



Health
Canada

Santé
Canada

Special Report on Maternal Mortality and Severe Morbidity in Canada

Enhanced

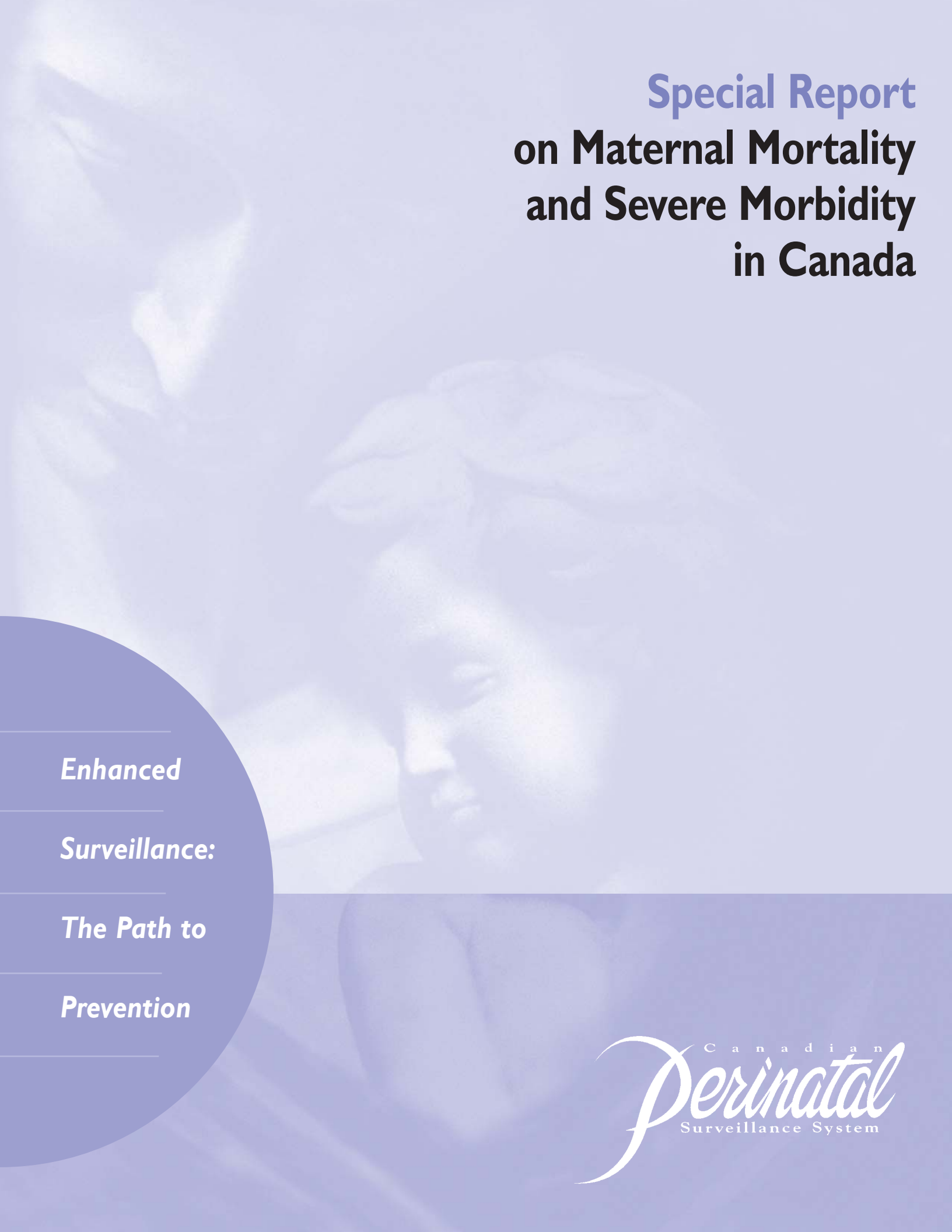
Surveillance:

The Path to

Prevention

C a n a d i a n
Perinatal
Surveillance System

Canada



Special Report
on Maternal Mortality
and Severe Morbidity
in Canada

Enhanced

Surveillance:

The Path to

Prevention

C a n a d i a n
Perinatal
Surveillance System

Our mission is to help the people of Canada
maintain and improve their health.

Health Canada

Copies of this report are available from:

Maternal and Infant Health Section
Health Surveillance and Epidemiology Division
Centre for Healthy Human Development
Population and Public Health Branch
Health Canada
Jeanne Mance Building #19, 10th Floor, A.L. 1910C
Tunney's Pasture
Ottawa, Ontario
K1A 0K9

Telephone: (613) 941-2395

Fax: (613) 941-9927

This publication can also be accessed electronically via the Internet at:

<http://www.hc-sc.gc.ca/pphb-dgspsp/rhs-ssg/index.html>

Également disponible en français sous le titre :

*Rapport spécial sur la mortalité maternelle et la morbidité maternelle grave au Canada — Surveillance accrue :
la voie de la prévention*

Suggested citation: Health Canada. Special Report on Maternal Mortality and Severe Morbidity in
Canada — Enhanced Surveillance: The Path to Prevention. Ottawa: Minister of Public Works and
Government Services Canada, 2004.

Published by authority of the Minister of Health

©Minister of Public Works and Government Services Canada, 2004

Cat. No. H39-4/44-2004E

ISBN 0-662-37064-3

Publication No. 5804

Table of Contents

Foreword	v
Contributors	vii
Introduction	1
Methods	5
<i>Provincial/Territorial-Level Maternal Death Review Activities Determined</i>	5
<i>List of Deaths Constructed from National Databases</i>	5
<i>Individual Case-Level Data Obtained from Provincial/Territorial Death Review Committees or Coroners/Medical Examiners</i>	6
<i>Expert Review and Analysis of Maternal Deaths</i>	6
<i>Occurrence of Severe Maternal Morbidity</i>	7
Key Findings	9
<i>Current Provincial/Territorial Maternal Death Review Activities</i>	9
<i>Maternal Deaths in Canada (excluding Quebec), 1997-2000</i>	12
<i>Direct Maternal Deaths in Canada (excluding Quebec), 1997-2000</i>	13
<i>Indirect Maternal Deaths in Canada (excluding Quebec), 1997-2000</i>	14
<i>Incidental Deaths in Canada (excluding Quebec), 1997-2000</i>	16
<i>Severe Maternal Morbidity in Canada (excluding Manitoba, Quebec and Nova Scotia), 1991-1992 to 2000-2001</i>	16
Discussion	19
<i>Current Provincial/Territorial Maternal Death Review Activities</i>	19
<i>Maternal Mortality in Canada</i>	20
<i>Severe Maternal Morbidity in Canada</i>	22
<i>Strengths and Limitations</i>	23
Key Recommendations to Enhance Surveillance of Maternal Mortality and Severe Maternal Morbidity in Canada	25
References	27
Appendix A: Maternal Death Data Collection Tool	29
Appendix B: Diagnostic and Procedure Codes Used in the Analysis of Severe Maternal Morbidity	35
Appendix C: List of Acronyms	36

Foreword

Canada's maternal mortality ratio is among the lowest in the world, yet even in a country that considers its health care system integral to its national identity, women continue to die during or shortly following a pregnancy. This *Special Report on Maternal Mortality and Severe Morbidity in Canada — Enhanced Surveillance: The Path to Prevention* from the Maternal Health Study Group of the Canadian Perinatal Surveillance System (CPSS) reminds us of this tragic and frequently avoidable reality. It identifies some shortcomings in our national, provincial and territorial continuous quality improvement efforts in comparison with benchmark international peers, and provides a series of recommendations for providers and leaders of maternity care in Canada to consider and implement.

The principles of multidisciplinary confidential case reviews, developed most notably in the United Kingdom, are applied to the Canadian scene, and the study of severe maternal morbidity “near misses” is introduced and encouraged. The rigorous analysis of our maternal deaths from 1997 to 2000 identified pulmonary embolism and

pre-eclampsia/pregnancy-induced hypertension (direct), cardiovascular (indirect), and motor vehicle collisions (incidental) as leading causes. Are there not opportunities for us to further reduce or eliminate these tragedies? When even devastating events become infrequent or rare, they can become lost in overall descriptive statistics. Higher frequency of undesirable outcomes in specific disadvantaged minorities can be overlooked.

This report is a significant and welcome contribution. It presents us with important challenges. I look forward to our response, and the continuing surveillance of maternal mortality and other important perinatal health outcomes by CPSS in future reports as a measure of our efforts.

Thank you on behalf of care providers and, most of all, the women and their families we serve.

David Young, MD, MSc, FRCSC
President
Society of Obstetricians and Gynaecologists
of Canada

Contributors

Principal Authors

I.D. Rusen, MD, MSc, FRCPC
Robert Liston, MB, ChB, FRCSC, FRCOG

Contributing Authors

Shi Wu Wen, MB, PhD
Sharon Bartholomew, MHSc

Expert Review Committee

Karen Acheson, MD, CCFP
Maureen Heaman, RN, MN, PhD
Robert Liston
Dana Paquette, MSc
I.D. Rusen
Reg Sauve, MD, MPH, FRCPC

Maternal and Infant Health Section Staff

Sharon Bartholomew
Ernesto Delgado
Patric Fournier-Savard, MSW
Ling Huang, MD, MSc
Adèle Lemay-Jones
Gina Marin
Catherine McCourt, MD, MHA, FRCPC
Louie McLeod
Hajnal Molnar-Szakács, MD, MSc
Dana Paquette
Jocelyn Rouleau

Maternal Health Study Group, Canadian Perinatal Surveillance System (External Members)

Thomas F. Baskett, MB, FRCS
Margaret Cyr
Kinga David, MHSc
William Fraser, MD, MSc, FRCSC
Maureen Heaman
K.S. Joseph, MD, PhD
Robert Kinch, MD
Michael Kramer, MD
Robert Liston
Beverley O'Brien, RM, DNSc
Karen Roberts
Reg Sauve
Susan Taylor-Clapp, RN, MSc

Acknowledgements

The Canadian Perinatal Surveillance System wishes to acknowledge the participation of the Offices of the Provincial and Territorial Chief Coroners and Chief Medical Examiners, and the four established Provincial and Territorial Maternal Death Review Committees. Their collaboration was essential for this project and it is greatly appreciated.

We would like to thank Dr. Alison Macarthur, Associate Professor, Department of Anesthesia, University of Toronto, for her constructive comments on an earlier draft of this report.

We are also grateful to Dr. William Fraser and Dr. Alexandre Dumont of the Department of Obstetrics and Gynaecology, University of Montreal, for their careful review of the French language version of this document.

Introduction

Maternal mortality has been used as a measure of the status of women, their access to health care and the capacity of the health care system to respond to their needs.¹ An estimated 529,000 maternal deaths occurred worldwide in 2000. Levels of maternal mortality show wide disparities between countries and regions, with 13 countries accounting for 67% of all maternal deaths. The highest estimated maternal mortality ratios (MMRs) in the world in 2000 were from Afghanistan and Sierra Leone at 1,900 and 2,000 maternal deaths per 100,000 live births, respectively.²

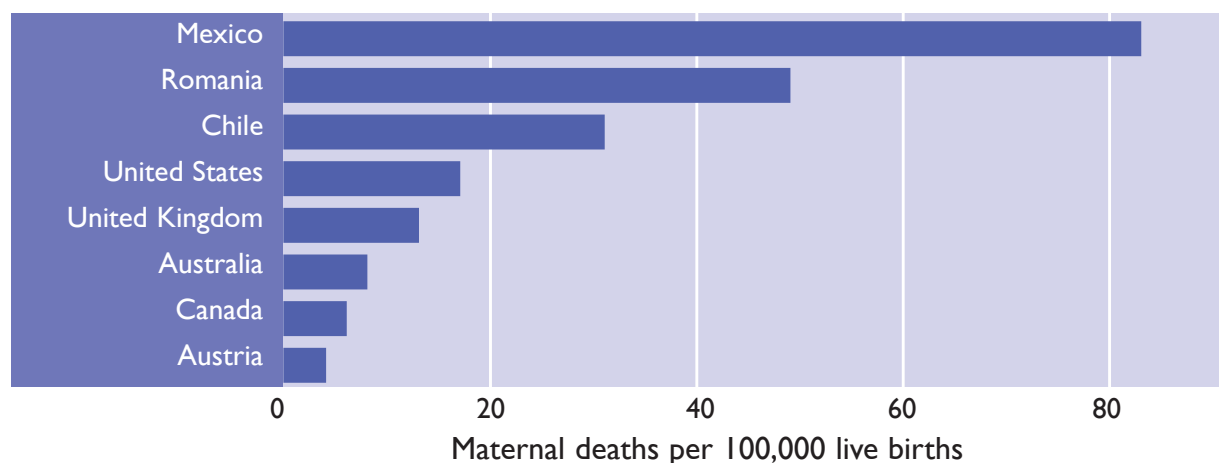
In response to this staggering burden of maternal deaths, the reduction of maternal mortality has been highlighted as an important goal for several initiatives, including the United Nations' Millennium Development Goals (MDGs). The MDGs aim for the global reduction of maternal mortality by 75% from 1990 levels (global estimate of 430 per 100,000 live births¹) by 2015.³

In many developed countries, including Canada, maternal mortality has already decreased markedly during the 20th century.^{4,5}

The most recent MMR estimates for selected countries with good death registration and good attribution of cause are presented in Figure 1. It is evident that Canada's MMR (based on national vital statistics) is one of the lowest in the world. Nonetheless, we cannot be complacent about our levels of maternal mortality. Pregnancy-related mortality surveillance in other countries has demonstrated increased mortality among disadvantaged groups in the population.^{5,6} Overall MMRs may mask important elevated risks for particular sub-groups of the Canadian population. Despite Canada's relatively low MMR, opportunities to further reduce the number of women dying as a result of their pregnancy must be explored.

Specific strategies to reduce maternal mortality are dependent on the baseline burden of maternal deaths. In the worst affected regions of the world, basic safe motherhood interventions are urgently needed and are likely to have a profound impact on the number of women dying of pregnancy-related causes. These interventions are

Figure 1 Maternal mortality ratios (MMRs) in selected countries (2000 estimates)²



described in detail elsewhere.⁷ In developed countries, with significantly lower levels of maternal mortality, enhanced surveillance efforts are a necessary starting point to identify prevention opportunities to further reduce mortality.

Limitations of vital registry systems to accurately track maternal deaths have been well documented.^{2,4} Maternal deaths may be missed and misclassified, even in countries with complete vital registration coverage and universal medical certification of death. Published estimates of MMRs often adjust officially reported rates of maternal death to account for the problem of under-reporting.² However, to better understand the persistent causes of maternal mortality and identify preventive opportunities, more countries are now seeking to enhance statistical, quantitative data with in-depth qualitative information.²

In-depth case investigations and reports can increase awareness of the occurrence and preventability of maternal deaths, recommend specific actions to improve quality of care and encourage the development and enhancement of maternal death reporting systems.^{2,6,8} Models of enhanced surveillance and in-depth case investigation and reporting are available from several countries:


- In the United Kingdom (U.K.), the **Confidential Enquiry into Maternal Deaths in the United Kingdom** was initiated in England and Wales in 1952. Now covering the U.K. as a whole, the aim of the enquiry is “to form part of the Government’s agenda for clinical governance to help ensure that all pregnant women and recently delivered women receive the best possible care delivered in

appropriate settings and taking account of their individual needs.”⁶ The report of the enquiry is produced every three years and provides detailed case information, as well as key recommendations based on the findings. Of critical value to the enquiry is a government requirement that all maternal deaths should be subject to the confidential enquiry and that all health professionals have a duty to provide the information required.⁶ The U.K. enquiry and report are viewed as the “gold standard” for maternal mortality surveillance.⁸

- The *Report on Maternal Deaths in Australia* has been produced triennially since 1964. The report aims to provide quality assurance of maternal care during pregnancy and the puerperium, to provide public health surveillance of maternal deaths and to refine a standard for the

reporting of maternal deaths.⁸ The Australian report also provides individual case-level detail, as well as comments on preventive opportunities. In contrast to the centrally-implemented U.K. enquiry, the Australian report is the product of various state and territorial Confidential Death Enquiries, a National Hospital Morbidity Database and a National Mortality Database.⁸ Consequently, the data incorporated into the report are variable in both detail and quality.⁸

- In the United States, the **Pregnancy Mortality Surveillance System (PMSS)** was established in 1987 and provides ongoing surveillance of all pregnancy-related deaths reported through individual state health departments, maternal mortality review committees, media and individual providers.⁹ In addition to careful review of the immediate and underlying cause of death, the PMSS obtains



In-depth case investigations and reports can increase awareness of the occurrence and preventability of maternal deaths, recommend specific actions to improve quality of care and encourage the development and enhancement of maternal death reporting systems.

additional information primarily from maternal death certificates and matched birth and fetal death certificates. The published reports comment on the available socio-demographic factors and their relation to the risk of maternal death.⁵ However, unlike the U.K. and Australian reports, the PMSS does not conduct individual reviews of the medical circumstances surrounding death and no individual case-level detail is provided.

In Canada, at the local level, deaths that occur in hospitals are usually the subject of thorough investigation by hospital review committees.⁴ However, the scope and outcome of these internal reviews are not routinely reported outside the institution. At the provincial and territorial levels, the conduct of maternal death investigations is likely variable. Furthermore, these provincial and territorial practices have not been previously summarized. Finally, at the national level, there is currently no systematic mechanism in place to synthesize and report on maternal deaths in Canada.

An issue closely related to maternal death investigation and reporting is the surveillance of severe maternal morbidity or “near miss” — i.e., women who were at serious risk of death but survived.⁶ As maternal deaths have become increasingly rare in industrialized countries, severe maternal morbidity surveillance has been proposed as a supplementary indicator to maternal mortality to monitor the quality of maternity care.^{6,10-12}

Severe maternal morbidity surveillance provides greater numbers of cases to review and to form the basis of conclusions and recommendations.⁶ Several of the existing national maternal death review committees have acknowledged the importance of enhancing severe maternal morbidity surveillance efforts.^{6,8} The most recent *Canadian Perinatal Health Report* has examined rates of amniotic fluid embolism (AFE) and post-partum hemorrhage.¹³ However, there are no published reports on the nation-wide occurrence of overall severe maternal morbidity in Canada.

The **Canadian Perinatal Surveillance System** (CPSS) was developed by Health Canada in 1995, with a mandate to contribute to improved health for pregnant women, mothers and infants in Canada through ongoing monitoring and reporting on perinatal health determinants and outcomes.¹³ One of CPSS’s three study groups, the Maternal Health Study Group (MHSG), focuses on key behaviours, health services and outcomes related to maternal health. The MHSG identified enhanced surveillance of maternal mortality and severe maternal morbidity as priority areas for maternal health surveillance in Canada. In this regard, the MHSG has undertaken studies on under-reporting of maternal mortality in Canada,⁴ cause-specific mortality during and after pregnancy,¹⁴ maternal readmission,¹⁵ and a comparison of maternal mortality and morbidity between trial of labour and elective cesarean section among women with previous cesarean delivery.¹⁶ The MHSG, with the support of the Society of Obstetricians and Gynaecologists of Canada (SOGC), initiated this special report on maternal mortality and severe maternal morbidity in Canada with the following four main objectives:

- to describe the current provincial and territorial activities to investigate and report on maternal deaths
- to review and summarize available individual case-level reports of maternal deaths occurring in Canada between 1997 and 2000
- to describe the occurrence and trends of severe maternal morbidity in Canada
- to make recommendations to enhance the surveillance of maternal mortality and severe maternal morbidity in Canada

Methods

This project was undertaken in five distinct stages.

Provincial/Territorial-Level Maternal Death Review Activities Determined

In each province and territory, the chief coroner/medical examiner and the college of medicine or college of physicians and surgeons were contacted and asked whether or not a formal provincial or territorial maternal death review committee exists. If the answer was yes, representatives from these committees were contacted and details regarding the committees' activities and willingness to participate in the project were obtained. Where no formal review committee existed, the role of the provincial and territorial coroner(s)/medical examiner(s) in maternal death investigations was explored, as well as their willingness to participate in this project.

List of Deaths Constructed from National Databases

As the first step in compiling maternal death case reports, a list of deaths during 1997-2000 was obtained from three administrative databases.

The first source was Statistics Canada's Canadian Vital Statistics System, which contains national databases of non-nominal data on live births, stillbirths and deaths.¹³ The process of death certification in Canada with specific reference to pregnancy has been described in detail elsewhere.⁴ Maternal deaths are those deaths that have been assigned an underlying cause of death code in chapter 11 ("Complications of pregnancy, childbirth and the puerperium") of the 9th Revision of the International Classification of Diseases

(ICD-9)¹⁷ or chapter XV ("Pregnancy, childbirth and the puerperium") of the 10th Revision of the International Classification of Diseases (ICD-10).¹⁸ From the Canadian Vital Statistics System, a preliminary list of deaths was constructed, containing the following variables: province of residence, age, date of death and single underlying cause of death.

The second data source utilized was the Discharge Abstract Database (DAD) from the Canadian Institute for Health Information (CIHI). The DAD captures hospital separation information — transfer, discharge or death — from the majority of Canada's acute care hospitals. Hospital separations from the province of Quebec and from parts of Manitoba were not included in the DAD during the study period for maternal deaths. The DAD contains non-nominal data on each hospitalization, including demographic and residence information, length of stay, most responsible diagnosis, secondary and co-morbid diagnoses, and procedures performed during the hospitalization.¹³ A combination of diagnostic and procedure codes was utilized to identify all deliveries, as well as abortions and ectopic pregnancies. Any record of these events combined with a hospital separation of "death" was used to capture hospital-based deaths.

Third, hospital separations from the province of Quebec were examined utilizing the *Système de maintenance et d'exploitation des données pour l'étude de la clientèle hospitalière (MED-ÉCHO)*.

Finally, deaths obtained from the two hospitalization databases were combined with the deaths from Statistics Canada's Canadian Vital Statistics System to obtain the list of database deaths for the period 1997-2000.

Individual Case-Level Data Obtained from Provincial/Territorial Death Review Committees or Coroners/Medical Examiners

Using the list of deaths obtained from the database searches, provinces and territories were approached for information on cases occurring in their jurisdiction during 1997-2000. In provinces and territories with established maternal death review committees, these bodies were contacted. Where such committees did not exist, the chief coroner/medical examiner or designate was approached. (In the Northwest Territories, information regarding maternal deaths was obtained from the Chief Coroner. Details regarding the existing maternal death review committee were not obtained until after the case review was completed.)

Provincial and territorial contacts were asked to confirm individual cases and provide information for these cases. Provinces and territories were also asked to identify and provide information on maternal deaths that were not ascertained from the databases. Provinces and territories with no deaths recorded in the databases during 1997-2000 were still contacted to identify any maternal deaths that may have been missed. Provincial and territorial contacts were asked to provide actual maternal death investigation reports or to complete a data collection tool (see Appendix A) which was constructed to capture key case information. No nominal information was requested.

Expert Review and Analysis of Maternal Deaths

An expert review committee was convened with representation from obstetrics, obstetric nursing, coroner/medical examiner's system, provincial/territorial maternal death review committees and national surveillance and epidemiology. Only cases with available coroner/medical examiner or provincial/territorial death review committee reports, or completed data collection forms were included in the formal review process. Information for each case was reviewed and discussed in detail. Classification of maternal death, as well as designation of principal cause, was carried out for each case. Definitions used to classify deaths are presented in Table 1.

Table 1 Definitions of maternal deaths

Maternal deaths:^a deaths of women while pregnant or within 42 days of the termination of the 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 obstetric deaths:**^a maternal deaths resulting from obstetric complications of the pregnant state (pregnancy, labour and puerperium); interventions, omissions or incorrect treatment; or a chain of events resulting from any of the above.
- **Indirect obstetric deaths:**^a maternal deaths resulting from previous existing disease or disease that developed during pregnancy, which was not due to direct obstetric causes but which was aggravated by the physiologic effects of pregnancy.

Incidental deaths:^b deaths due to conditions occurring during pregnancy, where the pregnancy is unlikely to have contributed significantly to the death, although it is possible to postulate a distant association.

Late maternal deaths:^c deaths of women from direct or indirect obstetric causes occurring between 42 days and one year after termination of pregnancy.

^a Definitions used in both ICD-9 and ICD-10.

^b Previously referred to as fortuitous deaths; "incidental" as defined in the *Report on Maternal Deaths in Australia, 1994-96*.⁸

^c New ICD-10 category.

In addition to the new category of **late maternal death**, several other differences in the coding and classification of maternal deaths exist between ICD-9 and ICD-10 and have been outlined elsewhere.⁴ The study period for this report includes years of both ICD-9 (1997-1999) and ICD-10 (2000) classification of deaths in Canada. As a result, the classification of death for this report was determined by consensus of the expert review committee and not with reference to one specific disease classification system. For example, deaths from cerebrovascular disorders during pregnancy, or within 42 days of termination of pregnancy, are classified as **direct maternal deaths** under ICD-9 but as **indirect maternal deaths** under ICD-10.⁴ The expert review committee classified cerebrovascular deaths based on individual case details and usually classified these deaths as **direct maternal deaths** for the purposes of this report.

Consensus was also reached as to the principal cause of death for each case. For example, deaths from intra-cranial hemorrhage (ICH) that occurred in conjunction with a diagnosis of pre-eclampsia were attributed to pre-eclampsia, while cases of ICH with no indication of pre-eclampsia were categorized as ICH deaths. Where such determinations were not possible based on the available information, additional details were sought from the respective coroner/medical examiner's office or provincial/territorial death review committee.

Following the classification and designation of cause for all reviewed cases, data were entered into EpiData (version 3.0, the EpiData Association, Odense, Denmark, 2003) and analyzed using Epi Info (version 6.04d, United States Centers for Disease Control and Prevention and World Health Organization, 2001). In keeping with international approaches, the overall maternal mortality ratio (MMR) was calculated as the combined number of direct and indirect maternal deaths per 100,000 live births.¹⁷ In addition, the direct, indirect, age-specific and cause-specific MMRs were

calculated. Live birth counts for MMR calculations were obtained from Statistics Canada's Canadian Vital Statistics System.

Occurrence of Severe Maternal Morbidity

Data for women admitted to hospital for deliveries for fiscal years 1991-1992 to 2000-2001 were abstracted from CIHI's DAD using a combination of codes as discussed above. Hospital separations from the province of Quebec and from parts of Manitoba and Nova Scotia were not included in the DAD during this period of study. Therefore, these provinces are not included in the severe maternal morbidity analysis. In contrast to the methods for ascertaining deaths, the severe maternal morbidity analysis excluded early pregnancy events, i.e., ectopic pregnancies and abortions that did not result in a live birth or stillbirth outcome.

The conditions and procedures suggestive of severe maternal morbidity were selected by an expert panel (obstetrics, obstetric nursing, national surveillance and perinatal epidemiology) of the CPSS's Maternal Health Study Group. These include: amniotic fluid embolism (AFE); obstetrical pulmonary embolism (not including AFE); eclampsia; shock (obstetrical, septic and other); pulmonary, cardiac and central nervous system (CNS) complications of anaesthesia; cerebrovascular disorders in the puerperium (including intra-cranial venous sinus thrombosis); uterine rupture; adult respiratory distress syndrome; pulmonary edema; myocardial infarction; acute renal failure following labour and delivery; cardiac arrest/failure or cerebral anoxia following obstetrical surgery; severe post-partum hemorrhage requiring hysterectomy or transfusion; and assisted ventilation.

To measure the overall burden of severe maternal morbidity, a rate per 1,000 deliveries was calculated, with the numerator being the number of patients who had any of the above conditions or procedures. Preliminary analysis of the data identified a coding error for myocardial infarction in hospital separation records for deliveries in Saskatchewan.

Therefore, Saskatchewan records were excluded from the calculation of myocardial infarction rates. For the calculation of total severe maternal morbidity rates, Saskatchewan deliveries were included, but Saskatchewan myocardial infarction cases were treated as non-cases. To ensure hemorrhage cases were truly severe cases, only records with postpartum hemorrhage associated with either hysterectomy or transfusion were counted. The ICD-9 and the Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures (CCP) codes for all relevant conditions and procedures are listed in Appendix B.

Overall rates of severe maternal morbidity in Canada were calculated for the decade of study. Also, rates of severe maternal morbidity in 1991-1993 were compared to rates in 1998-2000. Relative risks and 95% confidence intervals were calculated as a measure of secular trends, using 1991-1993 data as the reference.

Key Findings

Current Provincial/Territorial Maternal Death Review Activities

Table 2 contains information about maternal death review committees and coroner/medical examiner notification of maternal deaths in Canadian provinces and territories. Of note, only Manitoba, Saskatchewan, Alberta and Northwest Territories have established committees with a mandate to investigate all maternal deaths in their jurisdiction. Only six of thirteen provincial and territorial Coroner’s Acts (or equivalent legislation) specifically mention pregnancy in the list of cases to be reported to the coroner/medical examiner. However, in most provinces and territories, it was the opinion of the

coroner/medical examiner or designate that they would likely be notified of all maternal deaths in their jurisdiction. In some provinces and territories, such as British Columbia, notification does not necessarily translate into formal investigation as some deaths may be classified as “non-coroner cases” based on initial information, with no further investigation. Quebec was the only province without a maternal death review committee where a coroner is not routinely notified of all deaths related to pregnancy.

Table 3 contains details of the four established provincial and territorial maternal death review committees.

Table 2 Provincial/territorial maternal death review activities

Province/territory	Province/territory-wide maternal death review committee	Specific mention of “pregnancy” for notification of coroner/medical examiner in Coroner’s Act (or equivalent) ^a	Coroner/medical examiner would likely be notified of all pregnancy-related deaths ^b
Newfoundland and Labrador	No	Yes	Yes
Prince Edward Island	No	No	Yes
Nova Scotia	No	No	Yes
New Brunswick	No	Yes	Yes ^c
Quebec	No	No	No
Ontario	No	Yes	Yes
Manitoba	Yes	Yes	Yes
Saskatchewan	Yes	No	No
Alberta	Yes	Yes	Yes
British Columbia	No	Yes	Yes
Yukon	No	No	Yes ^d
Northwest Territories	Yes	No	Yes ^d
Nunavut	No	No	Yes

^a Five of six provinces/territories specifically mentioning pregnancy list “reasonably related to” or “reasonably attributed to” pregnancy. In these instances, incidental deaths may not be routinely reported; Manitoba simply lists “during pregnancy or during recovery from pregnancy.”

^b Province/territory-specific coroner/medical examiner’s opinion of likelihood of notification of all maternal deaths.

^c Would likely be notified, but may not be recorded or categorized as a maternal death within coroner/medical examiner’s records.

^d Deaths must be sudden and/or unexpected to be notified to coroner/medical examiner; this may apply to other jurisdictions but was specifically mentioned by these coroners/medical examiners.

Table 3 Province/territory-wide maternal death review committees

Province/territory	Date established	Committee composition	Definitions used for maternal deaths
Manitoba	Maternal and Perinatal Health Standards Committee of the College of Physicians and Surgeons of Manitoba established in 1977	Composed of 11 members, including physicians who provide obstetric care, obstetric anaesthesia and neonatal care, as well as midwives and rural/northern health care workers	Deaths to women either during pregnancy or within 42 days following termination of pregnancy
Saskatchewan	Perinatal and Maternal Mortality Study Committee of the College of Physicians and Surgeons of Saskatchewan was formed in 1973 when the Maternal Welfare and Perinatal Study Committees were amalgamated	Composed of eight members, including: obstetricians, paediatricians and/or neonatologists, and general practitioners (may include others)	Deaths to women either during pregnancy or within 42 days following termination of pregnancy
Alberta	Alberta Medical Association Committee on Reproductive Care formed in 1984 when the Maternal Welfare (1936) and the Perinatal (1955) Committees were amalgamated	Composed of 14 members, including obstetricians, neonatologists, paediatricians, general practitioners and midwives	Deaths to women known to be pregnant or within 90 days of delivery or termination of pregnancy
Northwest Territories	NWT Maternal and Perinatal Committee has been in existence since 1988	Composed of seven members, including: an obstetrician, a paediatrician, a family physician, the Chief Medical Officer of Health and a community health nurse	No specific definition for maternal death

Nature of ascertainment	Scope of investigation	Information dissemination mechanism
<p>Deaths are reported to the Committee from four sources: the Provincial Vital Statistics Office, hospitals, the Office of the Medical Examiner and the Provincial Health Department</p>	<p>Committee receives records from hospitals and physicians' offices, as well as autopsy and other details from the Office of the Medical Examiner as requested; preventability, as well as source of error/problem assessed</p>	<p>Publish summary of findings for physicians and other health professionals in the Committee's annual report. The report, which is also available to the public and is released to the media, can be viewed at: <http://www.cpsm.mb.ca></p>
<p>Deaths are reported to the Committee from Provincial Vital Statistics Office and hospitals</p>	<p>Copies of hospital records obtained for review; Coroner's information is provided on request but not automatically sent; preventability, as well as source of error/problem assessed</p>	<p>Annual summary of Committee activities is published in the newsletter of the Saskatchewan College of Physicians and Surgeons</p>
<p>Deaths are reported to the Committee from Vital Statistics, hospital medical records departments and the Office of the Medical Examiner</p>	<p>The Committee receives pertinent hospital charts, as well as autopsy information from the Office of the Medical Examiner; the review assesses preventability and standards of care</p>	<p>Summary findings reported in the annual publication <i>Alberta Reproductive Health: Pregnancies and Births</i>; results of case reviews presented to physicians in <i>Doctor's Digest</i></p>
<p>Deaths are reported to the Committee by the Chief Medical Officer of Health and the Vital Statistics Department</p>	<p>Committee reviews health centre and hospital charts, autopsy reports; review assesses preventability and standards of care</p>	<p>Annual summary of Committee activities sent to all Health Boards via the Deputy Minister of Health</p>

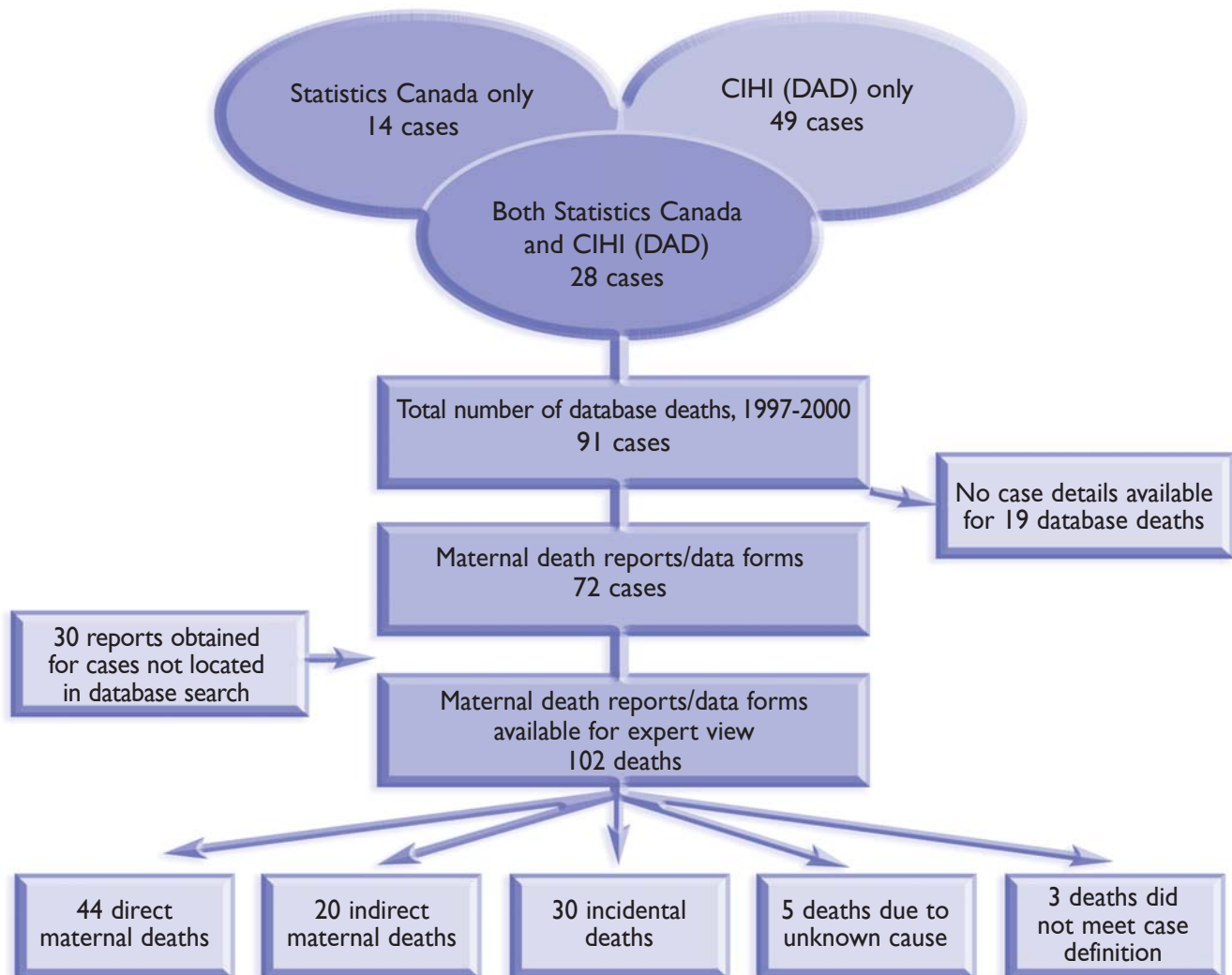
Maternal Deaths in Canada (excluding Quebec), 1997-2000

For the provinces and territories excluding Quebec, maternal death reports/data collection forms were obtained for 72 out of a total of 91 (79.1%) deaths recorded in the administrative databases (see Figure 2). Reports were obtained for only three of twenty (15.0%) database deaths from Quebec. Therefore, Quebec cases were excluded from the expert review.

Of the nineteen database deaths with no available reports/data collection forms, only one had been found in both the vital statistics and hospitalization databases, two were found only in the vital statistics database and sixteen recorded only in the hospitalization database,

the DAD. Of these sixteen records, four had codes suggesting malignancy as the underlying cause of death, suggesting that the DAD has a lower specificity for identifying true maternal deaths based on the ascertainment methods used. These 19 database deaths for which no additional case details were available were not included in either the case review or the calculated MMRs. An additional 30 reports/data collection forms were obtained from provinces and territories for deaths which had not been identified in the databases. These 30 cases were included in the case reviews and in the calculated MMRs, where applicable. (Only one direct and two indirect maternal deaths were obtained that had not been identified in the database search.)

Figure 2 Collection of maternal death reports, Canada (excluding Quebec), 1997-2000



Of the 102 reports/data collection forms obtained, a total of 64 maternal deaths (44 direct maternal deaths and 20 indirect maternal deaths) were identified for a total, direct and indirect MMR of 6.1, 4.2 and 1.9 per 100,000 live births, respectively. Of these sixty-four cases, all but three were originally ascertained through the search of the databases. Thirty cases were classified as incidental deaths. Of these, only eight were identified through the combined database search. Finally, five deaths were due to unknown cause and three deaths did not meet the case definitions used for this report. The latter three cases included two incidental deaths occurring in the post-partum period that were neither direct nor indirect, and one death occurring 13 years after delivery. These eight deaths were not included in the MMR calculations.

As shown in Table 4, among women aged 20 years and older, the MMR increased with increasing maternal age. However, it should be noted that the number of deaths in several of the age categories was small and the resulting confidence intervals are wide.

The stage of pregnancy when maternal deaths occurred is presented in Figure 3. Over 70% of deaths occurred at 24 weeks' gestation or later. Of these deaths occurring at 24 weeks' gestation or later, almost half occurred in the post-partum period (less than 42 days after delivery).

Direct Maternal Deaths in Canada (excluding Quebec), 1997-2000

The principal causes of the 44 direct maternal deaths are listed in Table 5. Pulmonary embolism and pre-eclampsia/pregnancy-induced hypertension were the leading causes of direct maternal death, each accounting for nine or 20.5% of direct maternal deaths. The MMR for each of these two leading causes of direct maternal death was 0.85 per 100,000 live births.

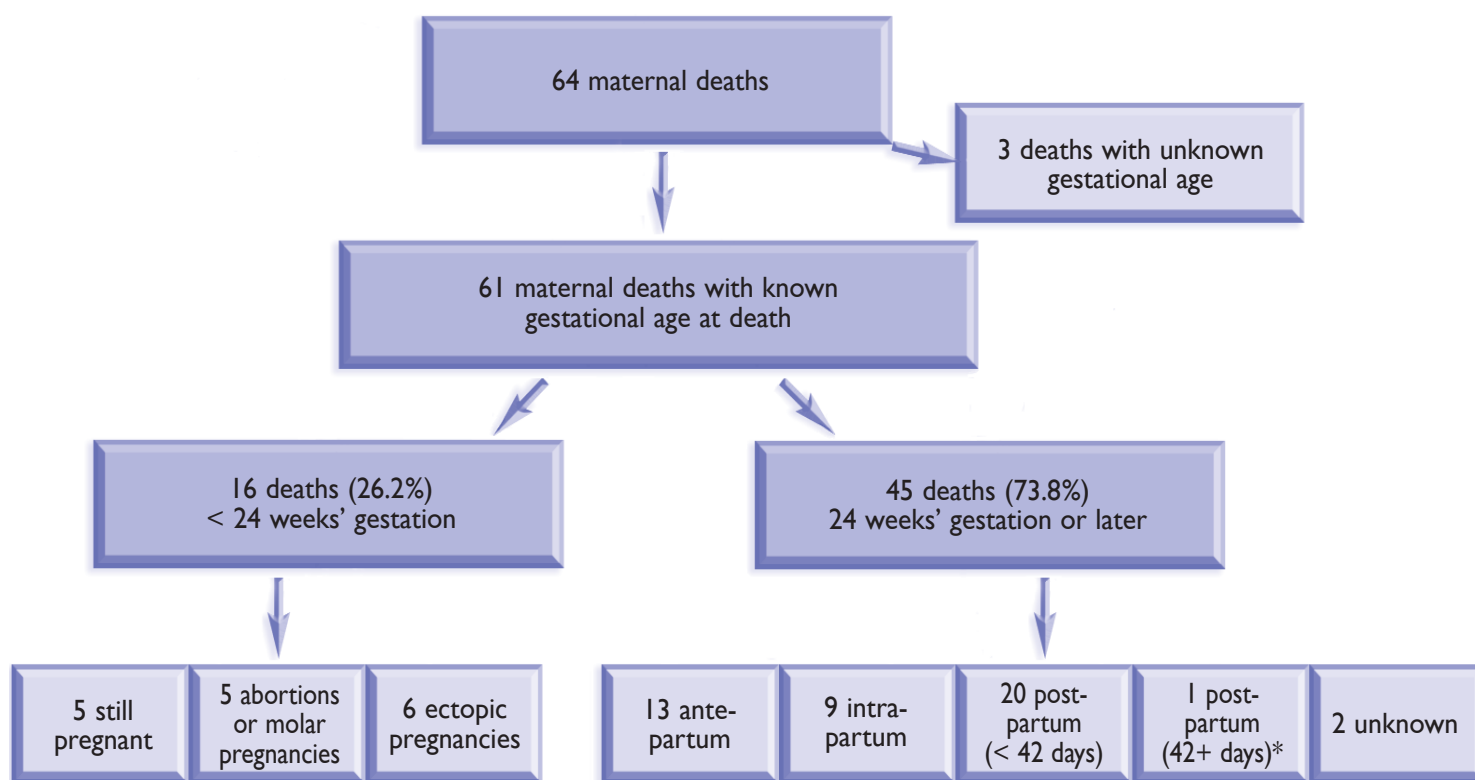
Of the nine deaths attributed to pulmonary embolism, four were classic cases of post-partum pulmonary embolism, two of the nine women had evidence of an underlying condition predisposing them to pulmonary embolism, and at least two women had a history of potentially inadequate thromboprophylaxis. One woman experienced an air embolism. Of the nine deaths attributed to pre-eclampsia/pregnancy-induced hypertension, five died from an intra-cranial hemorrhage. At least five of these nine women were under medical supervision and/or receiving medical management for pre-eclampsia/pregnancy-induced hypertension that had been identified prior to their death.

Amniotic fluid embolism (AFE) and intra-cranial hemorrhage (ICH) were the next leading causes of direct maternal death, each responsible for seven or 15.9% of direct maternal deaths. The MMRs for both AFE and ICH were 0.66 per 100,000 live births.

Table 4 Maternal mortality ratio (MMR) per 100,000 live births, by maternal age, Canada (excluding Quebec), 1997-2000

Age	Maternal deaths	Live births	MMR (95% CI)
< 20 years	2	62,236	3.2 (0.4-11.7)
20-24 years	4	187,062	2.1 (0.6-5.4)
25-29 years	16	321,753	5.0 (2.8-8.1)
30-34 years	24	316,588	7.6 (4.9-11.3)
35-39 years	15	142,968	10.5 (5.9-17.3)
40 years and older	3	24,221	12.4 (2.6-36.2)
Total	64	1,054,828	6.1 (4.7-7.7)

Figure 3 Stage of pregnancy of maternal deaths, Canada (excluding Quebec), 1997-2000



* Although this death occurred 60 days following delivery, the event leading to death occurred four hours post-partum. As a result, this death was included as a direct maternal death.

Of seven cases of AFE, five women had a clinical picture consistent with disseminated intra-vascular coagulation and hemorrhage. The seven cases of ICH included four with intra-cerebral hemorrhage, two with subarachnoid hemorrhage and one with pontine hemorrhage. The latter case was not typical of pregnancy-related ICH but was still classified as a direct maternal death due to ICH.

Ectopic pregnancies accounted for six or 13.6% of direct maternal deaths, for a MMR of 0.57 per 100,000 live births. In three of these cases, a diagnosis of ectopic pregnancy was missed, despite the women having sought medical attention. A fourth death was procedure related during laparoscopic management of an ectopic pregnancy.

Finally, hemorrhage was the principal cause of four or 9.1% of direct maternal deaths, for a MMR of 0.38 per 100,000 live

births. Hemorrhage also played a significant role in several maternal deaths that were ultimately attributed to other causes. Of note, from 1997 to 2000, no maternal deaths were attributed to primary post-partum hemorrhage.

Indirect Maternal Deaths in Canada (excluding Quebec), 1997-2000

The principal causes of the 20 indirect maternal deaths are listed in Table 6. The leading cause of indirect maternal death was cardiovascular disease, accounting for 12 or 60% of indirect deaths, for a MMR of 1.1 per 100,000 live births. One of the leading causes of indirect death within the cardiovascular disease category was coronary artery disease. Two of the four women whose death was attributed to coronary artery disease had a history of diabetes.

Table 5 Direct maternal deaths, by principal cause, Canada (excluding Quebec), 1997-2000

Cause of death	Number
Pulmonary embolism	9
Pre-eclampsia/pregnancy-induced hypertension	9
Amniotic fluid embolism (AFE)	7
Intra-cranial hemorrhage (ICH)	7
Ectopic pregnancy	6
Hemorrhage	4
<i>Placenta previa</i>	2
<i>Uterine artery tear</i>	1
<i>Intra-abdominal hemorrhage of unknown etiology</i>	1
Other	2
<i>Septic abortion</i>	1
<i>Anaesthesia-related</i>	1
Total	44

Note: Each death was assigned one principal cause by the expert review committee.

Table 6 Indirect maternal deaths, by principal cause, Canada (excluding Quebec), 1997-2000

Cause of death	Number
Cardiovascular disease	12
<i>Coronary artery disease</i>	4
<i>Cardiomyopathy</i>	4
<i>Primary pulmonary hypertension</i>	1
<i>Dissecting aortic aneurysm</i>	1
<i>Acute viral myocarditis</i>	1
<i>Aortic valve disease</i>	1
Other	8
<i>Cerebrovascular accident</i>	3
<i>Connective tissue disorder</i>	2
<i>Diabetes</i>	1
<i>Thrombotic thrombocytopenia</i>	1
<i>Adrenal insufficiency</i>	1
Total	20

Note: Each death was assigned one principal cause by the expert review committee.

Incidental Deaths in Canada (excluding Quebec), 1997-2000

The principal causes of the 30 incidental deaths are listed in Table 7. Injuries, and motor vehicle crashes in particular, were the leading cause of incidental deaths. Motor vehicle crashes accounted for over 65% of the injury-related deaths and 50% of all the incidental deaths. Of the 15 women who died as a result of a motor vehicle crash, 14 were occupants of a vehicle. Of these fourteen women, at least two were not wearing seat belts. In an additional five cases, it was unclear from the case reports whether seat belts had been properly worn. There was evidence of seat belt malfunction in one death.

Severe Maternal Morbidity in Canada (excluding Manitoba, Quebec and Nova Scotia), 1991-1992 to 2000-2001

A total of 2,548,824 delivery records were abstracted from CIHI's DAD for the period 1991-1992 to 2000-2001. Overall, 11,775 cases

of severe maternal morbidity were identified for a corresponding rate of 4.62 per 1,000 deliveries (see Table 8).

As Table 9 demonstrates, the rates of obstetrical pulmonary embolism (not including AFE), uterine rupture, adult respiratory distress syndrome, pulmonary edema, myocardial infarction, severe post-partum hemorrhage requiring hysterectomy and assisted ventilation increased substantially (50% or greater); the rates of cerebrovascular disorders in the puerperium (including intra-cranial venous sinus thrombosis) increased moderately (increase of less than 50%); and the rates of shock, severe post-partum hemorrhage requiring transfusion, and severe post-partum hemorrhage requiring hysterectomy or transfusion decreased. The rates of AFE, eclampsia, pulmonary, cardiac and central nervous system (CNS) complications of anaesthesia, acute renal failure following labour and delivery, cardiac arrest/failure or cerebral anoxia following obstetrical surgery, and overall severe maternal morbidity showed no consistent trends.

Table 7 Incidental deaths, by principal cause, Canada (excluding Quebec), 1997-2000

Cause of death	Number
Injuries	23
<i>Motor vehicle traffic crashes</i>	15
<i>Intentional self-inflicted injury or poisoning</i>	4
<i>Injury or poisoning of undetermined intent</i>	2
<i>Injury due to assault</i>	1
<i>Unintentional poisoning</i>	1
Other	7
Sepsis	3
Epilepsy	2
Hemorrhage	2
Total	30

Note: Each death was assigned one principal cause by the expert review committee.

Table 8 Occurrence of severe maternal morbidity in Canada (excluding Manitoba, Quebec and Nova Scotia), 1991-1992 to 2000-2001

Condition	Number of cases	Rate (per 1,000 deliveries)	95% CI
Amniotic fluid embolism (AFE)	151	0.06	0.05-0.07
Obstetrical pulmonary embolism (not including AFE)	407	0.16	0.14-0.18
Eclampsia	973	0.38	0.36-0.41
Shock (obstetrical, septic and other)	829	0.33	0.30-0.35
Pulmonary, cardiac and central nervous system (CNS) complications of anaesthesia	1,246	0.49	0.46-0.52
Cerebrovascular disorders in the puerperium (including intra-cranial venous sinus thrombosis)	412	0.16	0.15-0.18
Uterine rupture	1,898	0.74	0.71-0.78
Adult respiratory distress syndrome	205	0.08	0.07-0.09
Pulmonary edema	402	0.16	0.14-0.17
Myocardial infarction	31	0.01	0.01-0.02
Acute renal failure following labour and delivery	219	0.09	0.07-0.10
Cardiac arrest/failure or cerebral anoxia following obstetrical surgery	2,677	1.05	1.01-1.09
Post-partum hemorrhage requiring hysterectomy	892	0.35	0.33-0.37
Post-partum hemorrhage requiring transfusion	2,317	0.91	0.87-0.95
Post-partum hemorrhage requiring hysterectomy or transfusion	3,114	1.22	1.18-1.27
Assisted ventilation	387	0.15	0.14-0.17
Delivering women with one or more conditions	11,775	4.62	4.54-4.70

CI — confidence interval.

Table 9 Occurrence of severe maternal morbidity in Canada (excluding Manitoba, Quebec and Nova Scotia), 1991-1992 to 1993-1994 and 1998-1999 to 2000-2001

Condition	Rate (per 1,000 deliveries) 1991-1993	Rate (per 1,000 deliveries) 1998-2000	Relative risk (95% CI)
Amniotic fluid embolism (AFE)	0.06	0.05	0.83 (0.54-1.31)
Obstetrical pulmonary embolism (not including AFE)	0.12	0.20	1.73 (1.33-2.24)
Eclampsia	0.38	0.33	0.88 (0.75-1.05)
Shock (obstetrical, septic and other)	0.38	0.28	0.75 (0.63-0.89)
Pulmonary, cardiac and central nervous system (CNS) complications of anaesthesia	0.48	0.51	1.06 (0.92-1.22)
Cerebrovascular disorders in the puerperium (including intra-cranial venous sinus thrombosis)	0.14	0.19	1.42 (1.10-1.82)
Uterine rupture	0.58	0.92	1.60 (1.42-1.81)
Adult respiratory distress syndrome	0.07	0.10	1.50 (1.05-2.13)
Pulmonary edema	0.10	0.22	2.09 (1.60-2.72)
Myocardial infarction	0.00	0.02	3.70 (1.21-11.35)
Acute renal failure following labour and delivery	0.07	0.09	1.20 (0.84-1.71)
Cardiac arrest/failure or cerebral anoxia following obstetrical surgery	1.05	0.96	0.91 (0.82-1.00)
Post-partum hemorrhage requiring hysterectomy	0.26	0.46	1.76 (1.48-2.08)
Post-partum hemorrhage requiring transfusion	1.27	0.63	0.50 (0.44-0.55)
Post-partum hemorrhage requiring hysterectomy or transfusion	1.51	1.04	0.69 (0.63-0.76)
Assisted ventilation	0.10	0.24	2.47 (1.89-3.23)
Delivering women with one or more conditions	4.63	4.62	1.00 (0.95-1.04)

* Based on 1991-1993 as the reference.

CI — confidence interval.

Current Provincial/Territorial Maternal Death Review Activities

Investigation and reporting of maternal death in Canada is highly variable across the provinces and territories. The diversity of existing systems is striking — from comprehensive and highly detailed investigations to non-existent review mechanisms. Only four jurisdictions have province/territory-wide maternal death review committees with a mandate to investigate all maternal deaths. These committees work closely with coroners/medical examiners, vital statistics offices and hospitals to ensure complete ascertainment of maternal deaths. Once cases are ascertained, each committee conducts thorough reviews and determines the preventability of deaths, as well as likely sources of error. These committees represent an ideal model for provincial/territorial maternal death review activities.

In provinces and territories without active maternal death review committees, the coroners/medical examiners are likely notified of most, if not all, maternal deaths occurring in their jurisdiction. For most of these notified cases, a full coroner/medical examiner investigation will occur. Despite these efforts, in most provinces and territories, the results of coroner/medical examiner maternal death investigations are not collectively analyzed or categorized together as maternal deaths. Furthermore, the provinces and territories vary in defining which pregnancy-related deaths will be investigated, as well as the specific details collected for each maternal death. This variability is present even where review committees exist.

In many instances, the case details provided for this national review lacked the depth to completely assess the circumstances surrounding death. The data collection form, which was constructed from several existing maternal death review data collection tools, proved too detailed for this retrospective data collection

effort. In addition to pertinent details regarding medical management, specific information on low socioeconomic groups, Aboriginal women, recent immigrants to Canada and other vulnerable populations was not routinely available. Collection of these data, which may shed light on potential disparities in maternal death and severe illness in Canada, should be considered a priority for future reports. Finally, very limited information is disseminated regarding maternal death review activities in provinces and territories, and information is not systematically shared across jurisdictions.

Of note, efforts to highlight current provincial/territorial maternal death review activities for this report have already resulted in important steps to enhance maternal death review in Canada. First, in response to difficulties we encountered in obtaining case details of maternal deaths in Quebec, the Collège des Médecins du Québec has committed to establishing a process for maternal death reviews in Quebec and to collaborate on future Canadian maternal death review projects. Second, in response to our request for case details, one provincial death review committee identified potential gaps in its case notification mechanism. Subsequent improvement in this province-specific reporting procedure will ensure optimal ascertainment of maternal deaths in the future. Finally, requests for case details to one provincial chief coroner identified cases that were not reported to the coroner as required in the legislation; consequently, information sessions on reporting requirements were conducted for the area hospitals. These changes highlight the evolutionary process of maternal death surveillance in Canada. It is anticipated that each subsequent national report will result in further enhancements to the maternal death surveillance system at all levels, in addition to providing a valuable overview of maternal deaths in Canada.

Maternal Mortality in Canada

The total MMR of 6.1 per 100,000 live births (based on this review) is consistent with international estimates of the Canadian MMR, which accounted for probable under-reporting in the Canadian Vital Statistics System.² It is also consistent with estimates obtained from a previous record-linkage study.⁴ As highlighted in the introduction of this report, Canada's MMR is lower than MMR estimates from most other developed countries,² and also lower than MMRs from countries based on similar individual case reviews.⁶ The reason for Canada's relatively low MMR is not entirely clear. Universal health care coverage has been proposed as one possible explanation for Canada's enviable ranking.⁴ A population-based study conducted in North Carolina in the United States reported an adjusted odds ratio of 0.2 (95% CI 0.1-0.6) for pregnancy-related death associated with the receipt of prenatal care.¹⁹

The direct and indirect MMRs of 4.2 and 1.9 per 100,000 live births, respectively, were also within the range of previous Canadian estimates.⁴ The ratio of direct to indirect maternal deaths in Canada during 1997-2000 of 2.2:1 is very similar to the 2.3:1 ratio observed in Australia during 1994-1996.⁸ In contrast, the ratio of direct to indirect maternal deaths in the U.K. during 1997-1999 was 0.78, reflecting a greater inclination to classify non-direct deaths as indirect rather than incidental (see incidental deaths below).⁶ Furthermore, changes in maternal death classification guidelines between ICD-9 and ICD-10 clearly influence the distribution of deaths between the direct and indirect categories.⁴ For example, if future reports classify intra-cranial hemorrhage (ICH) as an indirect maternal death (in accordance with ICD-10), a marked decrease in the direct MMR and a concomitant increase in the indirect MMR is likely to be observed.

Maternal age was associated with the MMR, with a higher MMR observed with increasing maternal age after age 20. This maternal age effect has been consistently reported elsewhere.^{5,6,8} As the proportion of women who are delaying childbearing to later in life

has increased markedly in Canada in recent years,¹³ an age-related increase in the Canadian MMR may also be expected.

The five leading causes of direct maternal deaths were pulmonary embolism, pre-eclampsia/pregnancy-induced hypertension, amniotic fluid embolism (AFE), ICH and ectopic pregnancy. With the exception of ICH, these were also the most frequent causes of direct maternal death in the most recent report on maternal deaths in Australia.⁸ In the most recent U.K. data, thrombosis and thromboembolism, hypertensive disease of pregnancy, genital tract sepsis, ectopic pregnancy and AFE were the five leading causes of direct maternal deaths.⁶ As highlighted above, classification of ICH deaths will likely shift in future reports, and ICH will no longer remain a leading cause of direct maternal deaths.

Prevention of pulmonary embolism, the leading cause of direct maternal death in most reviews, has received particular attention. In the U.K., a substantial decline in the number of deaths due to pulmonary embolism has been attributed mainly to a marked decline in deaths after cesarean section following the 1995 publication of thromboprophylaxis guidelines.⁶ The most recent Canadian guidelines on the prevention and treatment of venous thromboembolism (VTE) in obstetrics were published by the Society of Obstetricians and Gynaecologists of Canada (SOGC) in 2000.²⁰ The case details that were available to us did not allow a complete review of the presence of risk factors and the compliance with preventive guidelines for all pulmonary embolism cases. However, suggestions of inadequate thromboprophylaxis were observed in at least two maternal deaths attributed to pulmonary embolism. Ongoing efforts should ensure that all health care workers are aware of, and in compliance with, SOGC clinical practice guidelines on the prevention and treatment of VTE in obstetrics. Adoption of more aggressive thromboprophylaxis guidelines may be an additional consideration.

As stated, pre-eclampsia/pregnancy-induced hypertension was a leading cause of direct maternal death in Canada during 1997-2000.

This has been consistently reported in other countries.^{5,6,8} The majority of deaths attributed to pre-eclampsia/pregnancy-induced hypertension in this series involved ICH. The predominance of ICH among deaths due to hypertensive disease has also been reported elsewhere and attributed to a failure of effective antihypertensive management.⁶ The available case details did not allow a complete assessment of the role of medical management in these deaths. Nonetheless, this review highlights that pre-eclampsia/pregnancy-induced hypertension remains a potentially lethal disease that requires a collaborative, intensive approach to treatment. Recent advances in the clinical management of pre-eclampsia/pregnancy-induced hypertension, for example, magnesium sulphate treatment, may result in a reduction in the number of maternal deaths attributed to this condition.²¹

Amniotic fluid embolism was a major cause of direct maternal death in Canada. Again, this finding has been reported elsewhere.^{6,8} Several possible risk factors for AFE have been previously identified, including advanced maternal age and use of oxytocic drugs.⁶ In this series, none of the seven women whose death was attributed to AFE was older than 34 years of age; three of seven cases involved induction of labour with oxytocic drugs. Despite the identification of risk factors, the ability to prevent AFE remains elusive.⁶

Of particular concern is the number of women who died due to an ectopic pregnancy despite seeking medical care for their symptoms. In one instance, further investigations (i.e., ultrasound) were not performed despite abdominal cramping and a positive pregnancy test. In a second case, symptoms were primarily gastrointestinal in nature. This concerning pattern of death from a ruptured ectopic pregnancy following presentation with gastrointestinal or urinary tract symptoms has been described elsewhere.⁶ Health care provider education and training should reinforce the need for a high index of suspicion of ectopic pregnancy, particularly with atypical presentations.

The absence of a single maternal death attributed to primary post-partum hemorrhage is encouraging. Once a leading cause of maternal

death in Canada and still a leading cause of maternal death worldwide,²² this finding is emblematic of the progress in reducing maternal mortality in many developed countries, including Canada. A similar reduction in maternal deaths attributed to primary post-partum hemorrhage has been reported elsewhere.^{6,8} Nonetheless, as discussed in this report, hemorrhage remains an important factor in many maternal deaths ultimately attributed to other causes. Furthermore, obstetric hemorrhage remains a major cause of severe maternal morbidity, even where its importance as a cause of maternal mortality has been reduced.¹¹

Three direct maternal deaths resulted from surgical or anaesthetic misadventure — a lacerated uterine artery during assisted vaginal delivery, a perforated abdominal aorta during laparoscopic management of an ectopic pregnancy and an inadvertent extubation post-operatively. While Canada's low MMR speaks to the safety of childbirth for women in Canada, these deaths are a sobering reminder of the risks associated with surgical intervention. As the rate of cesarean deliveries has been increasing steadily in Canada in recent years,¹³ an increase in the number of maternal deaths due to surgical and anaesthetic complications may be expected. Sound education, rigorous training requirements and constant vigilance are required to avoid such tragic cases.

Cardiovascular disease was the leading cause of indirect maternal deaths, as well as the single leading cause of maternal death overall. This prominence of cardiovascular disease deaths among all maternal deaths has also been reported in the U.K. and Australia.^{6,8}

As noted, among indirect maternal deaths attributed to cardiovascular disease during 1997-2000, coronary artery disease was the co-leading cause. Two of the four women who died of coronary artery disease had a medical history of diabetes. A high mortality rate among pregnant diabetics with ischemic heart disease has been previously reported.²³ As maternal age continues to increase and risk factors for coronary artery disease, such as smoking and diabetes, remain prevalent, maternal deaths due to coronary artery disease

may increase.⁶ Health care providers must be aware of the important role of cardiovascular disease and, increasingly, coronary artery disease in maternal deaths.

Ascertainment of incidental deaths, and deaths due to injuries in particular, was likely not complete in this study. Nevertheless, careful review of the case reports revealed the prominent role played by injuries and, in particular, motor vehicle crashes as the leading cause of incidental deaths. In two of these deaths, the woman was not wearing a seat belt. The correct use of seat belts is one clear measure to reduce morbidity and mortality among pregnant women. In one study, proper seat belt use and crash severity were the two best predictors of maternal-fetal outcomes in motor vehicle crashes.²⁴ A survey from the U.K. published in 2000 reported that only 48% of women identified the correct way to wear a seat belt in pregnancy.²⁵ Another study reported that while 86% of women used restraints while pregnant, almost half used them incorrectly.²⁶ Transport Canada's road safety material regarding seat belt use in pregnancy states:

“Pregnant women should always wear the lap and shoulder seat belt. The lap belt should be snug and low over the pelvic bones and not against the soft stomach area. The shoulder belt should be worn across the chest. Worn properly, the seat belt will not harm the baby.”²⁷

Ongoing efforts in Canada must ensure that all pregnant women are aware of the importance and correct usage of seat belts in pregnancy.

As noted earlier, many deaths classified as incidental in this review might also be reasonably classified as indirect maternal deaths. For example, in U.K. enquiries and reports, deaths due to epilepsy and suicide (in the absence of a long-standing history of previous mental illness) are classified as indirect.⁶ In this review, these deaths were all

classified as incidental. Clearly, these divergent approaches to the classification of death will affect both the overall and the indirect MMR. Future reports should revisit the ideal classification of various causes of death.

Severe Maternal Morbidity in Canada

Severe maternal morbidity analyses represent an important supplement to maternal mortality reviews. Mantel et al. proposed a framework to define severe maternal morbidity or “near miss.”¹¹ They suggest that near miss and maternal death are events on a continuum from normal healthy pregnancy, to organ dysfunction, to organ failure, to death. The conditions and procedures analyzed in this study include many of the conditions suggested by Mantel et al. The overall rate of severe maternal morbidity in this analysis was 4.62 per 1,000 deliveries. The availability of comparative rates from population-based studies is limited. Two Nova Scotia studies reported rates of eclampsia and uterine rupture (including both complete rupture and dehiscence) of 0.27 and 0.34 per 1,000 deliveries, respectively.^{28,29} These rates are lower than those observed in this analysis (0.38 per 1,000 deliveries for eclampsia and 0.74 per 1,000 deliveries for uterine rupture).

The reason for the observed variation in rates is not clear. The Nova Scotia studies were based on a database that is more comprehensive with greater clinical detail than CIHI's DAD — the database used in this study. This additional detail may eliminate false positive diagnoses of specific conditions, resulting in lower rates. Regional variation in outcomes secondary to variation in clinical practice is another possible explanation that should be explored in future studies.

The reasons for the observed temporal trends in severe maternal morbidity are also complex. Some trends reflect changes in demographic and clinical characteristics of pregnant women in Canada. In the past decade, Canada has witnessed a substantial increase in advanced maternal age and multi-fetal pregnancy,¹³ both factors that increase the risk of maternal morbidity.^{13,30,31} In

addition, changes in clinical practice can result in corresponding changes in specific measures of maternal morbidity. This is particularly true for procedures that are directly related to differences in clinical management, such as hysterectomy and transfusion. In this analysis, the rate of post-partum hemorrhage requiring hysterectomy increased, while the rate of post-partum hemorrhage requiring transfusion decreased in recent years.

Trends in other conditions, such as uterine rupture, may also be related to changes in clinical practice. The increase in the rate of uterine rupture mirrors quite closely the increase in trial of labour and attempted vaginal birth after previous cesarean delivery in Canada.¹⁶ Finally, improvements in diagnosis can lead to disease reclassification, which can artificially increase the rates of some conditions, while reducing the rates for others.³² In-depth analysis of each specific condition is needed to clearly elucidate the etiology behind the observed trends. Consideration of indicators that combine severe maternal morbidity and maternal death, for example, the ratio of deaths to near misses, may provide additional useful information. Future efforts to develop comprehensive and consistent approaches to the analysis of severe maternal morbidity will ensure its central role in the surveillance of maternal health in Canada and elsewhere.

Strengths and Limitations

This study of maternal death and severe illness in Canada has several strengths. It is the first national report on maternal death to go beyond vital statistics and hospitalization databases and death certificate reviews to actually examine individual case reports and the medical circumstances surrounding death. It is also the first report to describe the nation-wide occurrence of overall severe maternal morbidity, as well as trends over time.

The study was able to ascertain and collect case details for most maternal deaths. The use of both the vital statistics and hospitalization databases to construct the list of database deaths likely captured most direct and indirect maternal deaths. Subsequently, collaboration

with coroners/medical examiners, as well as existing provincial and territorial death review committees, resulted in coroner/medical examiner reports or completed data collection forms for most of these maternal deaths. Reports or data collection forms were obtained for almost 80% of the cases on the database death list.

Review of the remaining cases on the list for which reports could not be obtained suggested that several of these were not maternal deaths. Of the 64 direct or indirect maternal deaths ultimately included in the case review, all but three had been ascertained through the original database search. The MMRs based on this case review were consistent with previous estimates of the Canadian MMR, which had accounted for anticipated under-ascertainment of maternal deaths in the Canadian Vital Statistics System. Also, the distribution of maternal death by direct vs. indirect and specific causes was fairly consistent with reports from other countries.^{6,8} This further supports the relatively complete ascertainment of maternal deaths in this report for the population under study.

This study also suffers from several limitations. Quebec was not included in the maternal death review because of the limited availability of case details from that province. Manitoba, Quebec and Nova Scotia were all excluded from the analysis of severe maternal morbidity because of the limitations of the database used for that period of study.

Some maternal deaths were not included in the data presented. First, three cases from the list of database deaths were confirmed with provincial and territorial contacts, but additional case details were not available. In two instances, despite notification to the coroner, the deaths were classified as “non-coroner cases” and no formal investigation was conducted. In the third case, the coroner was able to confirm that the case existed, but the hospital had not complied with reporting procedures, and case details were not available in time for this report. (These three cases were not included in the data presented.) Second, previous reports have concluded that

cerebrovascular disorders may be particularly prone to under-reporting in the vital statistics system.⁴ In addition, the hospitalization database search may not have captured all cases of maternal death due to cerebrovascular disorders, particularly if the event occurred in the post-partum period. As a result, these deaths may not have been completely ascertained.

As well, the new category of “late maternal death” was likely not complete in this analysis. Only one late maternal death was ascertained during 1997-2000. This finding is not unexpected, as the ICD-10 coding system with a definition for late maternal death was implemented for year 2000 deaths only. Furthermore, the definition of maternal death used by most of the provincial/territorial death review committees does not include deaths beyond 90 days. Future reports may capture an increasing number of late maternal deaths.

As highlighted, incidental deaths were likely not well ascertained in this study. Only eight of thirty incidental deaths reviewed in this analysis were detected in the database review. The additional 22 reports of incidental deaths were received from just two of the ten provinces and three territories. It is likely that other jurisdictions had incidental deaths that were either not reported to the coroner/medical examiner or provincial/territorial review committee, or were not easily retrievable as incidental deaths by those bodies. As neither late maternal deaths nor incidental deaths are included in the MMR calculations, the poor ascertainment of these cases did not affect the reported MMRs.

As discussed above, another important limitation of this report is the variability in the detail and quality of the reports/data collection forms obtained. In many instances, the case details provided lacked the depth to completely assess the circumstances surrounding death.

It is important to note that the scope of this study did not include the broader issue of reproduction-related deaths, such as those due to sexually transmitted diseases or contraception.

Finally, the analysis of severe maternal morbidity was based solely on an administrative database. Such databases often lack pertinent clinical details and are prone to a certain degree of coding errors.³³ Conditions that are difficult to accurately and consistently diagnose, such as amniotic fluid embolism,³⁴ may be particularly prone to misclassification using administrative databases.

Fortunately, maternal death is rare in Canada. Nevertheless, review of the circumstances surrounding maternal death and severe illness provides important lessons for maternity care providers. Ongoing audit of death and severe illness must be a requirement for the maternity care system and for comprehensive perinatal health surveillance. This report marks the first step towards ensuring that these vital measures are consistently and routinely available.

Key Recommendations to Enhance Surveillance of Maternal Mortality and Severe Maternal Morbidity in Canada

1. Where feasible, specific maternal death review committees should be established (or maintained) as the ideal maternal death review mechanism.*
2. In jurisdictions without a specific maternal death review committee, the coroner/medical examiner should be a focal point for maternal death review activities.*
3. Whether in the form of a specific maternal death review committee or in collaboration with the coroner/medical examiner, an appropriate body should be authorized to review reports of maternal death and seek additional, pertinent case information as necessary.
4. Legislation on notification to coroners/medical examiners in all jurisdictions should specifically mention “pregnancy” to ensure complete ascertainment of maternal deaths.
5. Coroner/medical examiner reports on deaths during pregnancy or following pregnancy should be collated so that they are easily retrievable for maternal death review activities.
6. Consistency in the definition of maternal death and in the information collected on each maternal death should be attained across all jurisdictions, including attention to vulnerable populations.
7. An ongoing mechanism should be established for national synthesis and reporting of provincial/territorial maternal death investigations.
8. Maternal death review activities at the provincial/territorial, regional and national level must ensure timely feedback to health care providers and facilities active in maternity care.
9. Future efforts should refine the coding and classification system for severe maternal morbidity in Canada’s hospitalization databases, with particular attention to the change from ICD-9 to ICD-10.
10. Future reports should explore the use of indicators that combine severe maternal morbidity and maternal mortality, for example, the ratio of maternal deaths to “near miss.”
11. Consideration should be given to reviewing individual cases of specific types of severe maternal morbidity, where feasible.

*The size of the population may necessitate a regional-level review mechanism.

References

1. World Health Organization, United Nations Children's Fund. *Revised 1990 estimates of maternal mortality: a new approach by WHO and UNICEF*. WHO/FRH/MSM/96.11. Geneva: WHO, April 1996.
2. AbouZahr C, Wardlaw T. *Maternal mortality in 2000: estimates developed by WHO, UNICEF and UNFPA* [monograph on the Internet; cited 2003 Dec 2]. 2003. Available at: <http://www.childinfo.org/maternal_mortality_in_2000.pdf>.
3. World Health Organization. *Millennium Development Goals — Indicators* [homepage on the Internet; cited 2004 Feb 16]. Geneva: WHO, 2004. Available at: <http://www.who.int/mdg/goals/MDGsList_smartformat.pdf>.
4. Turner LA, Cyr M, Kinch RAH, Liston R, Kramer MS, Fair M, Heaman M. Under-reporting of maternal mortality in Canada: a question of definition. *Chronic Dis Can* 2002;23(1):22-30.
5. Chang J, Elam-Evans LD, Berg CJ, Herndon J, Flowers L, Seed KA, Syverson CJ. Pregnancy-related mortality surveillance — United States, 1991-1999. *MMWR Surveill Summ* 2003;52(2):1-8.
6. Department of Health, Welsh Office, Scottish Office Department of Health, Department of Health and Social Services, Northern Ireland. *Why Mothers Die. Report on Confidential Enquiries into Maternal Deaths in the United Kingdom, 1997-1999*. London: The Stationary Office, 2001.
7. SafeMotherhood.org. *What is safe motherhood?* [homepage on the Internet; cited 2004 Feb 11]. 2002. Available at: <http://www.safemotherhood.org/about/whatis_sm.html>.
8. Australia Institute of Health and Welfare. *Report on Maternal Deaths in Australia, 1994-96*. AIHW Cat. No. PER 13. Canberra: Australia Institute of Health and Welfare, 2001.
9. Ellerbrock TV, Atrash HK, Hogue CJR, Smith JC. Pregnancy mortality surveillance: a new initiative. *Contemp Ob Gyn* 1988;31:23-34.
10. Baskett TF, Sternadel J. Maternal intensive care and near-miss mortality. *Br J Obstet Gynaecol* 1998;105(9):981-4.
11. Mantel GD, Buchmann E, Rees H, Pattinson RC. Severe acute maternal morbidity: a pilot study of a definition for a near-miss. *Br J Obstet Gynaecol* 1998;105(9):985-90.
12. Drife JO. Maternal “near miss” reports? *BMJ* 1993;307(6912):1087-8.
13. Health Canada. *Canadian Perinatal Health Report, 2003*. Ottawa: Minister of Public Works and Government Services, 2003.
14. Turner LA, Kramer MS, Liu S. Cause-specific mortality during and after pregnancy and the definition of maternal death. *Chronic Dis Can* 2002;23(1):31-6.
15. Liu S, Heaman M, Kramer MS, Demissie K, Wen SW, Marcoux S. Length of hospital stay, obstetric conditions at childbirth, and maternal readmission: a population-based cohort study. *Am J Obstet Gynecol* 2002;187(3):681-7.
16. Wen SW, Rusen ID, Walker M, Liston R, Kramer MS, Baskett T, Heaman M, Liu S. Comparison of maternal mortality and morbidity between trial of labour and elective cesarean section among women with previous cesarean delivery. *Am J Obstet Gynecol* 2004 (in press).
17. World Health Organization. *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, 9th Revision, Vol. 1*. Geneva: WHO, 1977.
18. World Health Organization. *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, 10th Revision, Vol. 1*. Geneva: WHO, 1993.

19. Harper MA, Byington RP, Espeland MA, Naughton M, Meyer R, Lane K. Pregnancy-related death and health care services. *Obstet Gynecol* 2003;102:273-8.
20. Society of Obstetricians and Gynaecologists of Canada. *Prevention and Treatment of Venous Thromboembolism (VTE) in Obstetrics. SOGC Clinical Practice Guidelines for Obstetrics, Number 95*. Ottawa: SOGC, 2000.
21. Magpie Trial Collaboration Group. Do women with pre-eclampsia, and their babies, benefit from magnesium sulphate? The Magpie Trial: a randomized placebo-controlled trial. *Lancet* 2002;359:1877-90.
22. Global Health Council. *Making childbirth safer through promoting evidence-based care* [monograph on the Internet; cited 2004 Feb 11]. Washington: Global Health Council, 2002. Available at: <<http://www.globalhealth.org/assets/publications/MakingChildbirthSafer.pdf>>.
23. Bagg W, Henley PG, Macpherson P, Cundy TF. Pregnancy in women with diabetes and ischemic heart disease. *Aust N Z J Obstet Gynaecol* 1999;39(1):99-102.
24. Pearlman MD, Klinich KD, Schneider LW, Rupp J, Moss S, Ashton-Miller J. A comprehensive program to improve safety for pregnant women and fetuses in motor vehicle crashes: a preliminary report. *Am J Obstet Gynecol* 2000;182(6):1554-64.
25. Johnson HC, Pring DW. Car seatbelts in pregnancy: the practice and knowledge of pregnant women remain causes for concern. *BJOG* 2000;107(5):644-7.
26. Tyroch AH, Kaups KL, Rohan J, Song S, Beingesser K. Pregnant women and car restraints: beliefs and practices. *J Trauma* 1999;46(2):241-5.
27. Transport Canada. *Keep kids safe: car time 1-2-3-4* [homepage on the Internet; cited 2004 Feb 20]. Ottawa: Transport Canada, 2004. Available at: <<http://www.tc.gc.ca/roadsafety/tp/tp13511/en/tips.htm>>.
28. Lee W, O'Connell CM, Baskett TF. Maternal and perinatal outcomes of eclampsia: Nova Scotia, 1981-2000. *J Obstet Gynaecol Can* 2004;26:119-23.
29. Kieser KE, Baskett TF. A 10-year population-based study of uterine rupture. *Obstet Gynecol* 2002;100:749-53.
30. Hall MH, Bewley S. Maternal mortality and mode of delivery. *Lancet* 1999;354:776.
31. Wen SW, Demissie K, Yang Q, Walker M. Maternal morbidity and obstetric complications in triplets or higher order multiples. *Am J Obstet Gynecol* 2004 (in press).
32. Liu S, Semenciw R, Mao Y. Have diagnostic practices contributed to trends in leukemia incidence and mortality among Canadians? *Cancer Prev Control* 1999;3:202-6.
33. Huston P, Naylor CD. Health services research: reporting on studies using secondary data sources. *CMAJ* 1996;155:1697-702.
34. Davies S. Amniotic fluid embolus: a review of the literature. *Can J Anaesth* 2001;48(1):88-98.

Appendix A. Maternal Death Data Collection Tool

Date of form completion: _____

Province: _____

A. Background Information

1. Date of death _____

2. Date of birth _____

3. Age (in years) _____

4. Cause of death _____
(as determined by coroner/review committee where applicable/all sections on death certificate where available)

5. ICD-9 code _____

6. Was this a coroner's case _____

7. Was an autopsy performed _____

8. Gestation at time of death or termination of pregnancy _____

9. Was gestation confirmed by ultrasound _____

10. a) For deaths < 24 weeks' gestation: still pregnant _____
miscarriage/abortion/mole _____
ectopic _____

b) For deaths 24 weeks' gestation or later: ante-partum _____
intra-partum _____
post-partum < 42 days _____
post-partum _____

11. Place of death (hospital, home, other) _____

12. Deceased marital status _____

13. Deceased place of birth _____

- 14. Immigration status _____
- 15. Ethnicity _____
- 16. Language _____
- 17. Deceased occupation _____
- 18. Details of drug/alcohol/tobacco use _____
- 19. Relevant personal/social history/circumstances _____

B. Reproductive/Medical History

- 20. Contraceptive history (where available) _____
- 21. History of infertility (where available) _____
- 22. Previous pregnancies _____
(dates, gestation, birthweight, complications, delivery methods, other relevant details)
- 23. Past medical/surgical history _____

C. Current Pregnancy

- 24. LNMP _____
- 25. Ultrasound confirmation (if yes, at what gestational age) _____
- 26. Record of antenatal care _____
- 27. Specific comments of antenatal care _____

For deaths from miscarriage or termination of pregnancy

- 28. Date of miscarriage or TOP _____
- 29. a) Miscarriage (complete, incomplete, missed abortion, hydatidiform mole) _____
b) TOP (legal, other) _____
- 30. Location of death (home, hospital, other) _____

For deaths from ectopic pregnancy

- 31. Did the woman know she was pregnant _____
- 32. Was pregnancy confirmed by MD, midwife _____
- 33. Was diagnosis confirmed by ultrasound _____
- 34. Location of death _____
- 35. Medical personnel attending _____
- 36. Details of events leading to death, including operation, ICU _____

For deaths occurring before labour, other than ectopic or abortion

- 37. Cause of death _____
- 38. Summary of events _____

For deaths during labour and delivery

- 39. Date of delivery _____
- 40. Gestation at delivery _____
- 41. Admission to hospital (date and time) _____
- 42. Admission to delivery suite (date and time) _____
- 43. Onset of labour (date and time) _____
- 44. Place of delivery _____
- 45. Transfer in labour _____
- 46. Attendance during labour/delivery _____
- 47. Duration of labour by stage (hours and minutes) _____
- 48. Was labour spontaneous/induced (details of method, drug, dosages and times) _____
- 49. Mode of delivery _____
- 50. If assisted, method _____
- 51. Other relevant comments, including difficulty or delay in obtaining services/products, abnormalities arising out of labour, and indications for operative delivery

For cesarean section

52. Type _____

53. Medical staff _____

54. Describe operation and any difficulties encountered _____

Third stage

55. Estimated primary blood loss _____

56. Laceration/episiotomy/repair _____

57. Method of delivery of placenta _____

58. Membranes and placenta complete _____

59. Other comments on placenta _____

60. IV infusions required _____

61. Oxytocic drugs used during/after third stage _____

62. Other comments on third stage _____

Baby/babies

63. Birthweight _____

64. Gestational age at birth _____

65. Male/female _____

66. If live birth, outcome — asphyxia, death, transferred to ICU _____

67. If stillbirth, during/before labour _____

68. Autopsy findings on infant (where available) _____

Puerperium

69. Date of discharge _____
70. Time after termination of pregnancy (days/hours) _____
71. Details of any puerperal complications _____
72. Relevant laboratory findings, i.e., Hgb _____
73. Blood transfusion _____
74. Transfer to ICU _____
75. Readmission _____
76. Details of readmission (days after delivery, reasons) _____

D. Specific Categories of Death

Deaths from other medical or surgical conditions

77. Specific disorder _____
78. Pre-date pregnancy (age at onset and previous treatment) _____
79. Special care during pregnancy _____
80. Summary of events leading to death _____

Deaths from thromboembolism

81. Diagnosis date (gestation or time post-partum) _____
82. Site of thrombosis _____
83. Site of embolism _____
84. Past history of thromboembolism _____
85. Family history of thromboembolism _____
86. Risk factors _____
87. Thromboprophylaxis during pregnancy or delivery _____
88. Summary of events leading to death _____

E. Psychiatric and Social Services

89. History of problem _____

90. Summary of events leading to death _____

91. Mental health/social services provided before, during and after pregnancy _____

92. If suicide, post-natal depression, puerperal psychosis, relapse or recurrence of mental illness

Appendix B. Diagnostic and Procedure Codes Used in the Analysis of Severe Maternal Morbidity

International Classification of Diseases, Ninth Revision (ICD-9) Codes

1. Amniotic fluid embolism (AFE): 673.1
2. Obstetrical pulmonary embolism (not including AFE): 673.0, 673.2, 673.3, 673.8
3. Eclampsia: 642.6
4. Shock (obstetrical, septic and other): 669.1, 785.5, 998.0
5. Pulmonary, cardiac and central nervous system (CNS) complications of anaesthesia: 668.0, 668.1, 668.2
6. Cerebrovascular disorders in the puerperium (including intra-cranial venous sinus thrombosis): 674.0, 671.5, 430-434, 436, 437
7. Uterine rupture: 665.0, 665.1
8. Adult respiratory distress syndrome: 518.5, 518.81, 518.82
9. Pulmonary edema: 518.4, 428.1
10. Myocardial infarction: 410, 411
11. Post-partum hemorrhage requiring hysterectomy/transfusion:* 666.0, 666.1, 666.2, 666.3
12. Acute renal failure following labour and delivery: 669.3
13. Cardiac arrest/failure or cerebral anoxia following obstetrical surgery: 669.4

Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures (CCP) Codes

1. Ventilation: 13.62, 13.63
2. Transfusion (whole blood, packed cells): 13.03, 13.04
3. Abdominal hysterectomy: 80.2, 80.3

*Used in conjunction with CCP codes for transfusion or abdominal hysterectomy.

Appendix C. List of Acronyms

AFE	amniotic fluid embolism
CCP	Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures
CI	confidence interval
CIHI	Canadian Institute for Health Information
CNS	central nervous system
CPSS	Canadian Perinatal Surveillance System
DAD	Discharge Abstract Database
ICD-9	International Classification of Diseases, Ninth Revision
ICD-10	International Classification of Diseases and Related Health Problems, Tenth Revision
ICH	intra-cranial hemorrhage
MDGs	United Nations' Millennium Development Goals
MED-ÉCHO	Système de maintenance et d'exploitation des données pour l'étude de la clientèle hospitalière
MHSG	Maternal Health Study Group
MMR	maternal mortality ratio
PMSS	Pregnancy Mortality Surveillance System
SOGC	Society of Obstetricians and Gynaecologists of Canada
VTE	venous thromboembolism



**Special Report on Maternal Mortality and Severe Morbidity in Canada —
Enhanced Surveillance: The Path to Prevention**