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Maternal Morbidity and Near Misses: Determining the Real Numbers

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INTRODUCTION

Maternal morbidity, and in particular severe acute maternal morbidity (SAMM), is important in that it reflects a threat to maternal life. In many jurisdictions, maternal mortality is so low that studying maternal deaths alone provides an exceedingly narrow scope of information. With a fuller understanding of maternal morbidity and mortality, however, trends can be observed and gaps in care indentified, such that these parameters can be improved. Improving the health of mothers is a global priority, as reflected in the United Nations Millennium Development Goals[1].

To date, collection of maternal morbidity and mortality data has been hindered by variations in terminology and approach. First, several terms have been used to describe a significant threat to maternal life: severe maternal morbidity, SAMM and maternal near miss. Second, no standard approach exists for identifying a case where a maternal life was in jeopardy. To this end, World Health Organization (WHO) has sought to standardize terminology and case identification[2].

Research underway in Canada uses the new standardized terminology and case identification system proposed by WHO. Using this approach at the hospital level, and ultimately synthesizing these results with existing national database research, can provide much more comprehensive data on maternal near misses.

UNDERSTANDING WHO STANDARD TERMINOLOGY: MATERNAL NEAR MISS

As noted by Say *et al.*, three differing definitions of near miss or SAMM are found in the literature:

(1) A severe life-threatening obstetric complication necessitating an urgent medical intervention in order to prevent likely death of the mother;

(2) Any pregnant or recently delivered woman in whom immediate survival is threatened and who survives by chance or due to hospital care;

(3) A very ill woman who would have died had it not been that luck and good care was on her side[2].

Following a review of the literature and consultation with an international group of experts, the WHO Working Group on Maternal Mortality and Morbidity Classifications came up with a standard definition to describe severe threats to maternal life.

In the deliberations, the term 'near miss' was thought to best capture the intended meaning when considering a severe threat to maternal life[2]. This term has traditionally been used by the airline industry to describe a close call, or accident that was possible, but avoided[3]. In the medical field, it has been used similarly to refer to a situation that had the potential to cause harm, illness or injury, but did not[3].

In the context of maternal health, however, the near miss term historically has been used to refer to a condition where a woman experienced a severe complication, nearly died, but survived. Considering the term 'maternal near miss' best reflects the concept of 'nearly dying but surviving', the WHO Working Group recommended the use of this term instead of SAMM[2].

Next, a standard definition was proposed which would capture the meaning of the three differing definitions used in the literature. Furthermore, this definition is aligned with the International Statistical Classification of Diseases and Related Health Problems (ICD) 10th version[2].

A *maternal near miss* case[2] is therefore defined as: *'A woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy.'*

UNDERSTANDING WHO STANDARD APPROACH TO MATERNAL NEAR MISS CASE IDENTIFICATION

As identified by Say *et al.*[2], three main approaches facilitate maternal near miss case identification. First, *disease-specific criteria* use particular diseases, each with specific end-points that signify severe maternal morbidity. An example is pre-eclampsia, where the occurrence of specific negative sequelae (convulsions, hepatic involvement) signals a maternal near miss. Second, using *intervention-based criteria*, admission to an intensive care unit (ICU), for example, indicates a near miss. Third, *organ dysfunction criteria* can be applied, whereby certain markers, such as failure to form clots

or the need for a massive transfusion, represent a maternal near miss.

The WHO Working Group suggests that the organ dysfunction-based approach is 'the most promising frame for establishing a standard set of criteria'[2]. Although this approach would ideally rely on a minimum standard of critical care, including laboratory investigations, clinical criteria alone could be used to identify severe organ dysfunction in resource limited settings. Furthermore, the organ dysfunction-based approach is more comprehensive and more readily applied to a range of settings compared with disease-specific criteria, where there has been wide variation in outcomes used to identify maternal near miss, and when considering the likely exclusion of cases due to variable access to care when management-based criteria are used[2,4]. Table 1 describes advantages and disadvantages of each approach.

Organ system dysfunction-based approach

Specific criteria have been proposed to identify a near miss using the organ dysfunction-based approach. These include clinical criteria, laboratory marker and management-based proxies. Figure 1 outlines these criteria, delineated by organ system.

Means to collect maternal near miss data: the Canadian approach

Canadian stakeholders recently convened to improve maternal morbidity and mortality surveillance nationwide. Canada has unique barriers to efficient maternal health surveillance, including a large geographic area and division into multiple provinces and territories, each of which is separately responsible for health care delivery.

Multiple stakeholders are currently engaged in research or policy work to improve maternal health surveillance in Canada (not inclusive):

(1) The Public Health Agency of Canada (PHAC), which houses the Canadian Perinatal Surveillance System (CPSS) – the CPSS monitors, analyses and reports on the health of pregnant women, mothers and infants in Canada[9];

Table 1 Advantages and disadvantages of three approaches for use as a quality of care tool to identify maternal near miss cases. Reproduced from Say *et al.*[2], with permission

	Advantages	*Disadvantages*
Clinical criteria related to a specific disease entity	Straight forward to interpret Data can be obtained retrospectively from case notes and registers The quality of care of a particular disease can be assessed Complication rates for a particular disease can be calculated	Common direct causes of maternal mortality may be omitted* The criteria used to define morbidity often have too low a threshold of morbidity to be called maternal near miss Retrospectively collected information might be problematic due to poor documentation and hence bias† Difficult to use for ongoing audits for all morbidities‡
Intervention-based criteria	Simple to identify the cases usually on the basis of retrospective analysis of a register in the hospital Could be useful to identify the potential maternal near miss cases	Allows the identification of only a fraction of all severe morbidity cases, because of variation in accessibility of the intervention, eligibility criteria for an intervention, or in the case of ICU, what constitutes intensive care Biased by resources available**
Organ system dysfunction-based criteria	Mimics the confidential enquires into maternal death systems, thus the same system could be used to complement maternal death enquires. It might allow calculation of more stable summary measures of morbidity/mortality†† Allows for identification of critically ill women thereby establishing the pattern of diseases causing morbidity and their relative importance Allows for the identification of new and emerging disease priorities, and studying health system's response Keeps focus on severe diseases that should not cause death with appropriate care, such as severe PPH‡‡ Many hospitals have a severe adverse events committee and these can be a source of identifying cases Variation in defining identification criteria can be avoided particularly for similar settings, allowing the establishment of reliable summary estimates for maternal near miss	Dependent on existence of a minimum level of care including functioning laboratories and basic critical care monitoring Retrospective identification of cases might be difficult because of the inability to identify cases from registers

*In Waterstone *et al.*[5] pulmonary embolus was omitted because of the difficulty of diagnosing pulmonary emboli accurately when they are not fatal. Early pregnancy complications such as ectopic pregnancies and abortions are also often omitted

†Potentially the cases with the worst care would have the poorest notes

‡This system is useful to audit the care of a specific disease entity, but is not suitable for ongoing audits. The ability to examine the quality of care of a specific disease entity has been well illustrated by Bouvier *et al.*[6]

**A condition that is life threatening in a country where no appropriate response can be given may not be classified as a maternal near miss and interventions such as cesarean section may often be performed on women who are not suffering from severe morbidity

††As is currently being undertaken in Scotland[7]. The difference being the definition of the end point. Maternal death is easy to define, however, severe morbidity is more difficult, hence the need for objective criteria

‡‡It is not a common cause of death in high-income countries but is the most frequent cause of maternal near miss[7,8]

Box: Maternal life-threatening conditions

Dysfunctional system	Clinical criteria	Laboratory markers	Management based proxies
Cardiovascular	( ) Shock ( ) Cardiac arrest	( ) Severe hypoperfusion (lactate>5 mmol/L or >45mg/dL) ( ) Severe Acidosis (pH<7.1)	( ) Use of continuous vasoactive drugs ( ) Cardio-pulmonary resuscitation
Respiratory	( ) Acute cyanosis ( ) Gasping ( ) Severe tachypnea (Respiratory rate >40 bpm) ( ) Severe bradypnea (Respiratory rate <6 bpm)	( ) Severe hypoxemia (Oxygen saturation < 90% for ≥ 60 minutes or PaO2/FiO2<200)	( ) Intubation and ventilation not related to anaesthesia
Renal	( ) Oliguria non responsive to fluids or diuretics	( ) Severe acute azotemia (Creatinine ≥300μmol/l or ≥3.5 mg/dL)	( ) Dialysis for acute renal failure
Haematologic/ Coagulation	( ) Failure to form clots	( ) Severe acute thrombocytopenia (<50,000 platelets/ml)	( ) Massive transfusion of blood / red cells (≥ 5 units)
Hepatic	( ) Jaundice in the presence of preeclampsia	( ) Severe acute hyperbilirubinemia (Bilirubin>100 μmol/l or >6.0 mg/dL)	
Neurologic	( ) Prolonged unconsciousness (lasting >12h) ( ) Stroke ( ) Uncontrollable fit / status epilepticus ( ) Global paralysis		
Alternative severity proxy			( ) Hysterectomy following infection or haemorrhage

Figure 1 WHO near miss identification and classification tool. Adapted for Say *et al.*[2], with permission

(2) The Society of Obstetricians and Gynecologists of Canada (SOGC), a professional organization for gynecologists, obstetricians, family physicians, nurses, midwives and allied health professionals in Canada[10];

(3) Statistics Canada, a government agency that produces statistical information[11];

(4) The Canadian Institute for Health Information (CIHI), an independent, not-for-profit corporation that provides essential information on Canada's health system and the health of Canadians[12];

(5) The Canadian Maternal Morbidity Working Group, a group of researchers affiliated with various Canadian universities engaged in maternal morbidity and mortality research.

These stakeholders engage via national meetings and committees. Recent activities include a Joint SOGC–CPSS Committee on Maternal Mortality and Severe Morbidity aiming to make recommendations to improve national surveillance of maternal mortality and severe morbidity in Canada (written communication from Joint SOGC–CPSS Committee on Maternal Mortality and Severe Morbidity co-chair Kimberly Elmslie, PHAC, Ottawa, 2011 Feb 24). In addition, the Canadian Maternal Morbidity Working Group met with SOGC, Statistics Canada and CIHI representatives in late 2009 to discuss and create a consensus document on solutions for 'enhanced and consistent national surveillance of maternal mortality and severe maternal morbidity in Canada'[13].

To date, the primary research on maternal morbidity and mortality in Canada that looks at these entities broadly uses available databases[14–16]. Although database research is important in that it is simple, cost-effective and timely[16], it does have specific limitations which prevent a complete and comprehensive understanding of maternal near misses.

The Canadian Maternal Morbidity Working Group's consensus document outlined current deficiencies with maternal mortality and near miss surveillance in Canada. First, 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, do provide information on maternal mortality and maternal near miss, but without a systematic mechanism to compile these data nationally[13,14]. Furthermore, certain provinces may be excluded because of lack of participation in or alignment with existing databases[14,16]. Moreover, database research is subject to coding errors[13,15], and may not provide complete information regarding the relationship between various disease entities and conditions that threaten maternal life[15]. For example, a recent publication using data from the Discharge Abstract Database of CIHI identified temporal trends of increasing rates of severe PPH as well as acute renal failure and assisted ventilation. Based on information available from this particular database, it is not clear whether these trends were related or represented distinct pathological processes (Figure 2)[15].

Hospital-based maternal near miss research

Hospital-based research provides a more in-depth perspective on the relationship between certain disease entities and also can provide insight into the means by which social determinants of health factor into emerging trends. Although hospitals generally review cases of severe morbidity and mortality, these data are rarely available outside the respective institution, severely limiting national and international synthesis of data[13,14]. A standard approach to hospital-based data collection would allow for hospital to hospital comparisons as well as pooling of data to compare, for example, tertiary (i.e. high risk) centers with others.

Such a process would also identify trends based on patient features (i.e. obesity), hospital facilities (i.e. presence of ICU) or geographic considerations (i.e. distance to nearest hospital).

Hospital-based case identification is additionally advantageous in that any practitioner can use this approach, as it is simple and does not require detailed statistical knowledge. Furthermore, with the emergence of standardized case identification criteria from the WHO Working Group on Maternal Mortality and Morbidity Classifications, data can be pooled and compared across jurisdictions.

In accordance with the Canadian Maternal Morbidity Working Group's recommendations, efforts are currently underway to pilot an approach to maternal near miss research using the criteria proposed by the WHO Working Group. This approach is outlined in Figure 3.

Near miss cases will be defined using an organ-system dysfunction-based approach as outlined, and described in detail in the WHO near miss identification and classification tool in Figure 1.

All obstetric patients (more than 20 weeks pregnant) cared for at the piloting Canadian hospitals and meeting WHO near miss identification and classification tool criteria will be included as cases. No specific exclusion criteria are operational. The protocol will be circulated to all staff obstetricians and posted in the relevant clinical areas. If a patient fulfills any criteria listed in the WHO tool, the most responsible physician will be asked to report the case to the research team.

As a method of cross-reference, in order to ensure that no cases are overlooked, the research team will liaise with the blood bank and intensive care unit at their respective hospitals.

A time period of 1 year was chosen for this study to account for seasonal trends (i.e. illness related to flu), and because it is expected that there will be relatively few cases. One year of data collection should allow for an adequate initial pool of cases in order to:

(1) Assess the incidence of near misses at the piloting hospitals;

(2) Understand the major causes of maternal near miss at the piloting hospitals;

(3) Develop trial software designed to compile maternal near miss cases;

(4) Provide feedback to the Canadian Maternal Morbidity Working Group in advance of broader data collection nationally.

Being an exploratory pilot study, the goals are not to perform statistical analysis or derive specific conclusions, but rather to obtain an initial overview of the problem on which further research can be based.

Collected data will be stripped of identifying material, although age and health information relevant to the study will be maintained. Data will be entered into a software program, and will include details such as gravidity, parity, whether antenatal care was received, current pregnancy outcome, route of delivery, whether anesthesia was required, details regarding the primary obstetric problem (including pre-existing conditions like obesity and hypertension), details related to the near miss markers (using the organ system dysfunction-based approach) and details regarding the care received. Names of care providers involved in the case will NOT be included.

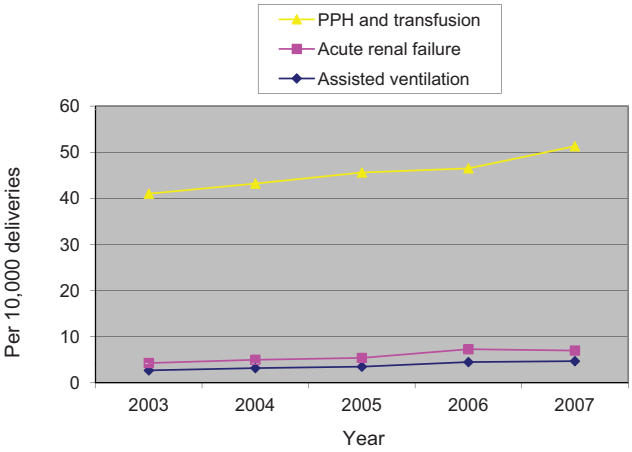

Figure 2 Near miss trends. Adapted from Liu *et al.*[11]

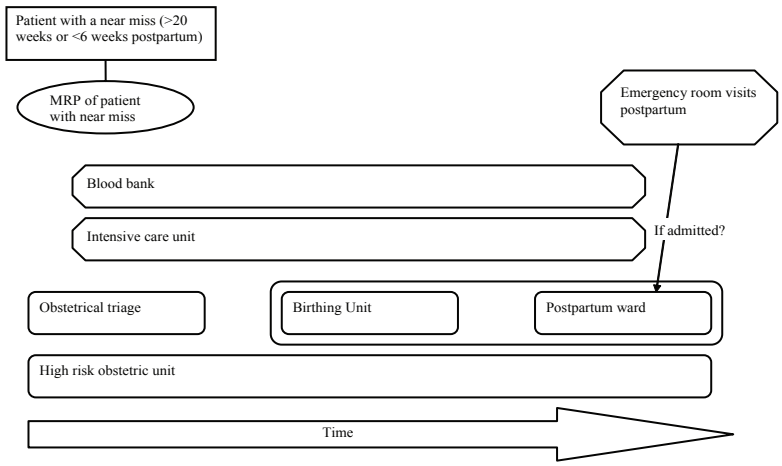

Figure 3 Hospital-based case identification flow chart. MRP, most responsible person

Upon completion of data collection, the data will be analysed and summarized according to recurring themes. These themes may be related to the primary obstetric problem (including predisposing conditions), details related to management (i.e. whether the patient underwent cesarean section) or any other commonality apparent on reviewing the data.

Ethical considerations in hospital-based maternal near miss research

Current estimates of the incidence of maternal near miss cases in Canada range from 4.62/1000 deliveries[14] to 13.8/1000 deliveries[16]. Thus, a large hospital with 3000 deliveries per year would expect anywhere from 13 to 42 cases. This is a relatively small number. When specific scenarios are considered, for example, the number of women requiring hysterectomy following infection or hemorrhage, the numbers will be even smaller when considered for only one institution. This may create a dilemma in that patient confidentiality must be maintained; however, there is great interest in understanding the circumstances surrounding particular cases. Thus, when data are published for an individual institution, there may be limitations in the number of details that can be included to ensure patient confidentiality. This barrier can be overcome when multiple institutions pool data.

Although the pilot studies in Canada will be subject to this barrier, once the hospital-based maternal near miss research is expanded more broadly, a wealth of data is expected that will surely compensate for this early limitation.

CONCLUSION

The development of a standardized definition and classification system by WHO is a critical tool in advancing maternal near miss research both in Canada and internationally. This tool will allow for cross-jurisdictional comparisons in maternal near miss research, and will ultimately advance understanding of current threats to maternal health.

Hospital-based maternal near miss research will supplement and fill gaps in existing database research currently conducted in Canada. With a more complete and comprehensive understanding of threats to maternal health, interventions can be designed to improve the health of mothers, in line with the United Nations Millennium Development Goals.

PRACTICE POINTS

- A complete and comprehensive understanding of threats to maternal health is required in order to improve the health of mothers
- Various approaches to maternal near miss research complement each other and provide a better understanding of emerging trends, interactions among different pathological processes, and interactions between pathology and social determinants of health
- Standardized terminology and classification systems to identify maternal near miss cases allow for cross-jurisdictional pooling and comparing of data, and ultimately a deeper understanding of threats to maternal health.

References

1. United Nations. Millennium Development Goals – Goal 5: Improve Maternal Health. 2011. http://www.un.org/millenniumgoals/maternal.shtml
2. Say L, Souza JP, Pattison RC. Maternal near miss – towards a standard tool for monitoring quality of maternal health care. Best Pract Res Clin Obstet Gynaecol 2009;23:287–96
3. Nashef SA. What is a near miss? Lancet 2003;361:180–1
4. Say L, Pattinson R, Gulmezoglu AM. WHO systematic review of maternal morbidity and mortality: the prevalence of severe acute maternal morbidity (near miss). Reprod Health 2004;1:3
5. Waterstone M, Bewley S, Wolfe C. Incidence and predictors of severe obstetric morbidity: case-control study. BMJ 2001; 322:1089–94
6. Bouvier-Colle M-H, Salanave B, Ancel PY. Obstetric patients in intensive care units and maternal mortality. RegionalTeams for the Survey. Eur J Obstet Gynecol Reprod Biol 1996;65:121–5
7. Brace V, Penney G, Hall M. Quantifying severe maternal morbidity: a Scottish population study. Br J Obstet Gynaecol 2004;111:481–4
8. Hall MH. Near misses and severe maternal morbidity. Why mothers die 1997–1999: The confidential enquiries into maternal deaths in the United Kingdom. London: RCOG Press: Department of Health, Welsh Office, Scottish Home and Health Department, Department of Health and Social Sciences, Northern Ireland, 2001:323–5
9. The Public Health Agency of Canada. Overview of the Canadian Perinatal Surveillance System. 2004. http://www.phac-aspc.gc.ca/rhs-ssg/overview-apercu-eng.php
10. The Society of Obstetricians and Gynaecologists of Canada. About SOGC. 2009. http://www.sogc.org/about/index_e.asp
11. Statistics Canada. About us. 2010. http://www.statcan.gc.ca/about-apercu/about-apropos-eng.htm
12. Canadian Institute for Health Information. Vision and Mandate. 2010. http://www.cihi.ca/CIHI-ext-portal/internet/EN/SubTheme/about+cihi/vision+and+mandate/cihi010703
13. Allen VM, Campbell M, Carson G, et al. Maternal mortality and severe morbidity surveillance in Canada. J Obstet Gynaecol Can 2010;32:1140–6
14. 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. http://www.phac-aspc.gc.ca/rhs-ssg/srmm-rsmm/index-eng.php
15. Liu S, Joseph KS, Bartholomew S, et al; Maternal Health Study Group of the Canadian Perinatal Surveillance System. http://www.ncbi.nlm.nih.gov/pubmed/21050517 Temporal trends and regional variations in severe maternal morbidity in Canada, 2003 to 2007. J Obstet Gynaecol Can 2010;32: 847–55
16. Joseph KS, Liu S, Rouleau J, et al; Maternal Health Study Group of the Canadian Perinatal Surveillance System. http://www.ncbi.nlm.nih.gov/pubmed/21050516 Severe maternal morbidity in Canada, 2003 to 2007: surveillance using routine hospitalization data and ICD-10CA codes. J Obstet Gynaecol Can 2010;32:837–46