Maternal deaths in Norway 2005–2009

BACKGROUND Norway has low maternal mortality, but such deaths are underreported even in high-income countries. Our goal was to identify the exact number of maternal deaths, the causes of death and the potential for improvement through medical care in Norway.

MATERIAL AND METHOD We traced maternal deaths in the period from 1 January 2005 to 31 December 2009 by linking the Medical Birth Registry and the Cause of Death Registry, supplemented with data from maternity clinics. We identified the cause of death and the lessons that could be learned by a meticulous review of each case.

RESULTS We found 26 maternal deaths during the period, 14 of which were due to direct causes and 12 to indirect causes. The maternal mortality ratio was 8.7/100 000 live births. Fourteen of the deaths were registered in official statistics. Of the 12 deaths that were not included in the statistics, 11 were found through matching the registers and one had been reported directly by the hospital. The most common causes of death were hypertensive disorders during pregnancy (n = 6), thromboembolism (n = 4) and mental illness (n = 4). None of the deaths due to thromboembolism appeared in official statistics. The same applied to nine of the 12 indirect maternal deaths. We found a potential for improved medical care in 14 of 26 cases. Half of these were deaths due to hypertensive disorders during pregnancy or thromboembolism.

INTERPRETATION Maternal death was considerably underreported in Norwegian official statistics during the period studied. Greater attention should be given to better blood-pressure treatment, stabilisation and timely delivery in the case of hypertension during pregnancy, and to screening for possible pulmonary embolism. The same applies to mental illness and internal medical disorders in pregnant women.

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Appendix at www.tidsskriftet.no/vangenengappendiks

Obstetric aid in Western countries has undergone major changes in the last decades and the number of women who die in connection with pregnancy has been substantially reduced. The decline in maternal deaths after the Second World War is one of the most impressive health impacts the world has ever witnessed. Institutional births and improved intensive care medicine offering options such as transfusions, treatment with antibiotics and operative deliveries have played a key role. Nevertheless, despite improved treatment women still die in connection with pregnancy and birth.

The registration of births and deaths is a fundamental public health responsibility. In Norway maternal deaths are registered on the death certificate, which often lacks information about pregnancy. The deaths are then registered in the Cause of Death Registry and form part of the cause of death statistics that Statistics Norway publishes regularly on its website, but often they are not registered as maternal deaths.

Experience from other European countries and the US shows that registration based on the death certificate alone is characterised by 40–60 % underreporting (1). A recent Swedish study showed 64 % underreporting of maternal deaths (2). Linking the medical birth register and the cause of death register can result in a considerable improvement in registration. This method was used in the latest survey of direct maternal deaths in Norway for the period from 1975 to 1995. The survey identified 5.5 direct maternal deaths per 100 000 births (3).

Hypertension during pregnancy was the major cause of death, followed by thromboembolism. The definition of maternal death in ICD-10 includes both direct and indirect deaths (Box 1), but we lack knowledge about indirect maternal deaths in Norway.

The UK has a well-developed system for reporting and investigating maternal deaths. For more than 60 years the Centre for Maternal and Child Health Enquiries (CMACE) has systematically reviewed all such deaths (4). In recent years greater attention has been paid to what can be learned, and reports from this work show an increased number of cases with indirect causes of death. Cardiac diseases have been the main cause of death since 2000. Mental illness is also an important indirect cause of death in the UK (4).

In 2010 gynaecologists with a special interest in the topic established the Norwegian audit group for maternal deaths in cooperation with the Norwegian Society for Gynecology and Obstetrics. Experienced gynaecologists from all the health regions in Norway take part while other specialists are invited to participate as required. At present this is organised as a research project and the group is part of a Nordic collaboration. The primary goal is to learn from adverse incidents in obstetrics.

MAIN MESSAGE

We identified 26 maternal deaths in a five-year period, 14 of which were reported in official statistics

Hypertensive disorders during pregnancy and thromboembolism were the most common direct causes of death

Mental illness was the most common indirect cause of death

Different medical care or organisation might have helped prevent half of the direct maternal deaths

Suboptimal factors may have contributed to a third of the indirect deaths

The aim of this study was to describe the incidence, causes of death and lessons to be learned from direct and indirect maternal deaths in Norway in recent years. We also investigated which deaths did not appear in official statistics.

Material and method

We collected data on maternal deaths occurring in Norway in the period from 1 January 2005 to 31 December 2009. Cases were identified by linking the Medical Birth Registry and the Cause of Death Registry. The officer responsible at the Cause of Death Registry transmitted data on all deaths of women aged 15 to 49 to the Medical Birth Registry. The data coordinator at the Medical Birth Registry linked information about deaths to information about births using personal identity numbers.

Cases where the date of death was given as ≤ 42 days after delivery were included in the study. Cases from the Cause of Death Registry coded O in accordance with ICD-10 (pregnancy, birth and post-natal period) which the matching of the registers had not elicited, were included in order to identify women who had died before giving birth. In addition, we traced cases from all maternity clinics in Norway directly.

The head of project (SV) collected detailed medical information, including laboratory samples and autopsy reports from the hospitals, and sent de-identified information to the members. The deaths were collated with Statistics Norway's official statistics (5), which are reported to the World Health Organization (WHO).

Working in pairs, we examined each case, and followed this by a plenary discussion. Each individual case was classified according to joint Nordic criteria and registered on a classification form used in Denmark, Sweden, Finland, Iceland and Norway, see *www.tidsskriftet.no/vangenengappendiks*. The form is a modified version of the CMACE classification form used in the UK (4).

Direct causes of maternal death were classified as hypertension during pregnancy, thromboembolism, haemorrhaging, amniotic fluid embolism, genital tract sepsis and other direct causes of death. Indirect maternal deaths are attributable to pre-existing illnesses that can be aggravated during pregnancy. These were classified as mental conditions, cardiac diseases, non-genital infections, diseases of the central nervous system, endocrine diseases, cancer (estrogen-dependent cancers, e.g. breast cancer) and other indirect causes (3).

Contributory suboptimal factors in medical care were classified on four levels based on the modified CMACE form:

- Level 0. No suboptimal factors
- Level 1. We can learn lessons from the suboptimal factors but it is unlikely that they contributed to the death
- Level 2. Suboptimal factors may have contributed to the death
- Level 3. Suboptimal factors have possibly contributed to the death. Different medical care or organisation could have prevented the death

On the basis of the overall data on cause of death and any suboptimal factors, we formulated learning points for each case. The maternal death ratio was calculated as the total of all direct and indirect maternal deaths per 100 000 live births.

Ethics

The study was approved by the regional ethics committee on 16 December 2010, document reference 2010/2854–6.

Results

We identified 26 maternal deaths altogether in the period from 1 January 2005 to 31 December 2009. Fourteen of these were directly related to pregnancy and 12 indirectly related. The maternal mortality ratio was 8.7/100 000 live births based on a total of 299 154 live births in this five-year period.

Fourteen maternal deaths were registered in official statistics during the same period (5), giving a maternal death ratio of 4.7 (Table 1).Two deaths registered in the official statistics were excluded since they occurred more than 42 days after delivery and were not covered by the definition of maternal death. Of the 12 deaths that were not included in the official statistics, eleven were found through matching the registers. In addition, one had been reported directly by the hospital concerned.

We found four deaths caused by thromboembolism. None of these appear in official statistics – three were not registered and one was wrongly classified as a death due to hypertension during pregnancy. Furthermore, nine of 12 indirect maternal deaths were not included in the official statistics. The three indirect deaths that were registered in the official statistics were caused by diseases of the central nervous system or by cardiac diseases.

Table 2 shows causes of death and level of suboptimal factors for both direct and indirect deaths. Hypertension during pregnancy was the most common underlying cause of death (n = 6). Symptoms and findings were described as including rise in blood pressure in the region of 220/120 mm Hg, headache, vomiting, stomach pains and later unconsciousness or severe respiratory problems. The direct cause of death was, for example, cerebral haemorrhage or respiratory collapse. Emergency perimortem Caesarian section had been carried out in half of the patients with hypertension during pregnancy.

BOX 1

In ICD-10 a maternal death is defined as «the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to (direct maternal deaths) or aggravated by the pregnancy or its management (indirect maternal deaths), but not from accidental or incidental causes».

Thromboembolism was the second most common cause of death (n = 4). Other direct causes of death included postpartum haemorrhage, amniotic fluid embolism, genital tract sepsis following the performance of cerclage and acute fatty liver.

Mental illness (suicide) was the most common indirect cause of death (n = 4). Other indirect causes were cardiac disease, disorders (haemorrhages) of the central nervous system, infection outside the genital tract, endocrine diseases, cancer and liver dysfunction.

In a review of all cases, we found a potential for improved medical care (level 2 or level 3) in 14 out of 24 deaths (Table 2).

The potential for improvement was greatest for deaths caused by hypertension during pregnancy and thromboembolism. In our assessment of suboptimal factors we concluded that better blood pressure treatment and more active monitoring of breathing difficulties would probably have preven-

Table 1 Overview of identified maternal deaths in our study compared with maternal deaths registered in the official cause of death statistics for the period from 1 January 2005 to 31 December 2009. Cause of death statistics are based on data from the Cause of Death Registry and are published on the website of Statistics Norway (5)

Year	This study	Official statistics
2005	5	2
2006	6	5
2007	8	5
2008	2	2[1]
2009	5	0[1]
Total	26	14

[1] One case has been omitted from the overview because it occurred > 42 days after delivery

Table 2 Overview of causes of death collated with level of suboptimal factors in the medical care. The level is allocated following a discretionary assessment of each individual case and is based on the division in the registration form (Vangen appendix)

	Level of suboptimal factors[1]			
	0	1	2	3
Causes of death				
Direct (n = 14)				
Hypertensive disorders during pregnancy	1			5
Thromboembolism	2			2
Other	1		3	
Indirect (n = 12)				
Psychiatric conditions		2	2	
Cardiac diseases	1		1	
Diseases of the central nervous system	2			
Other	3		1	
Total	**10**	**2**	**7**	**7**

[1] Level 0: No suboptimal factors. Level 1: Lessons can be learned from suboptimal factors but it is unlikely that they contributed to the maternal death. Level 2: Suboptimal factors may have contributed to the death. Level 3: Suboptimal factors have possibly contributed to the death. Different care or organisation might have prevented the death.

ted five of six deaths due to hypertension during pregnancy, and two out of four deaths due to thromboembolism. Moreover, we found that suboptimal medical care might have contributed to four indirect deaths.

Discussion

Altogether we found 26 direct or indirect maternal deaths, giving a maternal death ratio of 8.7/100 000. This is twice as high as reported in official statistics. Hypertension during pregnancy was the main cause of death, followed by thromboembolism and mental illness. Our assessment is that suboptimal factors in medical care may possibly have contributed to half of the direct maternal deaths. In addition, suboptimal factors in medical care may have contributed to one-third of the indirect deaths.

Similar death patterns are reported by several European countries (3, 4, 6, 7). The results also correlate with previous studies in Norway (3, 8). Andersgaard and colleagues found a high rate of caesarian section among the direct deaths. Contrary to the results of our study, several deaths were attributed to complications arising during the operation and not to the underlying reason for the surgical procedure. In theory the majority of direct maternal deaths are unavoidable. Our study reveals that there is still a preponderance of direct deaths.

In line with Andersgaard and colleagues, we assessed that suboptimal factors in medical care may have contributed to a large proportion of the direct maternal deaths. In five of six deaths due to hypertensive disorders during pregnancy our assessment was that level 3 suboptimal factors were present, i.e. suboptimal factors may have contributed to the deaths, and different care or organisation could have prevented them.

Improving treatment of blood pressure is important. In 2006 the Royal College of Obstetricians and Gynaecologists recommended treating pregnant women with systolic blood pressure of > 150–160 mm Hg (9). These recommendations now also apply in Norway (10). Women with life-threatening high blood pressure must receive immediate help to reduce their blood pressure as fast as possible, and their response to the medication must be monitored.

In two out of four deaths due to thromboembolism we assessed suboptimal factors at level 3. More active screening to exclude pulmonary embolism in the case of breathing difficulties and chest pains in pregnancy or the postpartum period appears to be important. Postpartum haemorrhaging was a direct cause of death. In such cases adequate and timely treatment is decisive.

As far as we know, our study is the first to give an overview of indirect maternal deaths in Norway. Experience from the UK shows that the proportion of indirect deaths due to the aggravation of pre-existing diseases in women is increasing (4). There is much to indicate that we will experience the same development in Norway.

Mental illness was the most important indirect cause of death in our material, and this correlates with UK results (4). The finding gives food for thought and underlines a need to direct attention to mental disorders in pregnant women (11). In our view, deficient follow-up may have contributed to the deaths in our material. Previous experience of depression is a risk factor for postpartum depression, and as a rule depression already occurs during the pregnancy (12).

Experience from other countries shows that indirect deaths caused by cardiac diseases are on the increase (4). This type of disease was also one of the causes of death in our material, and suboptimal medical care may have contributed. However, we found no deaths attributable to complications resulting from congenital heart disorders – a factor which plays a key role in other countries (4).

Our results indicate that maternal mortality in Norway is on the same level as that reported in Denmark (9.4/100 000), somewhat higher than in Sweden (6.5/100 000), but lower than in the UK (11.3/100 000) and the Netherlands (10.8/100 000) (2, 4, 6, 7). In comparison the official maternal mortality ratio Norway reported to WHO was 4.7/100 000 for the same period.

In countries where the reporting of maternal deaths is based on the death certificate alone, WHO automatically multiplies the ratio by 1.5. However, our findings suggest that this is insufficient. The matching of registers in our study traced 11 of 12 deaths that did not appear in the official statistics. Similar findings have been made in other countries (1, 2, 4).

This shows that routine linking of birth and death registers combined with direct reporting from hospitals is a method that can give a more exact estimate of maternal mortality in Norway. We are of the opinion that linking registers combined with the introduction of a rubric in the death certificate where pregnancy in the previous year can be indicated will contribute to more accurate official statistics, particularly in the case of indirect maternal deaths.

Making the exact registration and auditing of maternal deaths possible should be a public administration responsibility. The regional ethics committee has given the Norwegian audit group for maternal deaths permission to continue the work as a research project up to 2025. Routine reviews will also facilitate the follow-up of the development over time.

Classifying causes of death is challenging. The professional expertise and broad composition of the audit group and its cooperation

with other Nordic countries is a strength. Tracing cases by matching the Cause of Death register and the Medical Birth register has also proved to be a key factor. Both of these registers are almost complete.

Nevertheless we cannot rule out that some cases have not been registered. We can easily imagine that the risk of inadequate reporting of births increases when dramatic events occur. Incomplete death certificates may also have contributed to deficient registration. The relatively low number of deaths may have affected the cause of death pattern, but the finding that hypertensive complications are the main cause of death appears to be stable (3).

Conclusion

Deaths of mothers in connection with pregnancy and birth are considerably underreported in Norway. We found more than twice as many as were registered in the official statistics. Our results indicate that better medical care would probably have prevented half of the direct maternal deaths.

Greater attention to improving blood pressure treatment and more active screening to rule out pulmonary embolism in the case of breathing difficulties and chest pains during pregnancy or the postpartum period appear to be important. Even though no indirect deaths were assessed as being preventable by different treatment (level 3), many lessons can be learned from these cases.

The large proportion of deaths caused by medical illnesses shows the need for an inter-disciplinary team of obstetricians and other specialists with knowledge of internal medical disorders in pregnant women. Willingness to consult colleagues and other specialists internally or from other hospitals in difficult situations is crucial.

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