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An audit of 70 maternal deaths

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ABSTRACT

INTRODUCTION. Although women rarely die during pregnancy and childbirth in Denmark, keeping track of the maternal mortality rate and causes of death is vital in identifying learning points for future management of critical illness among obstetric patients and in pinpointing risk factors.

METHODS. We identified maternal deaths between 2002 and 2017 by linking four Danish national health registers, using death certificates and reports from hospitals. An audit group then categorised each case by cause of death before identifying any suboptimal care and learning points, which may serve as a foundation for national guidelines and educational strategies.

RESULTS. Seventy women died during pregnancy or within six weeks of a pregnancy in the study period. The most frequent causes of death were cardiovascular disease (n = 14), hypertensive disorder (n = 10), suicide (n = 10) and thromboembolism (n = 7). Suboptimal care was identified in 30 of the 70 cases.

CONCLUSIONS. Mortality from some of the most important causes of death decreased during the study period. No deaths from preeclampsia or thrombosis, two of the leading causes of death, were identified after 2011. In 2015-2017, suicide was the main cause of maternal death, which indicates that a stronger focus on vulnerability in pregnancy and childbirth is essential. Among the 70 deaths, 34% were potentially avoidable, indicating that it is essential continuously to focus on how to reduce severe maternal morbidity and mortality.

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Maternal mortality in Denmark is low, but every death represents the loss of a young woman. Therefore, it is necessary continuously to follow the maternal mortality rate and to monitor causes of death. Audit is an important method of identifying suboptimal factors and learning points for management of critical complications.

Various studies have indicated that underreporting of maternal deaths also occurs in countries with well-established national registers [1-3]. As a result, in 2002, the Danish Society of Obstetrics and Gynaecology (DSOG) formed a national maternal mortality audit group to identify and classify maternal deaths, and to audit each case to identify suboptimal care, learning points and areas needing future clinical guidelines [4].

The aim of this paper was to describe results from an audit of maternal mortality in Denmark covering the 2002-2017 period.

METHODS

We defined maternal deaths in accordance with the International Statistical Classi&;cation of Diseases and Related Health Conditions – tenth revision (ICD-10) [5] (**Table 1**). We identified deaths during and up to one year after a pregnancy by linking four national registers (Table 1). The linked data were combined with data from death certificates. For 2002-2007, direct reporting from hospitals was added. If a death was suspected to be maternal and had occurred within 42 days after a pregnancy, we requested the full medical records from hospitals and family doctors. We classified each case in accordance with the British Confidential Enquiries into Maternal Deaths classification [6].

TABLE 1 World Health Organization (WHO) definitions of maternal mortality and identification of Danish maternal mortality by linking four Danish national registers.

	Definition
WHO	
Maternal death	The death of a woman while pregnant or within 42 days of termination of pregnancy irrespective of the duration and site of the pregnancy
	From any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes
Direct maternal death	Death resulting from obstetric complications in pregnancy, labour or puerperium, from interventions, omissions or incorrect treatment
Indirect maternal death	Death resulting from previous existing disease or disease developed during pregnancy which was aggravated by the physiologic effects of pregnancy
Maternal mortality ratio	Maternal deaths per 100,000 live births
Danish national registers	
The Danish National Patient Register	All women who died within 1 yr of an obstetric ICD-10 code[a] were included All primary and secondary ICD-10 codes were extracted
The Civil Registration System	All women who died within 1 yr of an obstetric ICD-10 code[a] were included
The Cause of Death Register	All women who died within 1 yr of an obstetric ICD-10 code[a] were included All primary and secondary ICD-10 codes were extracted
The Danish Medical Birth Register	All women who died within 1 yr of an obstetric ICD-10 code[a] were included

ICD-10 = International Statistical Classification of Diseases and Related Health Conditions, tenth revision.
a) DO00-DO99 or DZ32-DZ399.

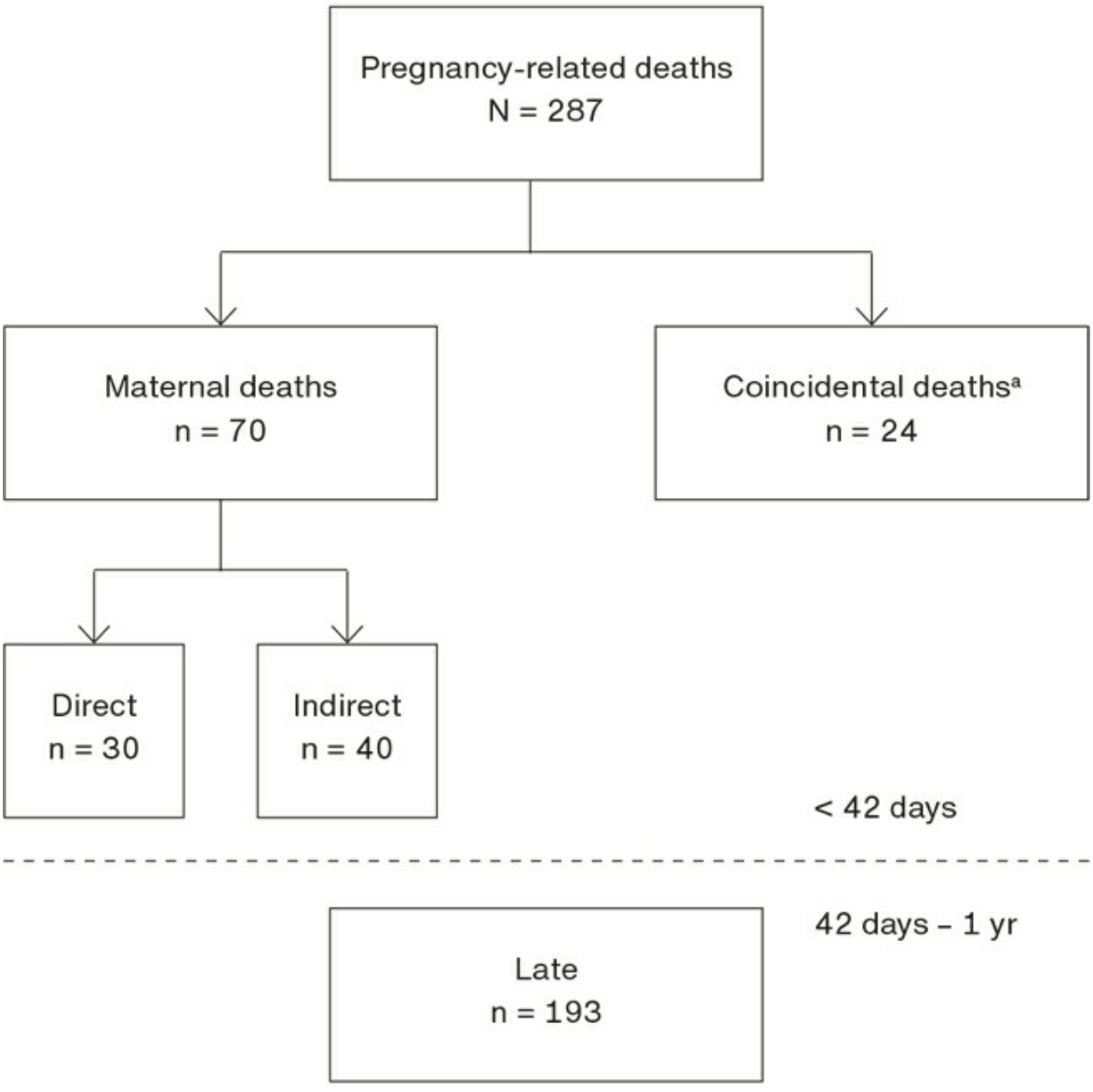
The audit group, which comprised five obstetricians, assessed each case focusing on learning points. When necessary, other specialists, e.g. midwives, cardiologists and oncologists, were consulted. Quality of care was classified as good care, minor suboptimality or major suboptimality, the latter meaning that a different management may have been expected to alter the outcome. Suboptimal factors were defined based on available scientific evidence, national guidelines and good clinical practice. Consensus was reached at audit meetings by common assessment of each case by the audit group.

Trial registration: not relevant.

RESULTS

From 2002 to 2017, a total of 287 women died during pregnancy or within one year after pregnancy, 70 of the deaths were defined as maternal (**Figure 1**). During the same period, 999,206 live births were registered in Denmark, producing an overall maternal mortality rate of 7.0 per 100,000 live births.

FIGURE 1 Classification of pregnancy-related deaths in Denmark, 2002-2017.



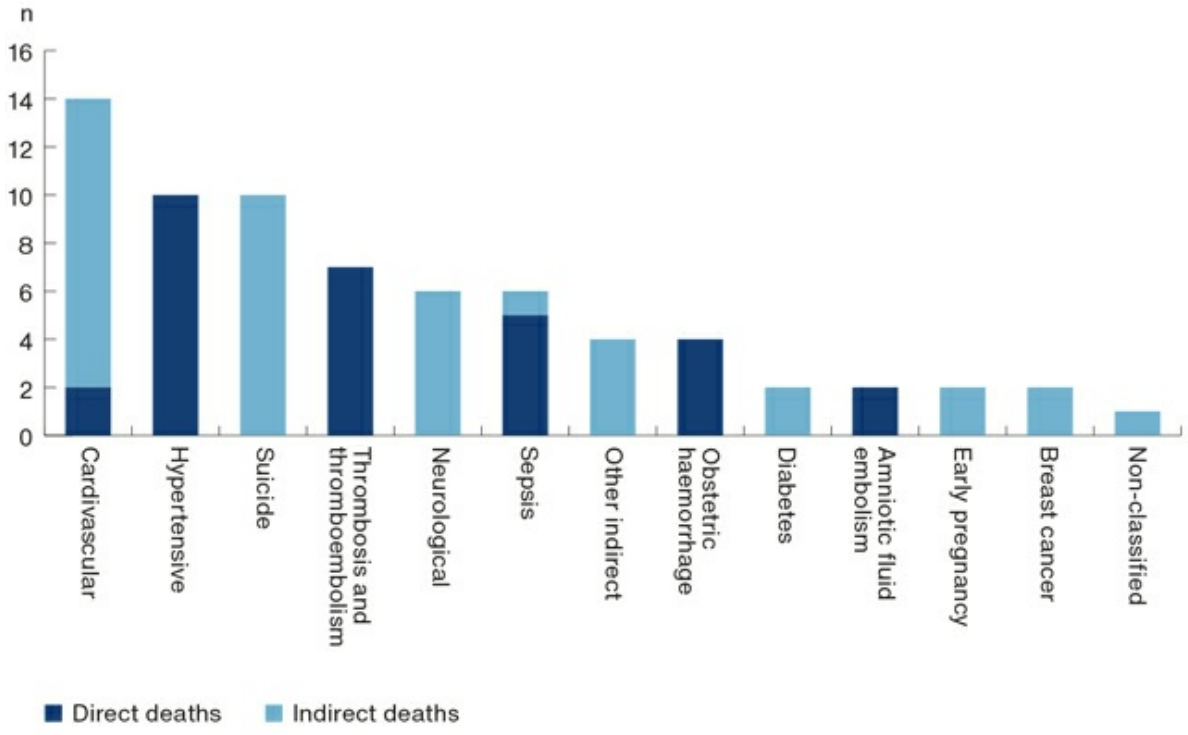
a) Examples of coincidental deaths: traffic accidents, cancer or murder.

Causes of death

The causes of death are presented in **Figure 2**.

Below follows a description of the most important categories with case stories as examples.

FIGURE 2 Number of maternal deaths in Denmark by cause of death, 2002-2017.



Cardiovascular disease

Fourteen women died from cardiovascular disease, including congenital and acquired cardiac conditions. Six of the women had a known cardiac disease before their pregnancy. Four women died from dissection of vessels, including the aorta, a coronary artery and the splenic artery. Other causes of cardiac death were peripartum cardiomyopathy, arrhythmias and coronary thromboses.

A 36-year-old woman had a normal pre-pregnancy blood pressure. During the last part of pregnancy, she slept in a sitting position due to breathlessness. A few days after an uncomplicated delivery, she was admitted to a psychiatry ward due to confusion. She had developed serious left-sided heart failure with a severely dilated left ventricle, very low ejection fraction and oedema. Her temperature was 39 °C and a curettage of infected retained tissue was performed. It was concluded that the infection had accelerated a slowly developing peripartum cardiomyopathy. She died 12 days after giving birth from cerebral herniation as a result of repeated ischaemic episodes.

Hypertensive disease in pregnancy

Nine women died of severe pre-eclampsia. One of the women had known pre-gestational hypertension. Seven of the women died from a combination of very high blood pressure, coagulopathy and eclamptic seizures, leading to intracerebral haemorrhage and herniation; one died from pulmonary oedema and one from a ruptured liver. Furthermore, one woman died of gestational hypertension with cerebral haemorrhage. The women died between 27 weeks of gestation and five days after giving birth. After 2011, no deaths from preeclampsia were registered.

A 32-year-old healthy primipara had a pre-pregnancy blood pressure of 125/80 mmHg. At 36 + 2, she contacted the labour ward because of severe abdominal pain, nausea and vomiting. Her blood pressure was 149/96 mmHg.

Her pain was interpreted as being of musculoskeletal origin. Three days later, her husband found her unconscious. Resuscitation at the emergency ward included perimortem caesarean section (CS). A ruptured liver was found. Both mother and child died. A blood test showed haemolysis, elevated liver enzymes (alanine aminotransferase 590 U/l) and low platelets (22 × 10^9/l).

Suicide

Ten women committed suicide within 42 days of a pregnancy, leading to a maternal suicide rate of 1.0 per 100,000 live births, six of whom had a known pre-pregnancy psychiatric history. Only one woman committed suicide while pregnant.

Venous thromboembolism

Seven women died of venous thromboembolism, four of whom died while pregnant (gestational ages ranging from 6 to 27 weeks). Three died within six weeks after a pregnancy. Only one had no risk factors. After 2010, no deaths were registered.

A 32-year-old woman with a BMI of 31 kg/m^2 had a CS because of breech presentation and large fibromas. Perioperative bleeding was 2,200 ml and thrombo-prophylaxis was prescribed, but because of the haemorrhage, administration met with reluctance. When she was mobilised 24 hours postoperatively, she had a cardiac arrest. Autopsy showed large bilateral pulmonary embolisms, deriving from the pelvic veins.

Genital sepsis

Six women died of sepsis, five of whom had direct obstetric infections. One woman died of an *Escherichia coli* sepsis ten days after an emergency cerclage and one died from sepsis with multiorgan failure three days after preterm rupture of membranes. Three women died of aggressive group A streptococcal (GAS) infection: One developed a puerperal infection with toxic shock syndrome after an uncomplicated vaginal delivery (case below); another woman, who weighed 140 kg, developed necrotising fasciitis after an emergency CS; and the third had sepsis in a twin pregnancy starting with gastrointestinal symptoms. She died within 24 hours of the first symptom.

A woman, who did not speak Danish, had an uncomplicated delivery. In the following days, she repeatedly contacted the emergency unit due to pain in one leg. Four days after giving birth, she was admitted to hospital due to sepsis. She ran a high temperature and deteriorated rapidly. Furthermore, she developed epidermolysis of one leg. Laparotomy revealed a cyanotic uterus and necrotic ovaries. Despite undergoing a hysterectomy, intensive care and high doses of broad-spectrum antibiotics, her condition accelerated to multi-organ failure and death within 48 hours of admission.

Obstetric haemorrhage

Four women died of haemorrhage, one died postpartum due to uterine atony after an uncomplicated delivery; one in week 37 of abdominal haemorrhage due to undiagnosed placenta percreta; and one of unrecognised intraperitoneal bleeding complicating an emergency CS. She had received thromboprophylaxis during pregnancy due to cardiac valve disease. The fourth woman died of a uterine rupture.

This woman had a BMI of 46 kg/m^2 and a CS three years earlier. She was induced with a balloon catheter in week 39 because of high blood pressure and gestational diabetes. This was followed by 3 mg of dinoproston because the cervix was still closed. After a sudden drop in blood pressure, the foetus died and the woman had a cardiac arrest soon thereafter. The autopsy revealed a uterine rupture and two litres of blood in the abdomen.

Neurological deaths

Six women died from non-preeclamptic cerebral haemorrhages or epilepsy.

Diabetes

Two women with pre-gestational insulin-dependent diabetes mellitus died. They both had unstable diabetes and several episodes of hypoglycaemia with unconsciousness during pregnancy. They were both found dead in their homes at 27 and 28 weeks of gestation, respectively. In neither cases was it proven that hypoglycaemia was the cause of death.

Amniotic fluid embolism

Two women died from amniotic fluid embolism, one while pushing in a bathtub. She suddenly lost consciousness and could not be resuscitated. The other woman had labour induced due to a high blood pressure and lost consciousness during labour. An emergency CS followed by a hysterectomy because of excessive bleeding was performed. She had a cardiac arrest in the operation room. In both cases, the autopsy concluded that an amniotic embolism was the cause of death.

Early pregnancy complications

Two women died from early pregnancy complications. One was admitted for severe abdominal pain at seven weeks of gestation. An intrauterine foetus was visible by ultrasound. She died in hospital seven hours after admittance. The autopsy showed a ruptured cornual pregnancy. The other woman was admitted for termination of pregnancy. Her uterus was empty with a 4 mm endometrium, but her P-human chorionic gonadotropin level (hCG) was elevated (8,236 U/l). She had no pain. Her P-hCG decreased to 7,131 U/l; but three days later, she was found dead in her home with a ruptured ectopic pregnancy.

Other causes of death

Included internal herniation after gastric bypass, pulmonary fibrosis, dissection of the splenic artery and severe asthma.

When the audit group assessed each case, it identified suboptimal care in 43% (30/70 cases). In 34% (24/70 cases), this was categorised as major suboptimal care.

DISCUSSION

Cardiovascular disease was the leading cause of maternal death, which is in accordance with findings in the other Nordic countries and the UK [7-9]. One possible explanation is that the pregnant population is getting older and that women with cardiac disease are rarely discouraged from pregnancy. It is recommended that women with cardiac risk factors or a known heart disease receive counselling before a planned pregnancy, and that they be referred to a multidisciplinary team of cardiologists and obstetricians early in pregnancy [10] (**Table 2**). Cardiac symptoms may resemble pregnancy symptoms. In several cases, we found that early signs of cardiac disease were misinterpreted, thus leading to a delay in medical management.

TABLE 2 General recommendations based on cases of maternal death.

Pre-pregnancy counselling is recommended if a pre-existing medical disease exists
Awareness of early clinical signs of severe illness or complications in pregnancy is important
Appropriate multidisciplinary specialist care is required in a pregnancy with severe medical complications
Severely ill women should only be transferred after stabilisation and if transfer is vital for her survival
Appropriate examination and treatment should always be prioritised in critically ill pregnant women
The woman's life should always be given priority over the baby's well-being
The use of an interpreter is essential if the woman does not speak Danish

Two women died from peripartum cardiomyopathy, a condition seen in one in 10,000 deliveries in Denmark. Onset is often late in pregnancy or within the first months after delivery. As the condition is rare and seen in women with no cardiac history, early symptoms may be misinterpreted [11].

Pregnancy increases the risk of vessel dissection in women with risk factors like hypertension, bicuspid aortic valve, Marfan, Turner or Ehlers-Danlos syndrome, which were found in several cases, but not always optimally managed.

No deaths from preeclampsia were registered after 2011. Based on guidelines, medical care in severe preeclampsia has become increasingly evidence based, with low-dose aspirin prophylaxis, lower blood pressure limits, peripartum fluid restriction and use of magnesium [12]. Recently, induction of labour as from 37 weeks also seems to reduce morbidity [13].

Similar improvements were seen concerning deaths from venous thromboembolism, the risk of which increases from early pregnancy and peaks just after delivery [14]. Improvements may be explained by widespread implementation of thromboprophylaxis as recommended in risk pregnancies, during immobilisation and preeclampsia, and after CS and severe postpartum haemorrhage [15].

After identifying five deaths due to genitally derived sepsis, three of which were GAS septicaemia, leading to the rapid death of otherwise healthy women, we focused on GAS. Cases and recommendations were presented at national meetings, and a guideline was published focusing on early signs of severe infection and clinical characteristics and on the importance of early treatment with antibiotics and radical surgical revision. No maternal deaths from GAS were registered after 2004.

The only deaths that did not decrease were suicides, which underpins the importance of continuously focusing on early recognition of vulnerability in pregnant women and on multidisciplinary cooperation when treating women with a psychiatric history. The maternal suicide rate was 1.0 per 100,000 live births. Based on data from the Danish Suicide Register and from Statistics Denmark, the suicide rate of an age-matched Danish female population (15-49 years) in the same period was 5.0 per 100,000 people. This corroborates studies showing a protective effect of pregnancy against suicides [16]. About 10% of pregnant women in Denmark need special care due to psychiatric or social vulnerability. Reports on maternal death have concluded that vulnerability and social seclusion increase the risk of dying from a pregnancy-related psychiatric condition [17].

In another study, we found a maternal mortality rate of 7.0 per 100,000 live births [6], which represents a decrease compared with a previous study on maternal death in Denmark [18]. Multiple factors may have contributed. Importantly, organisational changes in Denmark have led to fewer obstetrical centres with in-house obstetricians, access to intensive care and collaboration with a broad spectrum of medical specialties.

Furthermore, national guidelines under the auspices of the DSOG have been in place since 1997, including guidelines drawn up in collaboration with other medical societies, leading to uniform evidence-based management of severe complications in pregnancy [12]. Finally, the implementation of multi-professional obstetric team training may have been a contributing factor in improving treatment of maternal complications [19, 20].

Our results are in line with recently published data from all the Nordic countries based on data from 2005-2017 [9]. However, maternal death rates are still much higher in other parts of the world with an estimated MMR of 415/100,000 live births in the least developed countries [6].

CONCLUSIONS

We found low and decreasing maternal mortality rates [6], but women still suffer critical illness during pregnancy and childbirth, and potentially avoidable deaths should be reduced even further. Hence, it is essential that severe maternal morbidity and mortality are subject to ongoing surveillance, and this will be a future focus area of the Danish maternal mortality and morbidity audit group.

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