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Maternal near miss in three tertiary-level hospitals in Hong Kong

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Background: Maternal near miss refers to women who nearly died from a complication during pregnancy. We applied the World Health Organization near miss criteria to determine the incidence and aetiologies of maternal near miss in Hong Kong.
Methods: Medical records of women in three tertiary-level maternity centres in Hong Kong in 2019 who met any of the clinical, laboratory, or management criteria for maternal near miss were retrospectively reviewed. The maternal-near-miss ratio was calculated by the number of maternal-near-miss cases per 1000 livebirths. Women who were admitted to an intensive care unit were compared with women who were not in terms of obstetric characteristics, aetiologies, and organ dysfunctions.
Results: There were 11 075 livebirths in the three hospitals in 2019. 61 maternal-near-miss cases were identified. 29 of these were admitted to an ICU; the median length of stay was 2 days. The maternal-near-miss ratio was 5.51 per 1000 livebirths. The most common cause of maternal near miss was postpartum haemorrhage (52.5%), followed by severe complications of abortion or early pregnancy (24.6%). The most common organ dysfunction was coagulation/haematological dysfunction (45.9%), followed by cardiovascular dysfunction (42.6%), and uterine dysfunction (16.4%). 11.5% of women had more than one organ dysfunction. 73.1% of women with cardiovascular dysfunction did not require ICU admission (p=0.05). Women with uterine dysfunction resulting in a hysterectomy were more likely to be admitted to an ICU (p=0.037). Interventional radiology was more commonly performed on those who were admitted to an ICU than those who were not (24.1% vs 3.1%, p=0.022).
Conclusion: Most maternal-near-miss cases were attributed to postpartum haemorrhage and early pregnancy complications. Early identification and close monitoring are effective in improving maternal healthcare.

Keywords: Intensive care units; Maternal mortality; Postpartum hemorrhage; Pregnancy complications

Background

Hong Kong boasts one of the lowest maternal mortality rates in the world, with 0.10 maternal death per 100 000 livebirths between 2008 and 2017, a dramatic reduction from 4.43 maternal deaths per 100 000 livebirths between 1946 and 1977[1]. However, the number of maternal mortalities may be under-reported due to the lack of a confidential enquiry system to record maternal-near-miss morbidities. Between 2000 and 2019, suicide and hypertensive disorders were the leading causes of maternal death in Hong Kong[2].

Maternal near miss refers to women who nearly die from a complication during pregnancy, childbirth, or within 42 days of pregnancy termination[3]. Maternal near miss and maternal mortality share similar characteristics and pathological processes. The World Health Organization (WHO) maternal-near-miss criteria are a standardised tool to identify maternal-near-miss cases (Appendix)[3]. The criteria are widely used to assess both maternal morbidity and standards of maternity care.

Data on maternal-near-miss cases in Hong Kong are lacking. Investigation of maternal mortality and near miss may help address deficiencies in maternal care and facilitate changes in healthcare strategies to prevent potentially life-threatening events. This study aimed to determine the incidence and aetiologies of maternal near miss across three tertiary-level hospitals in Hong Kong,

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using the WHO criteria. Characteristics of maternal-near-miss cases with or without admission to an intensive care unit (ICU) were compared.

Materials and methods

This was an observational study conducted in three tertiary-level maternity centres in Hong Kong, namely Queen Mary Hospital, Pamela Youde Nethersole Eastern Hospital, and Tuen Mun Hospital.

Medical records of women admitted in the three hospitals between 1 January 2019 and 31 December 2019 who met any of the WHO clinical, laboratory, or management criteria for maternal near miss were retrospectively reviewed. Data collected included duration of hospital stay, mode of delivery, and pathology of near miss. The maternal-near-miss ratio (MNMR) was calculated by the number of maternal-near-miss cases per 1000 livebirths.[3]

Data were analysed using SPSS (Windows version 26; IBM Corp, Armonk [NY], US). Characteristics of maternal-near-miss cases with or without admission to an ICU were compared using the Chi-square test or Fisher's exact test for categorical data. Associations between ICU admission and risk factors were presented as odds ratios and 95% confidence intervals. A p value of <0.05 was considered statistically significant.

Results

There were 11 075 livebirths in the three hospitals in 2019. Of 343 women identified to have severe maternal complications, critical interventions, or admission to an ICU, 61 who had severe maternal outcomes with organ dysfunction met the near-miss criteria. 29 out of these 61 patients were admitted to an ICU; the median length of stay was 2 days. There was no case of maternal mortality in our cohort. The MNMR was 5.51 per 1000 livebirths. The mean MNMR for women admitted to an ICU was 2.62 per 1000 livebirths.

Maternal near miss most commonly occurred at term (≥37 weeks) [39.3%], followed by during the first trimester (29.5%) and at 24 to 36 weeks of gestation (21.3%) [Table 1]. Not being admitted to an ICU was associated with non-booking status for maternal check-up (p=0.026) and a gestational age of <12 weeks at presentation (p=0.003).

The most common cause of maternal near miss was severe postpartum haemorrhage (52.5%), followed by severe complications of abortion or early pregnancy (24.6%) [Table 2]. The most common organ dysfunction was coagulation/haematological dysfunction (45.9%), followed by cardiovascular dysfunction (42.6%), and uterine dysfunction (16.4%) [Table 2]. 11.5% of women had more than one organ dysfunction. 73.1% of women with cardiovascular dysfunction did not require ICU admission (p=0.05). 65.6% of women received ≥5 units of blood product transfusion, which included packed cells, platelet concentrates, and fresh frozen plasma. Women with uterine dysfunction resulting in a hysterectomy were more likely to be admitted to an ICU (p=0.037). Interventional radiology was more commonly performed on those who were admitted to an ICU than those who were not (24.1% vs 3.1%, p=0.022, Table 2).

Discussion

In the present study, the MNMR was 5.51 per 1000 livebirths, which is comparable to MNMRs in other developed countries[4] and lower than that reported by the WHO[3]. There was no case of maternal mortality in our cohort.

Severe postpartum haemorrhage was the leading cause of maternal near miss, which is in line with the existing evidence[4]. Two-thirds of the maternal-near-miss cases who developed postpartum haemorrhage underwent Caesarean sections. Placenta praevia and placenta accreta spectrum were the most prevalent causes, resulting in 40% of the Caesarean sections in our cohort. In an Italian study, Caesarean section delivery carries a five-fold increased risk of maternal near miss, compared with vaginal delivery[5]. However, this association may be confounded, as Caesarean sections can result from underlying maternal and obstetrical conditions rather than being a standalone risk factor. Nonetheless, undergoing a Caesarean section has been shown to be an independent risk factor for maternal morbidity and mortality[6].

Physicians should be vigilant to prevent postpartum haemorrhages and be prepared to manage such situations should they occur. Early identification of patients with risk factors for postpartum haemorrhage and thorough planning can help reduce maternal mortality and morbidity. The use of tranexamic acid as a therapeutic adjunct to control postpartum haemorrhage is recommended, with early administration preferred[7]. In the present study, 84.4% of patients with postpartum haemorrhage were given tranexamic acid, and 10% of patients were given carbetocin. Oxytocin has long been used as a prophylactic measure to prevent postpartum haemorrhage; carbetocin is a newer long-acting synthetic analogue of oxytocin, with agonist

Table 1. Obstetric characteristics of maternal-near-miss cases with or without admission to an intensive care unit (ICU)

	ICU admission (n=29)*	No ICU admission (n=32)*	Odds ratio (95% confidence interval)	p Value
Age, y				0.614
<18	0	0	-	
18-34	9 (31.0)	12 (37.5)	Reference	
35-39	11 (37.9)	14 (43.8)	1.05 (0.32-3.38)	
≥40	9 (31.0)	6 (18.8)	2.00 (0.52-7.69)	
Ethnicity				0.307
Chinese	26 (89.7)	25 (78.1)	Reference	
Other Asian countries	3 (10.3)	7 (21.9)	0.41 (0.10-1.77)	
Caucasians and others	0	0	-	
Education level				0.174
Secondary or below	15 (51.7)	10 (31.3)	1.69 (0.49-5.85)	
Tertiary or above	8 (27.6)	9 (28.1)	Reference	
Unknown	6 (20.7)	13 (40.6)	0.52 (0.13-2.02)	
Body mass index at booking, kg/m^2				0.095
<18.5	2 (6.9)	0	3.57 (0.11-111.71)	
18.5-22.9	3 (10.3)	2 (6.3)	Reference	
23-24.9	5 (17.2)	5 (15.6)	0.67 (0.08-5.88)	
25-29.9	13 (44.8)	12 (37.5)	0.72 (0.10-5.10)	
≥30	4 (13.8)	2 (6.3)	1.33 (0.11-15.70)	
Unknown	2 (6.9)	11 (34.4)	0.12 (0.01-1.26)	
Parity				0.574
0	7 (24.1)	11 (34.4)	Reference	
1	15 (52.7)	16 (50.0)	1.47 (0.45-4.80)	
≥2	7 (24.1)	5 (15.6)	2.20 (0.50-9.75)	
Booking status				0.026
Booked	24 (82.8)	18 (56.3)	Reference	
Non-booked	5 (17.2)	14 (43.8)	0.27 (0.08-0.88)	
Gestational age at presentation				0.003
<12 weeks	3 (10.3)	15 (46.9)	0.17 (0.04-0.74)	
12-23 weeks	2 (6.9)	2 (6.3)	0.85 (0.10-7.04)	
24-36 weeks	11 (37.9)	3 (9.4)	3.10 (0.69-14.02)	
≥37 weeks	13 (44.8)	11 (34.3)	Reference	
Postpartum	0	1 (3.1)	0.28 (0.01-7.67)	
Timing of delivery				0.432
Preterm (24w0d-33w6d)	2 (6.9)	1 (3.1)	1.69 (0.14-21.27)	
Late preterm (34w0d-36w6d)	8 (27.6)	2 (6.3)	3.38 (0.50-19.38)	
Term (37w0d-39w6d)	13 (44.8)	11 (34.4)	Reference	
Past term (beyond 40w)	2 (6.9)	3 (9.4)	0.56 (0.079-4.01)	

* Data are presented as No. (%) of patients

Table 1. (cont'd)

	ICU admission (n=29)*	No ICU admission (n=32)*	Odds ratio (95% confidence interval)	p Value
Medical comorbidities				-
Cardiac disease	1 (3.4)	1 (3.1)		
Hypertension	2 (6.9)	0		
Psychiatric disorder	1 (3.4)	0		
Diabetes	0	1 (3.1)		
Haematological disease	0	3 (9.4)		
Respiratory disease	1 (3.4)	0		
Others	1 (3.4)	0		
Obstetric risk factors				
Fibroid	1 (3.4)	0		
Multiple pregnancy	0	2 (6.3)		
Gestational diabetes	7 (24.1)	3 (9.4)		
Hypertensive disorders in pregnancy	1 (3.4)	1 (3.1)		
Placenta praevia / placenta accreta spectrum	10 (34.5)	2 (6.3)		
Length of hospital stay				0.001
≤7 days	10 (34.5)	25 (78.1)		
>7 days	19 (65.5)	7 (21.9)		
Mode of delivery				0.058
Normal vaginal delivery	3 (10.3)	6 (18.8)	Reference	
Instrumental delivery	1 (3.4)	1 (3.1)	2.00 (0.09-44.4)	
Caesarean section	22 (75.9)	8 (25.0)	5.50 (1.11-27.37)	
Status of infant at birth				
Alive (one born at 23 weeks at peri-viability gestation)	26	15		
Dead	0	0		
Status of infant at hospital discharge or 7th day of life if still in hospital				0.524
Alive	24 (92.3)	15 (100)		
Dead	2 (7.7)	0		
Admission to ICU				-
1-3 days	25 (86.2)	-		
≥4 days	4 (13.8)	-		
Maternal death	0	0		-

properties that are more effective than oxytocin's[8] and a similar adverse effect profile. Nonetheless, larger trials of carbetocin are in progress, and cost-effectiveness of carbetocin has been inconclusive. In addition, radiological intervention such as arterial balloon catheter placement and uterine artery embolisation has effectively decreased the hysterectomy rate[9], which in turn minimises maternal near miss and mortality.

24.6% of maternal-near-miss cases were caused by severe abortion or early pregnancy complications. More than half of these patients required a laparotomy, but most patients did not require admission to an ICU, likely owing to the low risk of further bleeding. Blood transfusion to

Table 2. Causes of maternal near miss, types of organ dysfunction, and critical interventions in women with or without admission to an intensive care unit (ICU)

	ICU admission (n=29)*	No ICU admission (n=32)*	p Value
Cause			
Severe postpartum haemorrhage	17 (58.6)	15 (46.9%)	0.013
Severe pre-eclampsia	1 (3.4)	0	
Eclampsia	0	0	
Sepsis or severe systemic infection	2 (6.9)	1 (3.1)	
Ruptured uterus	1 (3.4)	1 (3.1)	
Severe complications of abortion or early pregnancy complications caused by ectopic pregnancy (n=11), scar pregnancy (n=3), and septic abortion (n=1)	2 (6.9)	13 (40.6)	
Others (acute liver failure, peripartum cardiomyopathy, pulmonary embolism, maternal congenital cardiac disease, metastatic carcinoma, postpartum stroke, and asthma)	6 (20.7)	2 (6.3)	
Organ dysfunction			
Cardiovascular	7 (24.1)	19 (59.4)	0.005
Respiratory	5 (17.2)	0	0.020
Renal	2 (6.9)	0	0.222
Coagulation/haematological	16 (55.2)	12 (37.5)	0.167
Hepatic	2 (6.9)	0	0.222
Neurological	1 (3.4)	1 (3.1)	>0.99
Uterine	8 (27.6)	2 (6.3)	0.037
Critical intervention			
Admission to intensive care unit	29 (100.0)	-	-
Interventional radiology	7 (24.1)	1 (3.1)	0.022
Laparotomy	6 (20.7)	7 (21.9)	0.910
Use of blood products	17 (58.6)	23 (71.9)	0.277

* Data are presented as No. (%) of patients

correct their haemodynamic status on a general ward was sufficient. Although non-booking status for maternal check-up and early gestational age at presentation appeared to be protective factors against ICU admission, most such patients were diagnosed with ruptured ectopic pregnancy at first presentation, which may have led to a skewed result. In a Korean study, low socioeconomic status was associated with a higher risk of ectopic pregnancy[10]. In our cohort, there were 14 cases of ectopic pregnancy, 73.3% of which occurred in those who were unemployed or worked as domestic helpers. Lower socioeconomic status may restrict access to early medical care, thus delaying referrals and leading to adverse outcomes.

Improving transition of care by establishing special maternity care units may reduce the number of ICU admissions and length of ICU stay. Such units serve as an interim between general wards and the ICU so that high-risk obstetric conditions can be expertly monitored by a multidisciplinary team of obstetricians, obstetric anaesthetists, and specialised midwives with critical care training. Such units are expected to play a greater role in managing maternal morbidities.

Our study has some limitations. The lack of controls and the small sample size resulted in a broad 95% CI and less precision to estimate the effect. Longitudinal studies with an extended study period are warranted. Moreover, our data did not include neonatal characteristics; inclusion of the newborn characteristics is helpful when evaluating neonatal and maternal outcomes.

Suicide is the leading cause of maternal mortality in Hong Kong[2], but the WHO near miss criteria neglect

to address psychiatric conditions of patients. Further refinement of the criteria to include psychiatric conditions may improve the criteria's application and validity in the Hong Kong context.

Conclusion

Most maternal-near-miss cases were attributed to postpartum haemorrhage and early pregnancy complications. Early identification and close monitoring are effective in improving maternal healthcare.

Contributors

All authors designed the study, acquired the data, analysed the data, drafted the manuscript, and critically revised the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

All authors have disclosed no conflicts of interest.

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Data availability

All data generated or analysed during the present study are available from the corresponding author upon reasonable request.

Ethics approval

The study was approved by the Institutional Review Board of The University of Hong Kong / Hospital Authority Hong Kong West Cluster (reference: UW18-595), Hong Kong East Cluster Research Ethics Committee (reference: HKECREC-2018-099), and New Territories West Cluster Research Ethics Committee (reference: NTWC/REC/19022). Patients were treated in accordance with the tenets of the Declaration of Helsinki. Each patient provided written informed consent for all treatments, procedures, and publication.

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Appendix.
Inclusion criteria for maternal near miss[3]

Severe maternal complications

- Severe postpartum haemorrhage
- Severe pre-eclampsia
- Eclampsia
- Sepsis or severe systemic infection
- Ruptured uterus
- Severe complications of abortion

Critical interventions or intensive care unit use

- Admission to intensive care unit
- Interventional radiology
- Laparotomy (includes hysterectomy, excludes Caesarean section)
- Use of blood products

Life-threatening conditions (near miss criteria)

- Cardiovascular dysfunction
  - Shock, cardiac arrest (absence of pulse/heartbeat and loss of consciousness), use of continuous vasoactive drugs, cardiopulmonary resuscitation, severe hypoperfusion (lactate >5 mmol/l or >45 mg/dl), severe acidosis (pH <7.1)
- Respiratory dysfunction
  - Acute cyanosis, gasping, severe tachypnoea (respiratory rate >40 breaths per minute), severe bradypnoea (respiratory rate <6 breaths per minute), intubation and ventilation not related to anaesthesia, severe hypoxemia (O2 saturation <90% for ≥60 minutes or PAO_2/ FiO_2 <200)
- Renal dysfunction
  - Oliguria non-responsive to fluids or diuretics, dialysis for acute renal failure, severe acute azotaemia (creatinine ≥300 μmol/ml or ≥3.5 mg/dl)
- Coagulation/haematological dysfunction
  - Failure to form clots, massive transfusion of blood or red cells (≥5 units), severe acute thrombocytopenia (<50 000 platelets/ml)
- Hepatic dysfunction
  - Jaundice in the presence of pre-eclampsia, severe acute hyperbilirubinemia (bilirubin >100 μmol/l or >6.0 mg/dl)
- Neurological dysfunction
  - Prolonged unconsciousness (lasting ≥12 hours)/coma (including metabolic coma), stroke, uncontrollable fits/status epilepticus, total paralysis
- Uterine dysfunction
  - Uterine haemorrhage or infection leading to hysterectomy

Maternal vital status

- Maternal death