

Maternal mortality in British Columbia, 1987–2004

While there has been a steady decline in maternal deaths since 1922, more might be done to prevent the leading causes of death during pregnancy and childbirth: hemorrhage and embolism.

ABSTRACT:

Background: Maternal mortality is an important indicator of the risks of pregnancy and childbirth, the status of women, and the effectiveness of a health care system. Although maternal mortality rates are lower now than in the past, they continue to be a public health concern. The authors examined maternal mortality in British Columbia by reviewing information from 1987–2004 and comparing it with information from previous years.

Methods: Definitions for maternal death, direct obstetric death, and indirect obstetric death were based on definitions in the *International Statistical Classification of Diseases (ICD-9 and ICD-10)*. Data on the number of maternal deaths (1922–2004) and the specific causes of maternal death (1987–2004) were provided by the BC Vital Statistics Agency. Data on the total number of live births and live births by cesarean-section (1987–2004) were also provided by the agency. Maternal mortality rates were calculated per 100 000 live births. The findings about maternal death in BC during 1987–2004 were then compared with findings from previous studies in BC, Canada, and other countries.

Results: Thirty-five maternal deaths occurred in BC during 1987–2004. The maternal mortality rate during this period was 4 per 100 000 live births. Of the 35 deaths that occurred, 83% were due to direct causes and 17% were due to indirect causes. Hemorrhage (34%) was the most frequent cause of death, followed by embolism (28%). The next most common causes were infection (17%), other (10%), intracranial hemorrhage (7%), and hypertension (4%). The rate of maternal death involving C-sections was 4 per 100 000 live births by C-section. In 1987–2004, 51% of all obstetric deaths were potentially avoidable.

Conclusions: A review of the trends in BC since 1922 shows a steady decline in the number of maternal deaths and the maternal mortality rate. The number of avoidable deaths also shows a steady decline. However, steps can still be taken to reduce further maternal deaths, especially by hemorrhage and embolism. A greater consensus on the classification of events leading to maternal death and better monitoring of maternal deaths would improve the data. As well, more published studies about maternal mortality in individual Canadian provinces would give a better understanding of national trends.

Maternal mortality is an indicator of the risks of pregnancy and childbirth, the social and economic status of women, their access to health care, and the effectiveness of a health care system in meeting their needs.¹ Although maternal mortality rates are now lower than in past decades, they continue to be an important public health concern, both at the national and provincial level. In British Columbia, maternal mortality has been analyzed in published reports for the periods 1955–1962,² 1963–1970,³ and 1971–1986.⁴ We continued the examination of maternal mortality in BC by reviewing all reported maternal deaths for 1987–2004. We then analyzed the findings to consider causes and compared the data with published data for previous years to determine any trends of maternal mortality.

Methods

The definitions of maternal death, direct obstetric death, and indirect obstetric death used for this study were

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based on the definitions provided in the *International Statistical Classification of Diseases (ICD-9, ICD-10)*.^{5,6} A *maternal death* is the death of a woman while pregnant or within 42 days of the termination of the pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes.^{5,6} A *direct obstetric death* results from obstetrical complications during pregnancy, labor, or puerperium. These complications can result from interventions, omissions, or incorrect treatment, or from a chain of events involving any of the above.^{5,6} An *indirect obstetric death* results from previous existing disease or disease that developed during pregnancy, which was not due to direct obstetric causes but which was aggravated by the physiological effects of pregnancy.^{5,6}

The BC Vital Statistics Agency provided data on the number of maternal deaths for 1922–2004, the maternal mortality rates (per 1000 live births) for 1922–1986, the total number of live births for 1987–2004, and the number of live births by cesarean-section (C-section) for 1987–2004. The specific causes of maternal deaths for 1987–2004 were also provided by the BC Vital Statistics Agency. The maternal mortality rates for 1922–1986 were converted to rates per 100 000 live births. The maternal mortality rate and the C-section rate for 1987–2004 were also calculated. The numbers of maternal deaths and live births in BC included BC residents and nonresidents.

The findings were then compared with those from previous studies of maternal deaths in BC, Canada, and other countries.

Results

There were 780 614 live births and 35 maternal deaths in BC during 1987–

Table 1. Live births and maternal deaths in BC, 1955–2004.

| | 1955–1962 ² n (%) | 1963–1970 ³ n (%) | 1971–1978 ⁴ n (%) | 1979–1986 ⁴ n (%) | 1987–2004 n (%) |
|--------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|--------------------|
| Live births | 305 474 | 278 180 | 285 300 | 334 708 | 780 614 |
| Obstetric deaths | | | | | |
| Direct | 100 (78) | 60 (68) | 27 (71) | 10 (56) | 29 (83) |
| Indirect | 29 (22) | 28 (32) | 11 (29) | 8 (44) | 6 (17) |
| Total | 129 | 88 | 38 | 18 | 35 |
| Maternal mortality rate* | 42 | 32 | 13 | 5 | 4 |

* Number of direct and indirect maternal deaths per 100 000 live births.

Table 2. Causes of direct maternal deaths in BC, 1955–2004.

| | 1955–1962 ² n (%) | 1963–1970 ³ n (%) | 1971–1978 ⁴ n (%) | 1979–1986 ⁴ n (%) | 1987–2004 n (%) |
|--------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|--------------------|
| Hemorrhage | 40 (40) | 30 (50) | 12 (44) | 1 (10) | 10 (34) |
| Embolism | 23 (23) | 8 (13) | 3 (11) | 2 (20) | 8 (28) |
| Infection | 17 (17) | 15 (25) | 3 (11) | 1 (10) | 5 (17) |
| Intracranial hemorrhage ^a | – ^b | – ^c | – ^d | – ^d | 2 (7) |
| Hypertension | 10 (10) | 4 (7) | 8 (30) | 3 (30) | 1 (4) |
| Anesthesia | 5 (5) | 3 (5) | 0 (0) | 1 (10) | 0 (0) |
| Other | 5 (5) | 0 (0) | 1 (4) | 2 (20) | 3 (10) |
| Total deaths | 100 | 60 | 27 | 10 | 29 |

^a not reported as a category of direct cause in older studies

^b cases reported as indirect causes

^c unknown

^d none reported

2004 (**Table 1**). Of the 35 deaths, 29 (83%) were due to direct causes and 6 (17%) were due to indirect causes. The mean maternal mortality rate during the period was 4 maternal deaths per 100 000 live births. A division of the data into two periods, 1987–1995 and 1996–2004, did not show any statistical differences in results.

Direct obstetrical deaths

The specific causes of the direct obstetric deaths in 1987–2004 are shown in **Table 2**. The most common causes of direct deaths were hemorrhage (34%), embolism (28%), and infection (17%). Direct deaths also occurred because of other causes (10%), intracranial hemorrhage (7%), and hyperten-

sion (4%).

Hemorrhage: Ten maternal deaths in 1987–2004 were caused by hemorrhages. The most common was postpartum hemorrhage, which accounted for 50% of the hemorrhagic deaths. One death occurred after a stillbirth; another involved postpartum coagulation defects. Another death occurred from postpartum hemorrhage secondary to retained placenta during a home birth. Two other patients suffered post-C-section hemorrhage; one of these patients refused a blood transfusion.

One patient endured a spontaneous abortion with hemorrhage secondary to retained products of conception and disseminated intravascular coagulation. Another patient suffered an

Table 3. Comparison of cases with avoidable factors in BC during in 1955–1962,² 1963–1970,³ 1971–1986,⁴ and 1987–2004

| | 1955–1962 ² n (%) | 1963–1970 ³ n (%) | 1971–1978 ⁴ n (%) | 1987–2004 n (%) |
|-----------------|---------------------------------|---------------------------------|---------------------------------|--------------------|
| Obstetric death | | | | |
| Direct | 82 (82) | 57 (95) | 27 (73) | 17 (59) |
| Indirect | 19 (65) | 17 (61) | 4 (21) | 1 (17) |
| Total | 101 (78) | 74 (84) | 31 (55) | 18 (51) |

intraoperative hemorrhage as a result of a laceration of the uterus during a therapeutic abortion. Two deaths were caused by ruptured ectopic pregnancies. One hemorrhage death was the result of a tear in the uterine artery followed by exsanguination.

Embolism: Eight deaths due to embolisms occurred in 1987–2004. Deaths from amniotic fluid embolisms and pulmonary embolisms occurred in equal numbers. In one case, the patient had abruptio placentae, which was complicated by amniotic fluid embolism. One death caused by pulmonary embolism occurred intrapartum; another occurred 5 weeks post-C-section. One patient had a pulmonary embolism along with complications from obstetric surgery and procedures. One death resulted from antepartum deep vein thrombosis leading to pulmonary embolism.

Infection: Five patients suffered sepsis-related deaths. One patient died from puerperal sepsis. Another patient suffered pneumococcal meningitis during the 11th week of pregnancy. Two died from septic shock: one as a result of a *Clostridium welchii* infection; another occurred following C-section. One patient died 2 days following vaginal delivery from group A streptococci infection and multisystem failure.

Other: Three cases of maternal death

during 1987–2004 were classified as “other.” There was one case of maternal death from fatty liver disease during pregnancy. One patient died of circulatory system disease, and another from pulmonary edema complicated by adult respiratory distress syndrome 12 days post-C-section.

Intracranial hemorrhage: Two patients died from spontaneous subarachnoid hemorrhage, one during pregnancy and the other during labor.

Hypertension: One patient died from eclampsia during 1987–2004.

Indirect obstetric deaths

There were six indirect obstetric deaths during 1987–2004. One patient suffered from pre-existing atrial tachycardia and subsequent cardiomyopathy during the postpartum period. Another died from primary pulmonary hypertension. One death resulted from a cardiac arrest following intubation for a C-section. In another case, a ruptured spleen was the cause of death. One patient died from a ruptured aortic aneurysm 13 days post-C-section. Finally, a mother died as a result of thrombotic thrombocytopenic purpura following a C-section.

Deaths related to C-sections

Of the 35 maternal deaths, 8 occurred during or after C-section. The average C-section rate in BC during 1987–

2004 was 23% of all live births. The rate of maternal death per C-section therefore was 4 per 100 000 live births by C-section.

Avoidable deaths

Factor analysis of the proximate, supervening, and remote causes of each maternal death would require review of the individual patient charts. With only the causal information provided by Vital Statistics, an estimate of avoidability is somewhat speculative. To arrive at an estimate, hemorrhage was considered generally manageable with appropriate fluid resuscitation and surgery. Pulmonary embolic deaths may be reduced with prophylactic anticoagulants after operative delivery, and hypertensive deaths may be reduced with earlier delivery. Applying these principles to the causes provided, potentially 51% of the maternal deaths in BC during 1987–2004 may have been avoided (**Table 3**).

Maternal mortality trends

Data provided by the BC Vital Statistics Agency indicate that the maternal mortality rate (Figure) has steadily declined since 1922, from 622 per 100 000 live births to 4 per 100 000 live births. In 1982, 1984, 1990, and 1999 there were no cases of maternal mortality. Since 1969, the maternal mortality rate has been less than 10 deaths per 100 000 live births.

Conclusions

A comparison of findings from previous studies²⁻⁴ and the 1987–2004 study shows a continued decline in the maternal death rate in BC. A comparison also shows a steady decline in the number of avoidable deaths and that the distribution of direct and indirect deaths remains relatively unchanged across the studies. Previous reports²⁻⁴ showed hemorrhage to be the most common direct cause of maternal death, and this

continues to be the case today. Abortion deaths accounted for a large proportion of maternal mortality in the past,^{2,3} but this is not the case for 1987–2004, when the number of abortion-related maternal deaths were much smaller. Anesthesia-related complications were responsible for a smaller percentage of deaths than in previous decades,^{2,4} as none of the maternal deaths in 1987–2004 were anesthesia-related.

When compared with the national data published in the Special Report on Maternal Mortality and Severe Morbidity in Canada for 1997–2000,⁷ BC has a greater proportion of maternal deaths attributed to direct causes in 1987–2004 (83% vs 69%). BC also has a lower maternal mortality rate (4 per 100 000 live births) compared with that of Canada (6 per 100 000 live births).⁷ The causes of maternal mortality in BC and Canada⁷ were comparable: hemorrhage (34% vs 23%), embolism (28% vs 36%), infection (17% vs 2%), intracranial hemorrhage (7% vs 16%), hypertension (4% vs 21%), anesthesia (0% vs 2%), and other (10% vs 0%). Embolism was the leading cause of direct maternal deaths in Canada during 1997–2000⁷ rather than hemorrhage, which was the leading cause in BC for 1987–2004. In fact, there were no deaths due to primary postpartum hemorrhage reported in Canada during the study period, a sign of progress in reducing maternal mortality.⁷

Early diagnosis and appropriate medical care of pregnancy complications can obviously help reduce maternal deaths.^{8,9} In developed countries, technological advancements in obstetrical care, increased access to health services, and fewer births occurring at the extremes of women's reproductive age span have reduced risks associated with childbirth.¹⁰ Steps have been proposed to prevent further maternal

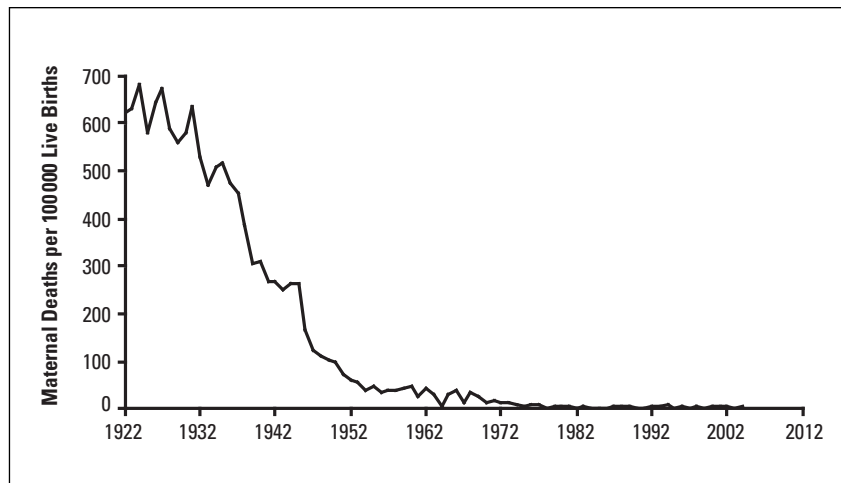


Figure. Maternal mortality rate in BC, 1922–2004.

Wider use of drugs such as heparin could prevent pulmonary embolism deaths, and prophylactic antibiotics used during C-sections could reduce the incidence of puerperal sepsis.

deaths.¹¹ One suggestion in the management of obstetric hemorrhage is that maternity units have drills so that when hemorrhage emergencies occur, all staff (including blood bank staff) can ensure the prompt delivery of large quantities of cross-matched blood.¹¹ In order to reduce preeclampsia-related deaths, women should receive antenatal education about symptoms associated with preeclampsia.¹¹ Wider use of drugs such as heparin could prevent pulmonary embolism deaths, and prophylactic antibiotics used during C-sections could reduce the incidence of puerperal sepsis.¹¹ Other factors—including biological, social, environmental, and institutional factors—need to be studied to further understand

maternal mortality and morbidity.¹²

The data presented in this paper are based on information from death certificates filed with the Vital Statistics Agency. In BC, the Physician's Medical Certification of Death has separate yes/no check-boxes to identify deaths that occurred during pregnancy, within 42 days postpartum, and between 43 days or 1 year postpartum. These check-boxes improve the reliability of maternal mortality data in BC. In spite of this, maternal deaths may still be underreported because of improper completion of death certificates and errors in coding the underlying cause of death.¹³ Although the coroner/medical examiner is likely to be notified of maternal deaths, notifica-

tion does not translate into formal investigation, since some deaths may be classified as “non-coroner cases” using initial information, with no further investigation called for.⁷

Previous BC studies^{2,4} reported more maternal deaths than were recorded in Vital Statistics Agency data for the time periods studied because the investigators reviewed medical and hospital records and interviewed physicians involved in the cases to augment the agency’s data. The classification of maternal deaths as direct or indirect also varied among the studies. For example, Carpenter and Bryans² classified thrombotic thrombocytopenic purpura as a nonrelated cause of death, whereas Wittmann and colleagues⁴ classified that as an indirect cause, as we did. Changes in the maternal death classification guidelines between *ICD-95* and *ICD-10*⁶ also influenced the distribution of death between direct and indirect categories.¹³ In this study, we added a new category of direct cause of maternal death: intracranial hemorrhage. Older studies^{2,4} do not have intracranial hemorrhage as a category for direct causes. In fact, intracranial hemorrhages may be reclassified in the future as an indirect maternal death in accordance with *ICD-10*.⁷

Even though some individual cases will remain subject to debate, greater consensus on the classification of maternal deaths could improve the quality of maternal death data.

Increasing the frequency of monitoring and using additional sources, such as case reports and maternal mortality review committee reports,⁹ could also improve the quality of maternal death data. In the past, a committee on maternal welfare sponsored jointly by the provincial Ministry of Health and the BC Medical Association reviewed all maternal deaths.⁴ Currently, BC does not have a provincial maternal death review committee.⁷ Continued im-

provement in monitoring would allow more accurate identification of trends.⁹

Finally, it should be noted that there have been few published studies about maternal mortality in individual Canadian provinces. A search on PubMed using the terms “maternal deaths” and “maternal mortality” and the names of each Canadian province generated only two relevant provincial studies.^{14,15} Clearly, we will need more provincial data to examine if we are to gain a better understanding of national maternal mortality trends.

International comparison shows that the mortality rate in British Columbia is among the best in the world, lower than Japan (8 per 100 000), Norway (11 per 100 000), the US (14 per 100 000), Russia (45 per 100 000), or Mexico (60 per 100 000).¹⁶ Although improvements are still possible, we can be proud of the current rates in this province.

Competing interests

None declared.

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