Maternal Mortality and Severe Maternal Morbidity Surveillance in Canada

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Abstract

The Canadian Perinatal Surveillance System has provided a comprehensive review of maternal mortality and severe maternal morbidity in Canada, and has identified several important limitations to existing national maternal data collection systems, including variability in the detail and quality of mortality data. The Canadian Perinatal Surveillance System report recommended the establishment of an ongoing national review and reporting system, as well as consistency in definitions and classifications of maternal mortality and severe maternal morbidity, in order to enhance surveillance of maternal mortality and severe maternal morbidity. Using review articles and studies that examined maternal mortality in general as opposed to maternal mortality associated with particular management strategies or conditions, maternal mortality and severe morbidity classifications, terminology, and comparative statistics were reviewed and employed to evaluate deficiencies in past and current methods of data collection and to seek solutions to address the need for enhanced and consistent national surveillance of maternal mortality and severe maternal morbidity in Canada.

Résumé

Le Système canadien de surveillance périnatale a fourni une analyse exhaustive de la mortalité maternelle et de la morbidité maternelle grave au Canada, et a identifié plusieurs limites importantes en ce qui concerne les systèmes nationaux existants de collecte de données maternelles, y compris la variabilité pour ce qui est du détail et de la qualité des données sur la mortalité. Le rapport du Système canadien de surveillance périnatale a recommandé la mise sur pied d'un système national continu d'analyse et de signalement, ainsi que le maintien d'une uniformité dans les définitions et les classifications de la mortalité maternelle et de la morbidité maternelle grave, et ce, afin d'améliorer la surveillance de la mortalité maternelle et de la morbidité maternelle grave. En utilisant des articles et des études d'analyse ayant examiné la mortalité maternelle en général (par opposition avec la mortalité maternelle associée à des stratégies de prise en charge ou à des pathologies particulières), les classifications, la terminologie et les statistiques comparatives portant sur la morbidité grave et la mortalité maternelles ont été analysées et utilisées pour évaluer les lacunes des méthodes passées et actuelles de collecte de données et pour chercher des solutions visant à répondre au besoin d'établir un système national amélioré et uniforme de surveillance de la mortalité maternelle et de la morbidité maternelle grave au Canada.

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INTRODUCTION

In 2004, the Canadian Perinatal Surveillance System provided a comprehensive review of maternal mortality (1997–2000) and severe maternal morbidity (1991–2001) in Canada.[1] This special report utilized data extracted from national administrative databases such as Statistics Canada's Canadian Vital Statistics System and the Discharge Abstract Database from the Canadian Institute for Health Information; additional information was obtained from provincial and territorial death review committees or coroners and medical examiners. The review identified several important limitations to existing national maternal data collection systems, including variability in the detail and quality of mortality data, under-reporting of maternal mortality by the Canadian Vital Statistics System, and the influence of changes in maternal death classification codes on the distribution of deaths between mortality categories (Table 1). Also, lower rates for selected severe maternal morbidities in provincial analyses than in the CPSS report suggested either that data collection differs between clinically focused provincial perinatal data-

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.

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bases or that patient demographics and clinical practice vary regionally. Among the recommendations to enhance surveillance of maternal mortality and severe maternal morbidity (Table 2), the CPSS emphasized a critical need for the establishment of an ongoing national review and reporting system, as well as consistency in definitions and classifications of maternal mortality and severe maternal morbidity.

In December, 2009, the University of Toronto coordinated a consensus meeting with national representation and international experts to review maternal mortality and severe morbidity classifications, terminology, and comparative statistics to evaluate deficiencies in past and current methods of data collection, and to seek solutions to address the need for enhanced and consistent national surveillance of maternal mortality and severe maternal morbidity in Canada.

METHODS

Prior to the consensus meeting, a Medline literature search was conducted using subject headings "maternal mortality" and "Canada." Review articles and studies that examined maternal mortality in general, as opposed to maternal mortality associated with particular management strategies or conditions, were selected. References from selected articles were also surveyed and further relevant studies selected and reviewed. A WHO study which systematically reviewed maternal morbidity and mortality worldwide was used as a reference for comparing Canadian to international statistics.[2] Publications referencing the WHO recent standardization of maternal mortality terminology were also reviewed.[3,4]

ABBREVIATIONS

CPSS	Canadian Perinatal Surveillance System
ICD	International Classification of Diseases and Related Health Problems
MMR	maternal mortality ratio

MATERNAL MORTALITY AND SEVERE MATERNAL MORBIDITY IN CANADA: WHERE ARE WE NOW?

Maternal Mortality

Maternal mortality is an important measure of quality in maternity care. There have been significant decreases in maternal mortality rates in developed countries during the 20th century,[5–7] and estimates of maternal mortality reported by the WHO in 2005 demonstrate that 99% of maternal deaths occur in developing countries.[8] Developing countries were shown to have an MMR of 450 maternal deaths per 100 000 live births, compared to the much lower MMR in developed countries of nine maternal deaths per 100 000 live births. The total MMR for Canada determined by the CPSS review was found to be lower than MMR estimates in other developed countries (6.1 per 100 000 live births).[7]

More recent observations of maternal mortality trends with time in the United States suggest that increases in pregnancy-related mortality ratios are likely due to improved ascertainment of pregnancy-related deaths.[6] Evaluation of documentation of maternal deaths in Canada demonstrated under-reporting of several important underlying causes of maternal death, including cerebrovascular disorders and pulmonary embolism, that was likely due to changes in coding and misclassifications.[9] The reporting of many indirect causes

Table 2. Key recommendations to enhance 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, with 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 misses.”
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

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of maternal deaths and the ascertaining of late pregnancy-related deaths such as those due to unintentional injury, violence, or mental illness required significant record review,[1] which becomes an important consideration in light of emerging information that (for the first time) more deaths were related to indirect causes than to direct causes.[7,10] In particular, suicide was one of the three leading causes of maternal deaths overall in the United Kingdom, and other violent causes and accidental drug overdoses also contributed to these increases in indirect maternal deaths.[7,10]

Severe Maternal Morbidity or Maternal Near Miss

Severe morbidity, or near-miss maternal mortality, has been proposed as a supplementary indicator for monitoring and improving the quality of maternity care,[11] although there are limited resources in place that allow national surveillance audits. The Netherlands report an incidence of severe maternal morbidity of 7.1 per 1000 deliveries (2004–2006),[12] with a rate of 5.3 per 1000 deliveries in Scotland (2003–2005),[7] and 5.1 per 1000 deliveries in the United States (1991–1997).[13] Severe maternal morbidity occurs in about 1 in 250 deliveries in Canada, for an overall rate of 4.38 per 1000 deliveries.[11] Challenges to our ability to compare quality of maternity care adequately between countries include changing demographic characteristics, changes in medical practice, organization resources for comprehensive data collection, and varying definitions of severe maternal morbidity (near miss).

Classifications of Maternal Mortality and Morbidity

A comprehensive review of maternal mortality and severe morbidity, with the ability to compare outcomes among hospitals, provinces, and countries, requires a consistent classification system. Several reviews have classified causes of maternal death as direct, indirect, and unrelated.[14–17] Perhaps the most well-established review of maternal mortality, the Confidential Enquiries into Maternal Deaths and Child Health in the United Kingdom classifies maternal deaths as direct, indirect, coincidental, and late.[7] This classification system was used by the CPSS in the special report[1] (Table 1) and allowed comparisons of maternal mortality ratios between Canada and other countries. The definitions were based on ICD codes.[18] Direct and indirect causes of death were defined using ICD-9 and ICD-10 versions. In ICD-10 incidental deaths previously referred to as fortuitous deaths were labelled pregnancy-related deaths, and direct and indirect deaths occurring between 42 days and one year after delivery were newly defined as late maternal deaths.

With important reductions in maternal mortality rates observed in developed countries, the evaluation of severe maternal

Table 3. WHO Maternal Near Miss Identification and Classification[3]

Clinical criteria	
Acute cyanosis	Loss of consciousness lasting ≥ 12 hours[e]
Gasping[a]	Loss of consciousness AND absence of pulse/heart beat
Respiratory rate > 40 or < 6 /min	Stroke[f]
Shock[b]	Uncontrollable fit/total paralysis[g]
Oliguria nonresponsive to fluids or diuretics[c]	Jaundice in the presence of pre-eclampsia[h]
Clotting failure[d]	
Laboratory-based criteria	
Oxygen saturation < 90% for ≥ 60 minutes	pH < 7.1
PaO_2/FiO_2 < 200 mmHg	Lactate > 5
Creatinine ≥ 300 µmol/1 or ≥ 3.5 mg/dl	Acute thrombocytopenia (< 50 000 platelets)
Bilirubin > 100 µmol/1 or > 6.0 mg/dl	Loss of consciousness AND the presence of glucose and ketoacids in urine
Management-based criteria	
Use of continuous vasoactive drugs[i]	Intubation and ventilation for ≥ 60 minutes not related to anesthesia
Hysterectomy following infection or hemorrhage	Dialysis for acute renal failure
Transfusion of ≥ 5 units red cell transfusion	Cardiopulmonary resuscitation (CPR)

[a]Gasping is a terminal respiratory pattern and the breath is convulsively and audibly caught.

[b]Shock is a persistent severe hypotension, defined by a systolic blood pressure < 90 mmHg for ≥ 60 minutes with a pulse rate of at least 120 despite aggressive fluid replacement (> 2L).

[c]Oliguria is defined as a urinary output < 30 mL/hr for 4 hours or < 400 mL/24 hr.

[d]Clotting failure can be assessed by the bedside clotting test or absence of clotting from the IV site after 7–10 minutes.

[e]Loss of consciousness is a profound alteration of mental state that involves complete or near-complete lack of responsiveness to external stimuli. It is defined as a Coma Glasgow Scale < 10 (moderate or severe coma).

[f]Stroke is a neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours.

[g]Condition in which the brain is in a state of continuous seizure.

[h]Pre-eclampsia is defined as the presence of hypertension associated with proteinuria. Hypertension is defined as a blood pressure of at least 140 mm Hg (systolic) or at least 90 mmHg (diastolic) on at least two occasions and at least 4–6 h apart after the 20th week of gestation in women known to be normotensive beforehand. Proteinuria is defined as excretion of 300 mg or more of protein every 24 h. If 24-h urine samples are not available, proteinuria is defined as a protein concentration of 300 mg/1 or more (≥ 1+ on dipstick) in at least two random urine samples taken at least 4–6 h apart.

[i]For instance, continuous use of any dose of dopamine, epinephrine or norepinephrine.

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morbidity (which includes those women requiring critical care and/or transfer to an intensive care unit) provides an alternative to the surveillance of maternal mortality and allows for optimization of quality obstetrical care. The Confidential Enquiries into Maternal Deaths and Child Health emphasizes the importance of reviewing cases of severe obstetric morbidity and complications (near-miss maternal mortality), but because of lack of resources, this is not yet possible.[7] While the United Kingdom Obstetric Surveillance System, the Scottish Confidential Audit of Severe Maternal Morbidity,[7] and others[4] define "near misses" as those women having organ dysfunction and organ failure who survive, the WHO emphasizes the challenges in applying this concept of near-miss maternal mortality.[2] Recently, the WHO Working Group on Maternal Mortality and Morbidity Classifications proposed a classification, based on organ systems, that allows for recognition of disease patterns, their relative importance, emerging priorities, and health system responses.[3]

GAPS IN CURRENT APPROACHES FOR COLLECTING DATA ON MATERNAL NEAR MISS: WHERE DO WE WANT TO BE?

International approaches to auditing maternal near miss are diverse, but they illustrate the value of administrative data, individual case review, and standardization of definitions for comparisons of near-miss rates over time and among countries.[2,18] In Canada, optimization of accurate data collection is limited by provincial differences in data collection, partial data collection by administrative databases, inadequate

consideration of social determinants of health, and inadequate categories in the definition of maternal near miss.

Reporting standards among Canadiam provinces vary widely.[1] The CPSS review of maternal mortality and severe morbidity highlighted limitations of hospitalization data for severe morbidity, such as specific coding errors in some provinces and incomplete data in others. National administrative databases in Canada, such as Canadian Institute for Health Information Discharge Abstract Database, are restricted in the amount of information available on demographic data, such as maternal age, parity, body mass index, or the timing in pregnancy of a morbid event. Currently, social determinants of health, information about which is essential for understanding how requirements such as clean water and adequate housing impact on rates of maternal near miss, are poorly collected nationally.[5,19] Collection of data on vulnerable populations, such as the Canadian Aboriginal populations, is deficient and requires comprehensive review and validation.

As previously emphasized, surveillance of maternal mortality and maternal near miss in Canada requires consistent and universally acceptable definitions to allow accurate documentation of maternal mortality and severe maternal morbidity, changes in outcomes over time, determination of MMR, and other relevant measures of quality of care, such as maternal death to near miss ratio. For example, changes in rates of induction of labour may alter the occurrence of amniotic fluid embolism, or management of atonic uterus may change from hysterectomy to use of transfusion of blood products. It is also necessary to consider pertinent categories for inclusion in the definition of maternal near miss, such as number of transfusions of more than five units of packed red blood cells, complete uterine rupture, eclampsia, hysterectomy, or ICU admission. Some ICD-10 codes may not adequately collect relevant information regarding maternal death, such as circumstances of suicide.

THE WHO CLASSIFICATION OF MATERNAL NEAR MISS

A recent WHO technical working group, a collaboration of clinicians, epidemiologists, program implementers, and researchers, established several principles regarding a current and appropriate classification system to facilitate the routine use of near-miss reviews for monitoring and improving the quality of obstetric care.[4] The system was required to be practical and understood by its users, with underlying causes exclusive of all other conditions, and compatible with and contributing to the 11th revision of ICD. Following an examination of the literature, of existing definitions, and of the feasibility for its application in a variety of settings, a definition with identification criteria for maternal near miss was developed and reviewed by external reviewers and stakeholders. This definition was tested in datasets in Brazil and Canada prior to review by the WHO Advisory Group and subsequent publication.[4]

The WHO definition of maternal near miss, "a woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy,"[3] reconciles previous near miss and severe acute maternal morbidity definitions, and is aligned with the definition of "maternal death" in ICD-10.[3] The WHO has proposed a standard terminology for cause of maternal death that includes the groups direct maternal deaths, indirect maternal deaths, and unanticipated complications of management, with categorization by these groups as well as by disease category and individual underlying causes. Deaths from suicide, from puerperal psychosis, and from postpartum depression were categorized as direct maternal deaths.[4] In particular, the identification criteria for maternal near miss are based on a set of markers that include basic laboratory tests, management-related markers, and clinical criteria based on the clinical assessment (Table 3).[3] Thresholds for these markers are derived from the Sequential Organ Failure Assessment score.[20] The WHO collection tool that includes the identification criteria is available in both paper form and electronically.

A CONFIDENTIAL ENQUIRY INTO MATERNAL DEATHS AND MATERNAL NEAR MISSES IN CANADA: CAN THIS BE A REALITY?

Administrative databases in Canada, such as Canadian Institute for Health Information Discharge Abstract Database, Statistics Canada's Canadian Vital Statistics System, and provincial administrative and perinatal databases, can provide some information on maternal mortality and maternal near miss, but there is currently no systematic mechanism in place on a national level to synthesize and report on maternal deaths in Canada.[1] There are variable reporting practices within provinces and territories, and reviews of maternal deaths by hospitals are not routinely available outside the institutions.[1] The development of a consistent and universally acceptable tool for the prospective ascertainment of data on maternal mortality and maternal near-miss events by the WHO should be a major step forward in promoting comprehensive surveillance of the quality of obstetrical care. This tool should facilitate comparisons over time and between countries. Several limitations of the tool have been identified, including some deficiencies in demographic and social determinants of health data collection and in categorizations of health outcomes. The tool is also based on the collection of hospital cases of maternal mortality and maternal near miss. As a result, it is unlikely to catch maternal deaths, and possibly severe maternal morbidities, that are somewhat remote from the birth event, and it is even more unlikely to capture late or "incidental" deaths. As previous Confidential Enquiries

into Maternal Deaths and Child Health reports have highlighted, these incidental deaths may be miscoded. Modifications to the tool to allow prospective collection of some of these predictors and outcomes, and augmentation of this tool with remaining information obtained from national and provincial administrative and perinatal databases (with deaths of women linked to births), for use in Canadian surveillance of maternal mortality and maternal near miss would be optimal. Involvement in data collection of front-line personnel, such as department or hospital heads and attending physicians, who have an interest in comprehensive data collection, should ensure timely access to complete information on these significant maternal events. Incorporation of local and jurisdictional review of these significant events should also ensure that the collected data are relevant to local stakeholders.

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REFERENCES

1. Maternal Health Study Group of the Canadian Perinatal Surveillance System. Special report on maternal mortality and severe morbidity in Canada. Enhanced surveillance: the path to prevention. Ottawa: Health Canada; 2004. Available at: http://www.phac-aspc.gc.ca/rhs-ssg/srmm-rsmm/index-eng.php. Accessed April 9, 2010.
2. Say L, Pattison RC, Gülmezoglu AM. WHO systematic review of maternal morbidity and mortality: the prevalence of severe acute maternal morbidity (near miss). Reprod Health 2004;1:3. doi:10.1186/1742–4755–1-3.
3. Say L, Souza JP, Pattison RC; WHO working group on maternal mortality and morbidity classifications. Maternal near miss—towards a standard tool for monitoring quality of maternal health care. Best Pract Res Clin Obstet Gynaecol 2009;23:287–96.
4. Pattinson R, Say L, Souza JP, van den Broek N, Rooney C. WHO maternal death and near-miss classifications. Bull World Health Organ 2009;87:733–804. Available at: http://www.who.int/bulletin/volumes/87/10/09–071001/en/index.html. Accessed April 9, 2010.
5. Hoyert DL, Danel I, Tully P. Maternal mortality, United States and Canada, 1982–1997. Birth 2000;27:4–11.
6. Chang J, Elam-Evans LD, Berg CJ, Herndon J, Flowers L, Seed KA, et al. Pregnancy-related mortality surveillance—United States, 1991–1999. MMWR Surveill Summ 2008;52:2–8.
7. Lewis G, ed. The Confidential Enquiry into Maternal and Child Health (CEMACH). Saving mothers' lives: reviewing maternal deaths to make motherhood safer—2003–2005. The seventh report on confidential enquiries into maternal deaths in the United Kingdom. London: CEMACH; 2007.
8. Maternal mortality in 2005. Estimates developed by WHO, UNICEF, UNFPA and The World Bank. Geneva: World Health Organization, WHO Press; 2007. Available at: http://www.who.int/whosis/mme_2005.pdf. Accessed April 9, 2010.
9. Turner LA, Cyr M, Kinch RAH, Liston R, Kramer MS, Fair M, et al. Maternal Mortality and Morbidity Study Group of the Canadian Perinatal Surveillance System. Under-reporting of maternal mortality in Canada: a question of definition. Chronic Dis Can 2002;23:22–30.
10. Stewart DE. A broader context for maternal mortality. CMAJ 2006;174:302–3.
11. Wen SW, Huang L, Liston RM, Heaman M, Baskett TF, Rusen ID, et al. Maternal Health Study Group, Canadian Perinatal Surveillance System. Severe maternal morbidity in Canada, 1991–2001. CMAJ 2005;173:759–63.
12. Zwart JJ, Richters JM, Ory F, deVries JIP, Bloemenkamp KW, van Roosmalen J. Severe maternal morbidity during pregnancy, delivery and puerperium in the Netherlands: a nationwide population-based study of 371,000 pregnancies. BJOG 2008;115:842–50.
13. Callaghan WM, Berg CJ. Pregnancy-related mortality among women age 35 years and older, United States, 1991–1997. Obstet Gynecol 2003;102:1015–21.
14. Baskett TF, Sternadel J. Maternal intensive care and near-miss mortality in obstetrics. Br J Obstet Gynaecol 1998;105:981–4.
15. Baskett TF, O'Connell CM. Severe obstetric morbidity: a 15-year population-based study. J Obstet Gynaecol 2005;25:7–9.
16. Baskett TF, O'Connell CM. Maternal critical care in obstetrics: J Obstet Gynaecol Can 2009;31:218–21.
17. Murphy C, Murad K, Deane R, Byrne B, Geary MP, McAuliffe FM. Severe maternal morbidity for 2004–2005 in three Dublin maternity hospitals. Eur J Obstet Gynecol Reprod Biol 2009;143:34–7.
18. World Health Organization. International classification of diseases. Available at: http://www.who.int/classifications/icd/en. Accessed April 9, 2010.
19. Penney G, Brace V. Near miss audit in obstetrics. Curr Opin Obstet Gynecol 2007;19:145–50.
20. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. Intensive Care Med 1996;22:707–10.

APPENDIX

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