RESEARCH ARTICLE

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A retrospective study of maternal near miss in the Critical Maternal Care Center in Suqian City, Jiangsu Province, China: A single-center study

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Abstract

Background and aims: Through a retrospective study of maternal near miss (MNM) cases treated by the Suqian Critical Maternal Care Center in Suqian City, Jiangsu Province, we summarized the most common diseases that caused MNM, treatment measures, and short-term prognosis in this region. The purpose of the research is to improve the clinical evidence of maternal health care in the region.

Methods: The study is a retrospective descriptive study. Among the pregnant women admitted to the Critical Maternal Care Center from 1 January 2015, to 31 December 2019, the pregnant women with severe pregnancy complications or comorbidities were identified as the research subjects. The study subjects were divided into an MNM group and a control group according to the MNM criteria recommended by the WHO.

A retrospective analysis of the study subject data, including causes and clinical manifestations of MNM, treatment measures, and short-term prognosis, was conducted.

Results: The total number of deliveries was 27 619. There were 145 women in the control group and 65 women in the MNM group. The number of MNM cases accounted for 2.4% (65/27619) of the total number of deliveries. Placenta previa, postpartum hemorrhage, and hypertension accounted for 72.3% (47/65) of the causes of MNM cases observed. In the MNM group, the most common clinical manifestation was bleeding (80.0%, 52/65). Sixty-three patients underwent massive blood transfusion (96.9%, 63/65), and 36 underwent hysterectomy (55.4%,36/65). The prevalence of interventional procedures and unplanned secondary operations in the MNM group was higher than that in the control group.

Conclusions: The top three causes of MNM were placenta previa, postpartum hemorrhage, and hypertension in pregnancy in Suqian area. Sufficient blood sources,

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convenient and fast blood transfusion procedures, and the use of large amounts of blood transfusion technology have an important impact on the success of treatment. Hysterectomy is still the main method of MNM treatment.

1 | BACKGROUND

Maternal near miss (MNM) is defined as a case of a woman who nearly died but survived a complication that occurred during pregnancy, childbirth, or within 42 days of termination of pregnancy.[1,2] With the improvement of the quality of maternal health care, the occurrence of maternal mortality has been correspondingly reduced. Merely using maternal mortality as an indicator of obstetric quality can no longer fully reflect the level of maternal health care. MNM has a similar experience with the death of pregnant women, and the further development of MNM may lead to the death of pregnant women.[3] Therefore, although early identification of high-risk factors that lead to MNM is helpful, focusing on an intervention for these patients can prevent the occurrence of maternal deaths. This view has become the consensus of obstetric experts.[4-7] Research on MNM has a positive role in improving the quality of maternal and child health care.[8,9]

In recent years, research on MNM has gradually increased.[8] The prevalence of MNM is related to the local economic level, health policy, education level, etc. The epidemiological characteristics of MNM in different regions are not the same. Studying the epidemiological and clinical course characteristics of MNM cases in the region can promote local maternal health work. Suqian is located in the northern part of Jiangsu Province, China. It includes two districts and three counties with a total population of nearly 6 million. Suqian is a relatively underdeveloped area in the province, and maternal health care is also in urgent need of improvement. Since 2016, the city has begun preparing for the establishment of maternal treatment centers in comprehensive medical institutions. These institutions will receive referral and treatment of critically ill pregnant women in the city, as well as training of medical staff. The government hopes to use these measures to improve local maternal health care.

2 | METHODS

2.1 | Study setting

The study is a retrospective descriptive study. The Affiliated Suqian Hospital of Xuzhou Medical University is a tertiary hospital and the main tertiary referral center for high-complexity obstetric and neonatal care in Suqian, Jiangsu Province. This hospital was assessed as the critical maternal treatment center in the Suqian area in 2016. This study retrospectively analyzed the clinical characteristics, treatment process, and outcome of MNM cases admitted to the treatment center from January 2015 to December 2019 and aimed to summarize the epidemiology and clinical characteristics of MNM in the Suqian area.

2.2 | Study population and inclusion criteria

Trained investigators obtained relevant research data by querying the medical records. In this study, the hospital's electronic medical record system was used to retrieve the medical record information of all pregnant women who were hospitalized from 1 January 2015, to 31 December 2019. The inclusion criteria of the research objects were as follows: (a) The pregnant women who were admitted to the intensive care unit (ICU) due to pregnancy complications or comorbidities; (b) pregnant women who underwent hysterectomy due to bleeding or infection; and (c) pregnant women who have experienced vital organ system failure due to pregnancy complications or comorbidities. The exclusion criteria were as follows: (a) the reason for admission to the ICU was only for the patient to undergo resuscitation observation after general anesthesia; and (b) the pregnant women had died.

Two obstetricians with senior professional titles reviewed the case data and divided the included subjects into the MNM group and the control group according to the WHO criteria for MNM (Table 1). Patients with severe pregnancy complications or comorbidities who met the WHO criteria for MNM were included in the MNM group. Patients with severe pregnancy complications or comorbidities who had not reached the WHO criteria for MNM were included in the control group.

2.3 | Data collection and analysis

Research subject data were obtained through the hospital's electronic medical record system. The data collected included age, number of pregnancies, gestational age, history of cesarean section, mode of delivery, causes and clinical manifestations of MNM, treatment measures (including interventional embolization, unplanned secondary surgery, hysterectomy, etc.), and prognosis.

We used SPSS Version 20.0 (SPSS Software, Chicago, IL, USA) for statistical analysis. The measurement data results are expressed as the

mean ± SD and were compared using the independent sample t test; count data are expressed as percentage and were compared using the chi-square test.

3 | RESULTS

3.1 | Annual incidence of MNM

The total number of deliveries from 2015 to 2019 was 27 619. There were 203 pregnant women with severe pregnancy complications or comorbidities, accounting for 7.4% (203/27 619) of the total number of deliveries. One pregnant woman died. A total of 145 pregnant women who did not meet the MNM definition were included in the control group. A total of 65 MNM pregnant women met the criteria for inclusion in the MNM group in this study. The number of MNM cases accounted for 2.4% (65/27 619) of the total deliveries (Table 2).

In the 5 years from 2015 to 2019, the change in the annual incidence of MNM was not statistically significant ($\chi^2 = 2.83$, $P > 0.05$). In the control group, the proportion of the annual delivery volume in 2015 was higher than those in other years ($\chi^2 = 37.31$, $P < 0.01$). The total number of patients in the MNM group and control group decreased year by year in 2015, 2016, and 2017, and the difference was statistically significant ($\chi^2 = 30.18$, $P < 0.01$), (Table 2).

3.2 | Demographic variables of MNM

The age of the MNM group was between 17 and 45 years old, with an average age of 31 years. All the demographic features between the study groups were comparable ($P > 0.05$), except there were statistically significant variations in the cesarean sections ($P < 0.01$) (Table 3).

3.3 | The primary diseases that cause MNM

Among the 65 cases of MNM, the most prevalent primary disease was placenta previa, accounting for 40% (26/65), followed by postpartum hemorrhage caused by uterine hypotony (20%,13/65), and hypertension in pregnancy (12.3%, 8/65). The above three causes resulted in 72.3% (47/65) of the total number of MNMs (Table 4).

3.4 | The most common clinical manifestations of MNM

Among 65 cases of MNM, 80% (52/65) cases have bleeding in clinical manifestations, which causes included placenta previa and placenta accrete, uterine hypotony, and placental abruption.

3.5 | MNM clinical interventions

Among 65 cases of MNM, 63 cases received a large blood transfusion volume (transfusion of red blood cell suspension ≥5 U or 1600 mL) (96.9%, 63/65). Forty-seven patients underwent continuous assisted ventilation (72.3%, 47/65). Thirteen patients underwent unplanned secondary operations (20.0%, 13/65), and 36 cases underwent hysterectomy(55.4%, 36/65).

TABLE 1 The WHO maternal near miss criteria

Clinical criteria	
Acute cyanosis	Loss of consciousness lasting ≤12 h
Gasping	Loss of consciousness AND absence of pulse/heartbeat Stroke
Respiratory rate >40 or <6/min	Uncontrollable fit/total paralysis
Shock	Jaundice in the presence of pre-eclampsia
Oliguria nonresponsive to fluids or diuretics	Loss of consciousness lasting ≤12 h
Clotting failure	
Laboratory-based criteria	
Oxygen saturation <90% for ≤60 min	pH <7.1
PaO2/FiO2 < 200 mm Hg	Lactate >5
Creatinine ≤300 mmol/L or ≤3.5 mg/dL	Acute thrombocytopenia (<50 000 platelets)
Bilirubin>100 mmol/L 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	Intubation and ventilation for ≤60 min not related to anesthesia
Hysterectomy following infection or hemorrhage	Dialysis for acute renal failure
Transfusion of ≤5 units red cell transfusion	Cardiopulmonary resuscitation (CPR)

TABLE 2 Annual delivery number of MNM group and control group between 2015 and 2019

Year	2015	2016	2017	2018	2019	Total	P
Delivery volume	5598	6103	5748	4869	5301	27 619	
MNM group	15	18	13	11	8	65	>0.05
Control group	57	29	26	10	23	145	<0.01
Total	72	47	39	21	31	210	<0.01

Clinical features	MNM group (n = 65)	Control group (n = 145)	χ^2 or T	P
Age (years, mean ± SD)	31.53 ± 6.15	30.32 ± 5.66	1.48	>0.05
Age ≥ 35 (%)	23 (35.4)	38 (26.2)	1.83	>0.05
Gestational week (%)				
<37	34 (52.3)	78 (53.8)	0.04	>0.05
≥37	31 (47.7)	67 (46.2)		
Number of deliveries (%)				
Primipara (%)	16 (24.6)	52 (35.9)		
Multipara (%)	49 (75.4)	93 (64.1)	2.59	>0.05
History of CS[a] (%)	37 (56.9)	48 (33.1)	10.57	<0.01
Delivery mode				
Vaginal delivery	12 (18.5)	4 (2.8)		
Cesarean section	53 (81.5)	141 (97.2)	13.57	<0.01

[a]CS, cesarean section.

TABLE 4 The primary disease of MNM

Primary disease	Number of cases	Percentage (%)
Placenta previa	26	40.0
PPH[a]	13	20.0
HDP[b]	8	12.3
AFLP[c]	4	6.2
Placenta implantation	2	3.1
Placental abruption[d]	2	3.1
Amniotic fluid embolism	2	3.1
Uterine rupture	2	3.1
Pregnancy with hematologic diseases	1	1.5
The birth canal laceration	1	1.5
Acute heart failure	1	1.5
Pulmonary embolism	1	1.5
Intraperitoneal bleeding[e]	1	1.5
Septic shock	1	1.5
Total	65	100.0

[a]PPH, Postpartum hemorrhage caused by uterine hypotony.
[b]HDP, Hypertensive disorder during pregnancy.
[c]AFLP, Acute fatty liver during.
[d]Refers to the two cases of placental abruption in the study that were not diagnosed with hypertension during pregnancy. The etiology of the cases of placental abruption caused by hypertensive disorders in pregnancy is classified into the category of hypertensive disorders in pregnancy. Among them, six cases of hypertensive disorders in pregnancy occurred placental abruption.
[e]Intraperitoneal bleeding: refers to one case of pregnant women with pre-epilepsy combined with scarred uterus. After cesarean section, there was a large amount of hemorrhage in the abdominal cavity. Surgical exploration revealed active bleeding of the omentum majus.

The usage rate of interventional therapy in the MNM group was 32.3% (21/65). The usage rate of interventional procedures in the control group was 3.45% (5/145); the usage rate in the MNM group was higher than the control group, and the difference was significant, $\chi^2 = 34.46$, P<0.01. Thirteen patients in the MNM group and two patients in the control group underwent unplanned secondary operations. The proportion of unplanned secondary operations in the MNM group was higher than that in the control group, and the difference was significant ($\chi^2 = 20.74$, P < 0.01).

Among 65 cases of MNM, 13 underwent unplanned secondary operations (20.0%, 13/65). The causes were postpartum hemorrhage due to uterine inertia, placenta previa, placental abruption, acute fatty liver, and internal hemorrhage after cesarean section. The most common surgical treatment method was hysterectomy.

Among 36 patients who underwent MNM hysterectomy, 22 had placenta previa, 2 had placenta accreta, and 7 had postpartum uterine hemorrhage caused by uterine hypotony. Nearly a quarter (9/34) of hysterectomy cases were unplanned secondary operations.

3.6 | Prognosis of MNM

Among 65 cases of MNM, 36 cases underwent hysterectomy (55.4%) and lost their fertility. Four patients underwent partial cystectomy or bladder repair (6.2%). One case of pulmonary embolism developed a long-term complication (severe cerebral palsy; 1.5%), and one case of uterine rupture caused neonatal death (1.5%).

4 | DISCUSSION

Different criteria for judging MNM have led to different reported incidence rates of MNM.[1,2,10] Studies have shown that clinical interventions and admission to the ICU as the standard of care are conducive to identifying MNM cases.[11] In this study, admission to the ICU ward was used as the initial inclusion criterion for the study. Considering that there may be differences in the standards for admission to the ICU ward between different medical institutions or doctors,[12] we have added additional conditions, that is, compliance with the MNM

criteria recommended by the WHO. Women who underwent hysterectomy due to bleeding or infection, regardless of whether they were admitted to the ICU or not, were included in this study.

The high rate of cesarean section in the past 10 to 20 years and the policy of encouraging re-birth in recent years have made more women with a history of cesarean section choose to give birth again, increasing the number of high-risk pregnant women. Studies have confirmed that pernicious placenta previa is closely related to a previous history of cesarean section.[13] In this study, the proportion of pregnant women with a history of cesarean section in the MNM group was significantly higher than that in the control group, and the proportion of pregnant women with a history of cesarean section in the placenta previa cases was also higher, which is consistent with previous research conclusions.[13,14]

Placenta previa, postpartum hemorrhage caused by uterine hypotony, and hypertension during pregnancy are the main causes of MNM in Suqian, Jiangsu Province. Placental abruption also accounts for a certain proportion of the causes of MNM.[15] In cases of placental abruption, even though there is not much bleeding during surgery or during delivery, it is still possible that DIC may be caused by the consumption of coagulation factors, which may lead to intractable postpartum hemorrhage. Most placental abruption is a complication of hypertension in pregnancy, but there are also some pregnant women who have no trauma or history of hypertension in pregnancy, and, therefore, it is often difficult to identify early. In this regard, it is particularly important to strengthen the training of medical staff in the early recognition of placental abruption.

In this study, two pregnant women had postoperative intra-abdominal hemorrhage: one experienced hemorrhage of the omental vessel, and the other experienced active hemorrhage of the small artery of the vaginal stump after hysterectomy. Due to the increased blood volume of pregnant women, combined with fluid supplementation after surgery, which masks the early clinical manifestations of internal hemorrhage and makes early recognition of internal hemorrhage difficult, often leading to DIC or shock decompensation status. Hysterectomy in obstetrics is often performed when pregnant women are in a state of massive hemorrhagic shock. If the bleeding is not completely stopped during the operation, internal bleeding may occur once blood pressure is restored after the operation, which will worsen the serious condition.

The construction of the maternal treatment center, the establishment of the treatment team, and the creation of various treatment programs, such as abdominal aortic balloon placement and mass blood transfusion programs, have played a positive role in the prevention of MNM.[16,17] The timing of interventional embolization, hysterectomy, and other treatment programs also has an important impact on the prognosis of MNM.

As the WHO pointed out, there is a story behind every death or MNM case. Through maternal death review and clinical review of MNM cases, problems in healthcare services were discovered, and improvement measures to reduce the occurrence of MNM and maternal deaths were proposed. In some developed countries and regions, the identification of MNM cases and the development of "MNM clinical review" are used as a means to evaluate and improve the quality of obstetric services. This approach is worthy of emulation.[11,18]

4.1 | Limitations of this study

The limitation of this study is that it was a retrospective single-center study. The hospital is a critical care center in the local area. The incidence of MNM in this study was only the incidence of this hospital and cannot reflect the incidence of MNM in the region. However, this hospital is the only treatment and referral center for pregnant women with severe comorbidities and complications in Suqian. Most MNM cases in this area are treated in this hospital. Therefore, the MNM cases in this study can represent the epidemiological characteristics and main disease causes of MNM.

5 | CONCLUSIONS

In Suqian, Jiangsu Province, placenta previa is the leading cause of MNM, followed by postpartum hemorrhage caused by uterine hypotony and hypertension in pregnancy. Postpartum hemorrhage caused by placenta previa and uterine hypotony is also the main reason for unplanned secondary operations and hysterectomy. Placental abruption is also one of the common causes of MNM. Intra-abdominal hemorrhage after cesarean section is difficult to detect early in the clinic, and it easily develops into DIC and leads to the occurrence of MNM.

In this study, more than 90% of MNM cases had a large blood transfusion volume during the treatment process. Therefore, sufficient blood sources, convenient blood transfusion procedures, and the use of a large number of blood transfusion techniques have an important impact on the success of treatment. Hysterectomy is still the main method of treatment for MNM. From 2015 to 2019, The number of pregnant women admitted to the ICU due to pregnancy complications or comorbidities has been decreasing year by year, which is related to the establishment of critical care centers and the continuous improvement of treatment. However, the incidence of MNM did not differ significantly between different years, which may be related to the insufficient number.

CONFLICT OF INTEREST
The authors declare that they have no competing interests in this section.

AUTHOR CONTRIBUTIONS
Conceptualization: Shumin Zhang, Yalan Qi, Yuelan Fang
Data Curation: Shumin Zhang, Xiumei Xue, Xiaojing Zhang, Qingling Cao, Yuelan Fang, Mingming Ge.

TRANSPARENCY STATEMENT

The Shumin Zhang affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study is a retrospective investigation, and the information of the patients in the study is anonymous. So informed consent is not required. Ethical clearance was sought and obtained from Ethics Committee of the Affiliated Suqian Hospital of Xuzhou Medical University (10 July 2020, SL2020213).

CONSENT FOR PUBLICATION

Not applicable.

DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are available from the corresponding author upon request.

REFERENCES

1. Say L, Souza JP, Pattinson 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;23:287-296.
2. World Health Organization. Conducting a Maternal near-Miss Case Review Cycle at Hospital Level. 2016. http://www.euro.who.int/en/health-topics/Life-stages/maternal-and-newborn-health/publications/2016/conducting-a-maternal-near-miss-case-review-cycle-at-hospital-level-2016. Accessed July 29, 2018.
3. Goldenberg RL, Saleem S, Ali S, et al. Maternal near miss in low-resource areas. *Int J Gynaecol Obstet*. 2017;138:347-355.
4. Oppong SA, Bakari A, Bell AJ, et al. Incidence, causes and correlates of maternal near-miss morbidity: a multi-centre cross-sectional study. *BJOG*. 2019;126:755-762.
5. Lazzerini M, Richardson S, Ciardelli V, Erenbourg A. Effectiveness of the facility-based maternal near-miss case reviews in improving maternal and newborn quality of care in low-income and middle-income countries: a systematic review. *BMJ Open*. 2018;8: e019787.
6. Zieleskiewicz L, Chantry A, Duclos G, et al. Intensive care and pregnancy: epidemiology and general principles of management of obstetrics ICU patients during pregnancy. *Anaesth Crit Care Pain Med*. 2016; 35(Suppl 1):S51-S57.
7. Donati S, Senatore S, Ronconi A. Obstetric near-miss cases among women admitted to intensive care units in Italy. *Acta Obstet Gynecol Scand*. 2012;91:452-457.
8. Abdollahpour S, Heidarian Miri H, Khadivzadeh T. The global prevalence of maternal near miss: a systematic review and meta-analysis. *Health Promot Perspect*. 2019;9:255-262.
9. de Lima THB, Amorim MM, Buainain Kassar S, Katz L. Maternal near miss determinants at a maternity hospital for high-risk pregnancy in northeastern Brazil: a prospective study. *BMC Pregnancy Childbirth*. 2019;19:271.
10. Witteveen T, Bezstarosti H, de Koning I, et al. Validating the WHO maternal near miss tool: comparing high- and low-resource settings. *BMC Pregnancy Childbirth*. 2017;17:194.
11. American College of Obstetricians and Gynecologists, Society for Maternal-Fetal Medicine. Obstetric care consensus no. 5: severe maternal morbidity: screening and review. *Obstet Gynecol*. 2016;128: e54-e60.
12. Paxton JL, Presneill J, Aitken L. Characteristics of obstetric patients referred to intensive care in an Australian tertiary hospital. *Aust N Z J Obstet Gynaecol*. 2014;54:445-449.
13. Jauniaux E, Alfirevic Z, Bhide AG, et al; Royal College of Obstetricians and Gynaecologists. Placenta praevia and placenta accreta: diagnosis and management: green-top guideline no. 27a. *BJOG*. 2019;126:e1-e48.
14. Mekango DE, Alemayehu M, Gebregergs GB, Medhanyie AA, Goba G. Determinants of maternal near miss among women in public hospital maternity wards in Northern Ethiopia: a facility based case-control study. *PLoS One*. 2017;12:e0183886.
15. Boisramé T, Sananès N, Fritz G, et al. Abruptio placentae. Diagnosis, management and maternal-fetal prognosis: a retrospective study of 100 cases. *Gynecol Obstet Fertil*. 2014;42:78-83.
16. Abdul-Kadir R, McLintock C, Ducloy AS, et al. Evaluation and management of postpartum hemorrhage: consensus from an international expert panel. *Transfusion*. 2014;54:1756-1768.
17. O'Brien KL, Shainker SA, Lockhart EL. Transfusion management of obstetric hemorrhage. *Transfus Med Rev*. 2018;32:249-255.
18. Tunçalp Ö, Souza JP. Maternal near-miss audits to improve quality of care. *BJOG*. 2014;121(Suppl 4):102-104.