM, Grivell RM, Crowther CA, Robinson JS. Antenatal interventions for overweight or obese pregnant women: a systematic review of randomised trials. *BJOG* 2010; **117:** 1316–26.

78 Herring S, Oken E, Haines J, et al. Misperceived pre-pregnancy body weight status predicts excessive gestational weight gain: findings from a US cohort study. *BMC Pregnancy Childbirth* 2008; **8:** 54.

79 Cogswell ME, Scanlon KS, Fein SB, Schieve LA. Medically advised, mother's personal target, and actual weight gain during pregnancy. *Obstet Gynecol* 1999; **94:** 616–22.

80 Confidential Enquiry into Maternal and Child Health. Diabetes in pregnancy: are we providing the best care? Findings of a national enquiry: England, Wales and Northern Ireland. London: CEMACH, 2007.

81 Tieu J, Middleton P, Crowther CA. Preconception care for diabetic women for improving maternal and infant health. *Cochrane Database Syst Rev* 2010; **12:** CD007776.

82 Diabetes in pregnancy: Management of diabetes and its complications from preconception to the postnatal period. Commissioned by the National Institute for Health and Clinical Excellence. London: National Collaborating Centre for Women's and Children's Health, 2008.

83 Lumley J, Chamberlain C, Dowswell T, Oliver S, Oakley L, Watson L. Interventions for promoting smoking cessation during pregnancy. *Cochrane Database Syst Rev* 2009; **3:** CD001055.

84 National Institute of Health and Clinical Excellence. NICE clinical guideline 26. Quitting smoking in pregnancy and following childbirth. London: National Institute for Health and Clinical Excellence, 2010.

85 Floyd RL, Sobell M, Velasquez MM, et al. Preventing alcohol-exposed pregnancies: a randomized controlled trial. *Am J Prev Med* 2007; **32:** 1–10.

86 Whitworth M, Dowswell T. Routine pre-pregnancy health promotion for improving pregnancy outcomes. *Cochrane Database Syst Rev*. 2009; **4:** CD007536.

87 Stade BC, Bailey C, Dzendoletas D, Sgro M, Dowswell T, Bennett D. Psychological and/or educational interventions for reducing alcohol consumption in pregnant women and women planning pregnancy. *Cochrane Database Syst Rev* 2009; **2:** CD004228.

88 Khong TY, De Wolf F, Robertson WB, Brosens I. Inadequate maternal vascular response to placentation in pregnancies complicated by pre-eclampsia and by small-for-gestational age infants. *Br J Obstet Gynaecol* 1986; **93:** 1049–59.

89 Hall MH, Chng PK, MacGillivray I. Is routine antenatal care worth while? *Lancet* 1980; **316:** 78–80.

90 Neilson JP. Symphysis-fundal height measurement in pregnancy. *Cochrane Database Syst Rev* 2000; **2:** CD000944.

91 Cnattingius S, Haglund B, Kramer MS. Differences in late fetal death rates in association with determinants of small for gestational age fetuses: population based cohort study. *BMJ* 1998; **316:** 1483–87.

92 McIntire DD, Bloom SL, Casey BM, Leveno KJ. Birth weight in relation to morbidity and mortality among newborn infants. *N Engl J Med* 1999; **340:** 1234–38.

93 Hutcheon JA, Zhang X, Platt RW, Cnattingius S, Kramer MS. The case against customised birthweight standards. *Paediat Perinat Epidemiol* 2010; **25:** 11–16.

94 Frøen JF. A kick from within—fetal movement counting and the cancelled progress in antenatal care. *J Perinat Med* 2004; **32:** 13–24.

95 Mangesi L, Hofmeyr GJ. Fetal movement counting for assessment of fetal wellbeing. *Cochrane Database Syst Rev* 2007; **1:** CD004909.

96 ISA position statement: fetal movement monitoring. Brisbane: International Stillbirth Alliance, 2009. http://www.stillbirthalliance.org/doc/ISA_DFM_Position_Statement_Consultation_Draft.pdf (accessed on Sept 1, 2010).

97 Preston P, Mahomed K, Chadha Y, et al. Proceedings of the ISA and ISPID Joint Conference, 8–10 October 2010; Sydney, Australia. *J Paediatr Child Health* 2010; **46** (suppl 3)**:** 45.

98 Tveit JV, Saastad E, Stray-Pedersen B, et al. Reduction of late stillbirth with the introduction of fetal movement information and guidelines—a clinical quality improvement. *BMC Pregnancy Childbirth* 2009; **9:** 32.

99 Loftin RW, Habli M, Snyder CC, Cormier CM, Lewis DF, Defranco EA. Late preterm birth. *Rev Obstet Gynecol* 2010; **3:** 10–19.

100 Duley L, Henderson-Smart DJ, Meher S, King JF. Antiplatelet agents for preventing pre-eclampsia and its complications. *Cochrane Database Syst Rev* 2007; **2:** CD004659.

101 Askie LM, Duley L, Henderson-Smart DJ, Stewart LA, on behalf of the PARIS Collaborative Group. Antiplatelet agents for prevention of pre-eclampsia: a meta-analysis of individual patient data. *Lancet* 2007; **369:** 1791–98.

102 National Institute for Health and Clinical Excellence. NICE clinical guideline 107. Hypertension in pregnancy: the management of hypertensive disorders during pregnancy. Commissioned by the National Institute for Health and Clinical Excellence. London: Royal College of Obstetricians and Gynaecologists, 2010.

103 Crowther CA, Hiller JE, Pridmore B, et al. Calcium supplementation in nulliparous women for the prevention of pregnancy-induced hypertension, preeclampsia and preterm birth: an Australian randomized trial. FRACOG and the ACT Study Group. *Aust N Z J Obstet Gynaecol* 1999; **39:** 12–18.

104 Hofmeyr GJ, Lawrie TA, Atallah AN, Duley L. Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems. *Cochrane Database Syst Rev* 2010; **8:** CD001059.

105 Alfirevic Z, Stampalija T, Gyte GM. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. *Cochrane Database Syst Rev* 2010; **1:** CD007529.

106 Salihu HM, Shumpert MN, Slay M, Kirby RS, Alexander GR. Childbearing beyond maternal age 50 and fetal outcomes in the United States. *Obstet Gynecol* 2003; **102:** 1006–14.

107 Orentlicher D. Multiple embryo transfers: time for policy. *Hastings Cent Rep* 2010; **40:** 12–13.

108 Gulmezoglu AM, Crowther CA, Middleton P. Induction of labour for improving birth outcomes for women at or beyond term. *Cochrane Database Syst Rev* 2006; **4:** CD004945.

109 Kenyon S, Boulvain M, Neilson JP. Antibiotics for preterm rupture of membranes. *Cochrane Database Syst Rev* 2010; **8:** CD001058.

110 Macones GA, Parry S, Nelson DB, et al. Treatment of localized periodontal disease in pregnancy does not reduce the occurrence of preterm birth: results from the Periodontal Infections and Prematurity Study (PIPS). *Am J Obstet Gynecol* 2010; **202:** 147 e1–8.

111 Michalowicz BS, Hodges JS, DiAngelis AJ, et al. Treatment of periodontal disease and the risk of preterm birth. *N Engl J Med* 2006; **355:** 1885–94.

112 Newnham JP, Newnham IA, Ball CM, et al. Treatment of periodontal disease during pregnancy: a randomized controlled trial. *Obstet Gynecol* 2009; **114:** 1239–48.

113 Dunn PM, McIlwaine G. Perinatal audit: a report produced for the European Association of Perinatal Medicine. New York, NY: Parthenon, 1996.

114 Pattinson RC, Say L, Makin JD, Bastos MH. Critical incident audit and feedback to improve perinatal and maternal mortality and morbidity. *Cochrane Database Syst Rev* 2005; **4:** CD002961.

115 Pattinson R, Kerber K, Waiswa P, et al. Perinatal mortality audit: counting, accountability, and overcoming challenges in scaling up in low- and middle-income countries. *Int J Gynaecol Obstet* 2009; **107** (suppl 1)**:** S113–21, S121–22.

116 Bergsjo P, Bakketeig LS, Langhoff-Roos J. The development of perinatal audit: 20 years' experience. *Acta Obstet Gynecol Scand* 2003; **82:** 780–88.

117 CESDI. 8th annual report. Confidential enquiry into stillbirths and deaths in infancy. London: CESDI, 2001.

118 Flenady V, King J, Charles A, et al. Clinical practice guideline for perinatal mortality. Version 2.2, April 2009. http://www.psanzpnmsig.org (accessed Sept 1, 2010).

119 Flenady V, Mahomed K, Ellwood D, et al. Uptake of the perinatal society of Australia and New Zealand perinatal mortality audit guideline. *Aust N Z J Obstet Gynaecol* 2010; **50:** 138–43.

120 Flenady V, Jennings B, Teale G, et al. Implementation of the PSANZ guideline for perinatal mortality. Proceedings of the ISA and ISPID Joint Conference, 8–10 October 2010; Sydney, Australia. *J Paediatr Child Health*. 2010; **46:** 46.

121 de Reu P, Van Diem M, Eskes M, et al. The Dutch Perinatal Audit Project: a feasibility study for nationwide perinatal audit in the Netherlands. *Acta Obstet Gynecol Scand* 2009; **88:** 1201–08.

122 van Diem M, De Reu P, Eskes M, et al. National perinatal audit, a feasible initiative for the Netherlands!? A validation study. *Acta Obstet Gynecol Scand* 2010; **89:** 1168–73.

123 McDonnell KA, Strobino DM, Baldwin KM, Grason H, Misra DP. Comparison of FIMR programs with other perinatal systems initiatives. *Matern Child Health J* 2004; **8:** 231–38.

124 Wigglesworth JS. Investigation of perinatal death. *Arch Dis Child* 1987; **62:** 1207–08.

125 Silver RM, Varner MW, Reddy U, et al. Work-up of stillbirth: a review of the evidence. *Am J Obstet Gynecol* 2007; **196:** 433–44.

126 Flenady V, Silver RM, Incerpi M, et al. Essential diagnostic workup of stillbirths. In: Facchinetti F, et al, eds. Stillbirth: understanding and management. London: Informa Healthcare, 2010.

127 Corabian P, Scott NA, Lane C, Guyon G. Guidelines for investigating stillbirths: an update of a systematic review. *J Obstet Gynaecol Can* 2007; **29:** 560–67.

128 Khong TY. A review of perinatal autopsy rates worldwide, 1960s to 1990s. *Paediatr Perinat Epidemiol* 1996; **10:** 97–105.

129 Doyle LW. Effects of perinatal necropsy on counselling. *Lancet* 2000; **355:** 2093.

130 Khong TY, Tanner AR. Foetal and neonatal autopsy rates and use of tissue for research: The influence of 'organ retention' controversy and new consent process. *J Paediatr Child Health* 2006; **42:** 366–69.

131 Stock SJ, Goldsmith L, Evans MJ, Laing IA. Interventions to improve rates of post-mortem examination after stillbirth. *Eur J Obstet Gynecol Reprod Biol* 2010; **153:** 148–50.

132 Laing IA. Clinical aspects of neonatal death and autopsy. *Semin Neonatol* 2004; **9:** 247–54.

133 Gordijn SJ, Erwich JJ, Khong TY. The perinatal autopsy: pertinent issues in multicultural western Europe. *Eur J Obstet Gynecol Reprod Biol* 2007; **132:** 3–7.

134 Gordijn SJ, Erwich JJ, Khong TY. Value of the perinatal autopsy: critique. *Pediatr Dev Pathol* 2002; **5:** 480–88.

135 Vujanic GM, Cartlidge PH, Stewart JH, Dawson AJ. Perinatal and infant postmortem examinations: how well are we doing? *J Clin Pathol* 1995; **48:** 998–1001.

136 Thornton CM, O'Hara MD. A regional audit of perinatal and infant autopsies in Northern Ireland. *Br J Obstet Gynaecol* 1998; **105:** 18–23.

137 Wright C, Cameron H, Lamb W. A study of the quality of perinatal autopsy in the former northern region. The Northern Perinatal Mortality Survey Steering Group. *Br J Obstet Gynaecol* 1998; **105:** 24–28.

138 Burnley H, Moore I. An audit to assess the quality of necropsies performed on stillborn infants. *J Clin Pathol* 2005; **58:** 93–94.

139 Sun CC, Revell VO, Belli AJ, Viscardi RM. Discrepancy in pathologic diagnosis of placental lesions. *Arch Pathol Lab Med* 2002; **126:** 706–09.

140 Khong TY, Gordijn SJ. Quality of placental pathology reports. *Pediatr Dev Pathol* 2003; **6:** 54–58.

141 Cohen MC, Paley MN, Griffiths PD, Whitby EH. Less invasive autopsy: benefits and limitations of the use of magnetic resonance imaging in the perinatal postmortem. *Pediatr Dev Pathol* 2008; **11:** 1–9.

142 Breeze AC, Gallagher FA, Lomas DJ, Smith GC, Lees CC. Postmortem fetal organ volumetry using magnetic resonance imaging and comparison to organ weights at conventional autopsy. *Ultrasound Obstet Gynecol* 2008; **31:** 187–93.

143 Hagmann CF, Robertson NJ, Sams VR, Brookes JA. Postmortem magnetic resonance imaging as an adjunct to perinatal autopsy for renal-tract abnormalities. *Arch Dis Child Fetal Neonatal Ed* 2007; **92:** F215–18.

144 Brookes JS, Hagmann C. MRI in fetal necropsy. *J Magn Reson Imaging* 2006; **24:** 1221–28.

145 Huisman TA. Magnetic resonance imaging: an alternative to autopsy in neonatal death? *Semin Neonatol* 2004; **9:** 347–53.

146 Royal College of Paediatrics and Child Health. The future of paediatric pathology services: fetal, perinatal and paediatric pathology; a critical future. Report of a working group to restore and develop specialist paediatric pathology: a critically important specialty, essential for the best quality care of children. London: Royal College of Paediatrics and Child Health, 2002.

147 Duke W, Shin M, Correa A, Alverson CJ. Survey of knowledge, attitudes, and practice management patterns of Atlanta-area obstetricians regarding stillbirth. *Womens Health Issues* 2010; **20:** 366–70.

148 Tugwell P, Bennett KJ, Sackett DL, Haynes RB. The measurement iterative loop: a framework for the critical appraisal of need, benefits and costs of health interventions. *J Chronic Dis* 1985; **38:** 339–51.

149 Henderson-Smart DJ, Osborn D, Evans N, Beeby P, Jeffery H. Do we practice evidence-based care in our neonatal intensive care units? *Clin Perinatol* 2003; **30:** 333–42.

150 The Cochrane Library. UK: John Wiley & Sons, 2007. http://www.thecochranelibrary.com (accessed Sept 1, 2010).

151 Rotter T, Kinsman L, James E, et al. Clinical pathways: effects on professional practice, patient outcomes, length of stay and hospital costs. *Cochrane Database Syst Rev* 2010; **3:** CD006632.

152 Thomas L, Cullum N, McColl E, Rousseau N, Soutter J, Steen N. Guidelines in professions allied to medicine. *Cochrane Database Syst Rev* 2000; **2:** CD000349.

153 Doumit G, Gattellari M, Grimshaw J, O'Brien MA. Local opinion leaders: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2007; **1:** CD000125.

154 Pattinson R, Kerber K, Buchmann E, et al, for *The Lancet*'s Stillbirths Series steering committee. Stillbirths: how can health systems deliver for mothers and babies? *Lancet* 2011; published online April 14. DOI:10.1016/S0140-6736(10)62306-9.

155 Tursan d'Espaignet E, Bulsara M, Wolfenden L, Byard RW, Stanley FJ. Trends in sudden infant death syndrome in Australia from 1980 to 2002. *Forensic Sci Med Pathol* 2008; **4:** 83–90.

156 Smith GC. First-trimester determination of complications of late pregnancy. *JAMA* 2010; **303:** 561–62.

157 International Stillbirth Alliance. Brisbane: International Stillbirth Alliance, 2009. http://www.stillbirthalliance.org (accessed Sept 1, 2010).