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Maternal mortality in Denmark, 1985–1994

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ABSTRACT

Objectives: In Denmark, maternal mortality has been reported over the last century, both locally through hospital reports and in national registries. The purpose of this study was to analyze data from national medical registries of pregnancy-related deaths in Denmark 1985–1994 and to classify them according to the UK Confidential Enquiry into Maternal Deaths (CEMD).

Study design: All deaths of women with a registered pregnancy within 12 months prior to the death were identified by comparing the Danish medical registries, death certificates, and relevant codes according to International Classification of Diseases (ICD-10). All cases were classified using the UK CEMD classification. Cases of maternal death were further evaluated by an audit group.

Results: 311 cases were classified. 92 deaths (29.6%) occurred ≤ 42 days after termination of pregnancy. Of these, 30 were classified as *direct* obstetric deaths, 30 as *indirect* obstetric deaths, and 32 as *fortuitous* deaths. Among the *late* pregnancy-related deaths (>42 days), 1 woman died from a direct obstetric cause, 46 from indirect causes, and 172 from fortuitous causes. Hypertensive disorders of pregnancy were the major cause of *direct* maternal deaths. The rate of maternal deaths constituted 9.8/100,000 maternities (i.e. the number of women delivering registrable live births at any gestation or stillbirths at 24 weeks of gestation or later).

Conclusion: This is the first systematic report on deaths in Denmark based on data from national registries. The maternal mortality rate in Denmark is comparable to the rates in other developed countries. Fortunately, statistics are low, but each case represents potential learning.

Obstetric care has changed and classification methods differ between countries. Prospective registration and registry linkage seem to be a way to ensure completion. This retrospective study has provided the background for a prospective study on registration and evaluation of maternal mortality in Denmark.

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1. Introduction

Any pregnancy-related death is a tragedy to the relatives and to the professionals involved.

Over the last century, registration of maternal deaths shows decreasing figures especially in the developed countries but global

differences are considerable. The number of maternal deaths in the third world is similar to the numbers of Western Europe a century ago [1–4].

The Danish medical registers provide a unique possibility to identify and link data concerning medical and obstetric morbidity and mortality with data on causes of death [5].

Every Danish inhabitant has a personal identification number (Central Personal Registration number (CPR)) and patients admitted to hospitals are registered in the National Patient Registry (NPR) by diagnosis and surgical procedures. From the NPR, all births are registered in the Medical Birth Registry (MBR) and all deaths are registered by death certificates in the Causes of Death Registry (CDR). Using CPR numbers, it is possible to link data from all these registries.

The Danish National Board of Health is responsible for all national health registries. Previous reports from other developed

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Abbreviations: AFEa, amniotic fluid embolism; CDR, The Causes of Death Registry; CEMD, Confidential Enquiries into Maternal Deaths; CPR, Central Personal Registration number; CS, Caesarean section; DICd, disseminated intravascular coagulation; EUGe, extrauterine gestation; GA, gestational age; HELLP, haemolysis, elevated liver enzymes, low platelets; ICD-10, International Classification of Diseases, Version 10; NPR, The National Patient Registry; MBR, Medical Birth Registry; UK, United Kingdom.

countries have shown rates of maternal death from 7 to 12 per 100,000 live births. However, the methods of registering maternal mortality vary greatly [1–4,6–8]. Identifying cases of maternal mortality includes autopsy reports, medical reports, death certificates, local and national registries, personal reports to local committees and interviews with family and health care providers. This is the first systematic report on maternal deaths in Denmark based on national registries.

In the United Kingdom (UK), maternal deaths have been registered systematically since 1952 (Confidential Enquiries into Maternal Deaths (CEMD)) [8–10]. By subgrouping deaths from obstetric or other medical reasons of death, the CEMD has been able to draw attention to high-risk groups among pregnant women and to identify avoidable or substandard factors.

The purpose of this study was to analyze maternal mortality over a 10-year period as well as to design and describe a model for prospective registration and evaluation of maternal deaths in Denmark, using data based on a linkage between different medical registries in Denmark over a 10-year period (1985–1994). In addition, the registry data on maternal deaths were evaluated and compared to data from other registries.

2. Study design

All female deaths in Denmark from 1985 to December 1994 with a pregnancy registered less than 12 months prior to the death (*pregnancy-related death*) were identified by comparing data from the medical registries (CDR, MBR and NPR). The relevant cases were compared with the NPR in order to identify relevant ICD-10 codes. All cases were classified according to the CEMD classification based on the registered ICD-10 codes and the information from the death certificate [8–10] (Table 1).

The UK classification introduced by the CEMD is applied in this study. All deaths within 42 days of delivery, miscarriage or termination of pregnancy from any cause related to or aggravated by pregnancy or its management but not from accidental or incidental causes, were classified as *maternal deaths* (Fig. 1) [8]. As in the CEMD, we defined *direct* maternal deaths as resulting from “obstetric complications of the pregnant state (pregnancy, labour

Table 1
CEMD classification edition.

Classification of maternal deaths	
Direct deaths	Thrombosis and thromboembolism
	Hypertensive disease of pregnancy
	Haemorrhage
	Amniotic fluid embolism
	Early pregnancy deaths
	Infection/sepsis
	Anaesthetic
	Other
Indirect deaths	Cardiac
	Psychiatric
	Other
Fortuitous	Suicide
	Murder/violence
	Accident
	Cancer
	Other non-obstetric causes or unknown cause
Late maternal deaths	Obstetric
	Fortuitous

and puerperium), from interventions, omissions, incorrect treatment or from a chain of events resulting from any of the above” and *indirect* maternal deaths as resulting “from previous existing disease or disease that developed during pregnancies, which were not due to direct obstetric cause, but which were aggravated by the physiologic effects of pregnancy”. *Fortuitous* maternal deaths were defined as “deaths from unrelated causes which happened to occur in pregnancy or puerperium”. *Late* maternal deaths occurred between 42 days and 1 year after termination of pregnancy, miscarriage or delivery due to direct or indirect maternal causes. The non-obstetric deaths were classified as a result of suicide, murder/violence, accident, cancer, other non-obstetric causes or unknown cause (Table 1). Until 1994 all deaths from suicide were classified as fortuitous maternal deaths.

The following data were recorded: date and reason for last hospital admittance due to a pregnancy-related cause; date of death; data on post-mortem examinations; data on pregnancy-

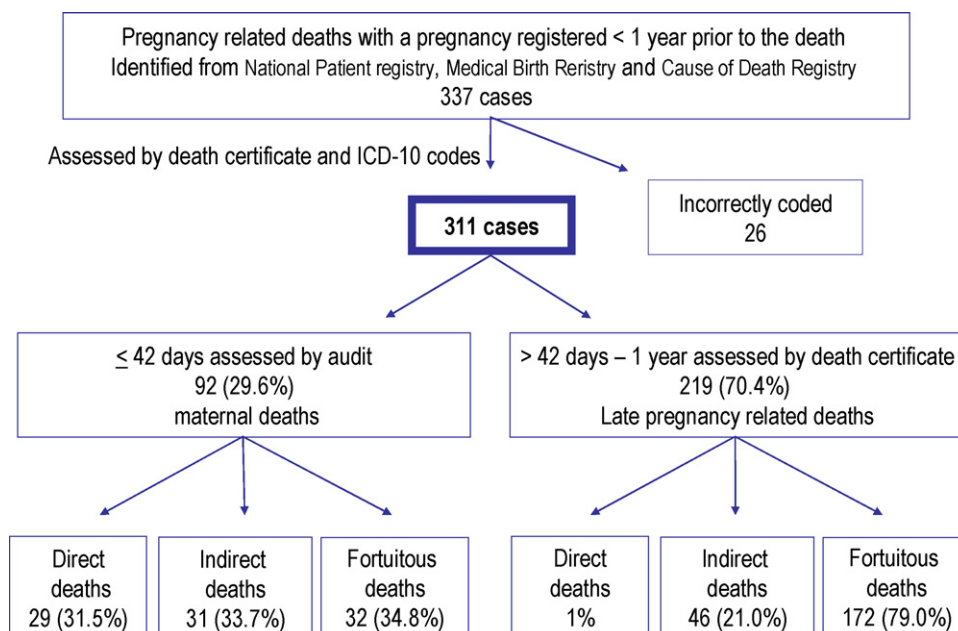


Fig. 1. Classification of maternal deaths 1985–1994.

related causes of death; notification of a previous history of psychiatric disease or psychosis after delivery; information from the death certificate as regards drug or alcohol abuse.

By initial registry linkage we identified 337 cases of maternal death either dying while pregnant or dying within 1 year from termination of pregnancy. Twenty-six cases were incorrectly coded and excluded, leaving 311 cases eligible for classification. Ninety-two women died within 42 days from the termination of pregnancy and 219 women died between 42 days and 1 year from the termination of pregnancy (*late deaths*).

Following primary classification of all pregnancy-related deaths into maternal deaths (*direct* and *indirect*) and *late deaths*, we applied for hospital records concerning all maternal deaths.

We asked for the hospital records of all 92 women who died within 42 days of termination of pregnancy. Eighty (87%) records were returned to us from the hospitals for further analysis.

When a hospital record was available, information on the last pregnancy-related contact with the hospital was used for further classification (Fig. 1). A group of four senior obstetricians (JLS, BB, TW, MM) with previous audit experience and two junior obstetricians (BRA and HBW) who reviewed all the cases of maternal death decided on the subclassification. Each case was analyzed separately, comparing data from death certificates, ICD-10 codes and hospital records. Discrepancies concerning classification were discussed until an agreement was reached among the members of the group. A few cases of disagreement were further discussed with the Director of the UK CEMD, who then made the final decision.

Data on age-related causes of death from cancer and suicide were obtained from the NPR and CDR [5].

The rate of maternal death was calculated as deaths from obstetric causes per 100,000 maternities, “obstetric causes” being *direct* and *indirect* causes of death and “maternities” being the number of pregnancies resulting in a live birth at any gestation and stillbirths occurring at 26 weeks of gestation or later, i.e. the majority of women at risk of dying from obstetric causes. (In Denmark termination of pregnancy prior to 26 weeks of gestation is classified as an abortion.)

The data were analyzed by the Statistical Package for Social Sciences. The study was approved by the local ethics committee and the Danish Data Protection Agency.

3. Results

A total of 337 pregnancy-related deaths in the period 1985–1994 were identified through the national registries and death certificates. Of these, 26 were excluded because of incorrect ICD-10 codes or missing information on cause of death, leaving 311 pregnancy-related deaths for further subclassification (Fig. 1). During the years 1985–1994, 612,786 maternities (618,021 live births) were registered.

During the period 1985–1994, there were 29 *direct* and 31 *indirect* maternal deaths, 32 *fortuitous* deaths less than 42 days after the pregnancy-related contact, and 219 *late pregnancy-related deaths*, of which 47 were *late maternal deaths* (Table 2). According to the CEMD classification, the rate of maternal mortality constituted 9.8 per 100,000 maternities, while the rate of fortuitous causes amounted to 5.2 per 100,000 maternities.

Of the 60 maternal deaths, 29 were classified as *direct* obstetric deaths and 31 as *indirect* obstetric deaths (Table 2). Table 3 briefly describes each case of *direct* maternal death. For further details on each case please contact the authors.

Deaths related to hypertensive disorders of pregnancy were the major cause of *direct* maternal deaths (Table 2), comprising one

Table 2
Pregnancy-related deaths.

		Time of death	
		≤42 days	>42 days (Late)
Direct deaths	Thrombosis and thromboembolism	6	0
	Hypertensive disease of pregnancy	9	0
	Haemorrhage	2	0
	Amniotic fluid embolism	4	0
	Early pregnancy deaths	3	0
	Infection/sepsis	4	0
	Anaesthetic	1	1
	Total	29	1
Indirect deaths	Central nervous system	7	15
	Cardiac	9	7
	Other: infectious	5	5
	Diabetes	1	1
	Neoplastic	4	1
	Respiratory	3	3
	Blood	0	1
	Other	2	13
	Total	31	46
Fortuitous deaths	Suicide	9	61
	Murder/violence	3	15
	Cancer	4	49
	Accident	15	44
	Other non-obstetric or unknown cause	1	20
	Total	32	172
Total	92	219	

case of essential hypertension, three cases of pre-eclampsia, two cases of eclampsia, and four cases of HELLP syndrome.

Deaths caused by traffic accidents represented the majority (15 (47%)) of the 32 fortuitous deaths <42 days after the pregnancy-related contact.

Of the 219 *late pregnancy-related deaths*, 47 constituted *late obstetric deaths* of which only 1 was a *direct* obstetric death (Table 2). 172 *late pregnancy-related deaths* resulted from fortuitous causes, and the majority died from suicide (61 (35.5%)) (Table 3).

According to the death certificates, 45 of the 61 (74%) women who committed suicide had a previous psychiatric history, and 13 (21%) had a history of alcohol or drug abuse. Twenty-nine women (47%) committed suicide after a legal abortion (of these, 4 were within 42 days of termination), and 23 (37%) after delivery (1 was within 42 days of delivery).

Over the 10-year period, the mortality rate resulting from suicide was 9.9 per 100,000 maternities compared to 13.6 per 100,000 women of fertile age (15–49 years). The mortality rate resulting from cancer constituted 8.8 per 100,000 maternities compared to 38.1 per 100,000 women of fertile age (15–49 years).

The average age of death was 30.9 years. No differences related to the age of death existed among the groups. The average age among all women giving birth during the same period was 28.4 years.

4. Discussion

Modern antenatal and obstetric care has influenced the maternal mortality rate. Furthermore, different methods have been used to improve identification and classification of maternal deaths.

Comparing registries, we discovered tendencies in the distribution of maternal deaths. Noticeably, a higher rate of fortuitous and late deaths were found than by the UK CEMD [8,10], perhaps resulting from more comprehensive data from the registry

Table 3

Description of the direct maternal deaths.

Subgroup	Gestational age at admission	Type of delivery	Death days	Diagnostics supporting diagnosis	Autopsy	Classification reliable
1. Thrombosis	39	Vaginally	28	+	+	+
2. Thrombosis	29 ^a	CS	21	+	+	+
3. Thrombosis	20	No	15	+	+	+
4. Thrombosis	31	CS ^b	2	+	–	+
5. Thrombosis	20 ^a	Vaginally-induced	4	–	+	+
6. Thrombosis	33	CS	3	+	+	+
7. Eclampsia HELLP	39	CS	21	+	–	+
8. Eclampsia	32 ^a	No	0	+	–	+
9. Eclampsia abruption	39 ^a	No	0	–	+	–
10. Preeclampsia HELLP	41	Vaginally-vacuum extraction	0	+	–	+
11. Preeclampsia HELLP	40	Vaginally	0	+	–	+
12. Eclampsia	26	No	0	+	–	+
13. HELLP	27	No	0	+	–	+
14. Preeclampsia DIC	40	Vaginally	0	+	–	+
15. Eclampsia	34	CS	0	+	–	+
16. Haemorrhage	29	CS	0	+	–	+
17. Haemorrhage	40	CS	0	+	–	+
18. Amniotic fluid embolism/haemorrhage	40	Vaginally	0	+	+	–
19. Amniotic fluid embolism	40	Vaginally	0	+	+	+
20. Amniotic fluid embolism	41+	Induced/CS ^b	0	+	–	+
21. AFE/incompatible blood transfusion	39	Vaginally VE	0	–	–	–
22. Early EUP	10 ^a		0	+	+	+
23. Early EUP	14 ^a		0	+	+	+
24. Early EUP	Unknown		0	+	+	+
25. Infection	41	Vaginally	2	+	–	+
26. Infection	40	Vaginally	2	+	–	+
27. Infection	22 ^a	Vaginally/induced	0	+	–	+
28. Infection	40	CS	2+	+	–	+
29. Anaesthetic	40	CS	0	+	–	+
30. Anaesthetic	30	CS	Late	+	–	+

AFE = amniotic fluid embolism; EUP = extrauterine pregnancy.

^a Intrauterine fetal death.^b Emergency cesarean section on dying mother, all fetus died shortly thereafter.

comparison between the NPR and the CDR identifying more deaths from non-obstetric causes.

Danish death certificates are filled out on paper forms and do not contain a “pregnancy box” [3]. We identified cases of maternal death not found by registry linkage, who were pregnant according to the death certificate, but not yet seen in the “hospital system”. It would facilitate fast identification of maternal deaths if a notification of pregnancy within the last year was added to the death certificate. By request from the CEMD, such an initiative has been introduced in the UK [8].

In Denmark, one previous article on maternal deaths found 67 maternal deaths from 1970 to 1979 based on death certificates [11]. Maternal deaths before 28 weeks of gestation were not requested from the local departments. The study calculated a maternal mortality rate of 11.4 per 100,000 live births.

The data in the present study are retrospective. This constitutes a limitation of further case assessment in order to identify substandard care. Some of the women would be treated differently today due to new medical knowledge.

Since 1985 pregnant women in Denmark with a history of thromboembolism or thrombosis in pregnancy have been treated with high dose heparin until 4 weeks post-partum. Pregnant women with hypertensive disorders are seen in obstetric care units. The drugs of choice were in 1985, as today, methyldopa, labetalol and nifedipine. In cases of severe pre-eclampsia and eclampsia the drugs of choice in 1985–1994 were hydralazine, phenytoin or diazepam. Magnesium sulphate was introduced in 2003.

In researching registry data, the validity of the ICD-10 coding is essential. In our study, we had to exclude 0.7% of the identified cases due to incorrect ICD-10 classification.

During the last 15 years, the ICD definition of maternal deaths has changed. Consequently, international comparisons will prove

more difficult [12]. In 1989, the ICD-10 classification was approved to define late maternal deaths, including accidental and incidental causes of death. Some countries exclude fortuitous deaths, late deaths, and deaths following early pregnancies [3].

Definitions of maternal mortality differ and are dependent on local guidelines and facilities, and furthermore they are used indiscriminately. Baseline data and the use of the same nominator and denominator are essential for the comparison of maternal deaths. At the same time, rates and ratios are used unsystematically. The CEMD classification defines maternal mortality as the **rate of maternal deaths per 100,000 maternities** (i.e. the number of women delivering registrable live births at any gestation or stillbirths at 24 weeks of gestation or later) [10]. The Dutch classification defines maternal mortality **rate as the number of maternal deaths per 100,000 women of reproductive age** [7]. The Maternal Mortality **Ratio** for international comparison defined by the WHO is the number of direct and indirect maternal deaths per 100,000 live births [9]. Pregnancy-related deaths can occur in relation to both live and stillbirths, therefore live births as denominator seem questionable.

When analyzing data on maternal mortality, the optimal choice of denominator would be the total number of pregnancies, including pregnancy loss prior to 24 weeks of gestation. However, this number will always be underestimated because of very early miscarriage. When the nominator represents maternal deaths, the denominator should be the number of maternities as in the CEMD classification.

Although our system is not based on personal reporting but register linkage we decided to classify maternal mortality according to the classification used in the UK by the CEMD [8]. A similar system is used in the Netherlands, Australia, New Zealand and Singapore [4,7].

In this study, the rate of maternal deaths constituted 9.8 per 100,000 maternities. During the same period, the rate was 10 per 100,000 maternities in the UK, 7.4 per 100,000 live births in Sweden, and 9.7 per 100,000 live births in the Netherlands [7,8,13].

As previously shown, we found a lower risk of dying from suicide and cancer compared to non-pregnant women in the same age group. This demonstrates the importance of comparisons with relevant age groups and the correct use of denominator.

Suicide represented the main cause of late pregnancy-related deaths and this has been the result of other studies as well [10,13]. Some of the maternal suicidal deaths might have been avoided, as 74% of the cases included a previous psychiatric history. The data emphasize the importance of particular focus on identifying pregnant women with previous psychiatric history during antenatal care [10]. In the future, cases of suicide should be classified as *indirect* deaths, comparable to the classification used by the CEMD.

Over a 10-year period, 18 cases of death were related to violence or murder. The prevalence of violence during pregnancy varies from 0.9% to 20.1% in 18 different studies [14]. Over the last decade, violence against pregnant women has been given more attention [9]. As a result of a recent CEMD report, questions regarding domestic violence are included in routine antenatal care in the UK in order to detect women at high risk, thereby enabling preventive action to be taken [9].

The reported incidence of severe maternal morbidity varies from 0.05% to 1.09% but definitions of severe morbidity vary greatly [15–17]. Collecting data and evaluating obstetric morbidity and mortality may also contribute to the development of training programs among doctors, midwives and nurses [8–10,18,19].

In conclusion, the best way to collect reliable data on maternal deaths is by comparing data collected continuously with data from national registries, death certificates and hospital records. Furthermore, analyzing each case is essential as they are often complex, multifaceted and difficult to assess.

Since 2002, a continuous national registration as well as audits of all maternal deaths have taken place in Denmark by the initiative of the Danish Society of Obstetrics and Gynaecology. The completion of the continuously collected data is optimized by comparison with registry data.

Finally, thorough clinical knowledge about both severe maternal morbidity and mortality should contribute to the future development of obstetric management.

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