Severe Maternal Morbidity: Admission Shift From Intensive Care Unit to Obstetric High-dependency Unit

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Research Article

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Abstract

Background: To study temporal trends of intensive care unit (ICU) admission in obstetric population after the introduction of obstetric high-dependency unit (HDU).

Methods: This is a retrospective study of consecutive obstetric patients admitted to the ICU/HDU in a provincial referral center in China from January 2014 to December 2019. The collected information included maternal demographic characteristics, indications for ICU and HDU admission, the length of ICU stay, the total length of in-hospital stay and APACHE II score. Chi-square and ANOVA tests were used to determine statistical significance. The temporal changes were assessed with chi-square test for linear trend.

Results: A total of 40 412 women delivered and 447 (11.1‰) women were admitted to ICU in this 6-year period. The rate of ICU admission peaked at 15.9‰ in 2016 and then dropped to 6.7‰ in 2019 with the introduction of obstetric HDU. The average APACHE II score increased significantly from 6.8 to 12.3 (P<0.001) and the average length of ICU stay increased from 1.7 to 7.1 days (P<0.001). The main indications for maternal ICU admissions were hypertensive disorders in pregnancy (39.8%), cardiac disease (24.8%), and other medical disorders (21.5%); while the most common reasons for referring to HDU were hypertensive disorders of pregnancy (46.5%) and obstetric hemorrhage (43.0%). After adjusting for the proportion of high-risk pregnancies, the establishment of HDU reduced 20% of ICU admission (aOR = 0.804, 95% CI =0.666-0.972).

Conclusions: The introduction of HDU helps to reduce ICU utilization in obstetric population.

Background

Admission of pregnant or postpartum women to intensive care unit (ICU) is an indicator of severe maternal morbidity and an endpoint for clinical audit in quality of care [1]. Despite the proportion of high-risk pregnancies in China increased from 15.7–24.7%, maternal mortality rates decreased from 34.2 per 100 000 to 18.3 per 100 000 live births from 2008 to 2018 [2], which implied an improvement in perinatal care. On the other hand, the growth of complicated pregnancies caused an increase in maternal ICU admissions [3], which meant a rising need of medical resources and expenses. Therefore, monitoring of the trend of ICU admission may help us understand the reasons of the change and develop interventions to improve medical service.

High dependency unit (HDU) provides a level of care which lies in between a general ward and an ICU, which has been suggested to reduce the need for ICU beds [4]. As previous researches from China showed, the incidence of pregnancy related ICU admission varied from 5.6 to16 per 1000 deliveries [3, 5]. However, little was known about the respective roles of obstetric HDU and ICU in caring severe maternal morbidity in this region. Accordingly, the present study aims to study the temporal trend of ICU admission with the introduction of maternal HDU and assess the characteristics of pregnancy-related ICU and HDU admissions.
Methods

Study design and settings

This is a retrospective study of consecutive obstetric patients admitted to the ICU/HDU of Nanjing Drum Tower Hospital from January 2014 to December 2019. The obstetric service in this hospital has high patient acuity and was accredited as a provincial referral center for severe maternal morbidity in 2016. To cope with the rising demand for a higher level of care, the institute introduced obstetric HDU in 2017. The general ICU was a 20-bed unit led by intensivists whereas the obstetric HDU was a 5-bed unit staffed with obstetricians and specialized nurses.

The research has been approved by the Ethical Committee of Nanjing Drum Tower Hospital and a waiver of individual informed consent was granted. Information of cases admitted to ICU of any causes during the pregnancy or within 42 days postpartum was abstracted from medical records and did not identify participants. Women delivered in other institutions and transferred to the hospital in postpartum period were excluded in the analysis.

Participants and Variables

The women's characteristics included age, parity, type of pregnancy (singleton or multiple), gestational age of delivery and mode of delivery (vaginal or cesarean delivery). The ICU admission information included the length of ICU stay, the total length of in-hospital stay and APACHE II score, calculated within 24 hours of ICU admission based on the worst clinical, and physiologic indicators. The indications for ICU/HDU admissions were classified into obstetric and non-obstetric complications. Organ dysfunction was defined using the WHO Working Group approach, which included clinical criteria, laboratory markers and management-based proxies. If a woman was admitted to the ICU more than once, the stay with the worst clinical manifestations (the highest APACHE II score or the longest stay) were included in this study.

Statistical methods

Statistical analysis was performed with SPSS 26.0. Normally distributed data were presented as mean with SD; and categorical outcomes were summarized using frequency distributions. Chi-square and ANOVA tests were used to determine statistical significance. The temporal changes were assessed with chi-square test for linear trend.

To estimate the associations between maternal clinical features and ICU admission, characteristics for women with and without ICU admission were compared using Chi-square tests, odds ratios (OR) and 95% confidence intervals (CI). Multiple logistic regression was used to estimate OR of ICU admission while adjusting for maternal risk factors (age, obesity, multiple pregnancy, pre-gestational hypertension, pre-gestational diabetes, pre-eclampsia, and placenta previa) and the introduction of HDU. A p value of 0.05 was used as the cut-point for significance.
Results

During this 6-year period, a total of 40,412 women delivered at the hospital and 447 women were admitted to ICU, making an overall ICU admission rate of 11.1 per 1000 deliveries. The rate peaked at 15.9 per 1000 deliveries in 2016 and then dropped to 6.7 per 1000 deliveries in 2019.

There were 9 maternal deaths with the overall maternal mortality rates 2.0 per 100 ICU admission and 22.3 per 100,000 hospital deliveries. No significant differences were found regarding the yearly ICU mortality rates. Cardiac diseases were the leading cause of maternal death (5/9, including 3 cases of severe pulmonary hypertension, one case of heart failure secondary to Sjogren syndrome and one woman with prosthetic valve thrombosis), followed by infections (2/9, one with severe virus pneumonia and one with septic miscarriage), lymphoma (1/9) and cerebral hemorrhage (1/9).

Demographics of Pregnancy-related ICU admission

Overall, the median age of the women admitted to the ICUs was 29.4 years; 16.8% were older than 35 years (Table 1). Nulliparous women comprised 65.1% of the ICU admissions, and the proportion decreased over time (P < 0.001). Most of the patients were admitted during the postpartum period (88.1%) and had undergone cesarean deliveries (85.7%).

The average APACHE II score, an indicator of severity, increased significantly from 6.8 in 2014 to 12.3 in 2019 (P < 0.001). At the same time, the average length of ICU stay increased from 1.7 day to 7.1 days (P < 0.001), and the median hospital stay increased from 8.4 to 14.1 days (P = 0.002).

Indications for maternal ICU admission

The main causes for maternal ICU admission were hypertensive disorders in pregnancy (39.8%), cardiac diseases (24.8%), and other medical disorders (21.5%) (Table 2). Women could have had more than one complication. Over the 6-year period, the proportion of obstetric hemorrhage (from 25.0–4.0%; P = 0.015) and hypertensive disorders (from 46.2–28.0%; P = 0.034) decreased significantly, whereas the percentage of cardiac diseases increased from 26.9–42.0% (P = 0.024).

In the analysis of the breakdown of maternal organ dysfunctions (Table 2), respiratory dysfunction (29.1%) had the highest incidence, followed by hematological dysfunction (25.1%) and cardiovascular dysfunction (18.6%). From 2014 to 2019, both respiratory dysfunction (11.5% – 44.0%, P = 0.007) and cardiovascular dysfunction (5.8% – 32.0%, P < 0.001) showed increased trends.
Table 1
Characteristics of Women with Pregnancy-Related ICU Admissions

|                          | Overall | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  | P          |
|--------------------------|---------|-------|-------|-------|-------|-------|-------|------------|
| ICU admission            | n = 447 | n = 52 | n = 56 | n = 117 | n = 102 | n = 70 | n = 50 |            |
| No. of deliveries        | 40412   | 5737  | 5269  | 7357  | 7428  | 7107  | 7514  |            |
| Rate of ICU admission (%)| 11.1    | 9.1   | 10.6  | 15.9  | 13.7  | 9.8   | 6.7   | < 0.001    |
| Age (mean ± sd)          | 29.4 ± 5.3 | 29.1 ± 5.3 | 29.1 ± 5.7 | 29.1 ± 4.9 | 29.6 ± 4.8 | 29.6 ± 5.8 | 30.3 ± 5.7 | 0.818      |
| Age ≥ 35 years n (%)     | 75 (16.8) | 7 (13.5) | 12 (21.4) | 17 (14.5) | 17 (16.7) | 11 (15.7) | 11 (22.0) | 0.545      |
| Nulliparous n (%)        | 291 (65.1) | 47 (90.4) | 47 (83.9) | 71 (60.7) | 59 (57.8) | 37 (52.9) | 30 (60.0) | < 0.001    |
| Multiple pregnancy n (%) | 39 (8.7)  | 5 (9.6)  | 2 (3.6)  | 12 (10.3) | 11 (10.8) | 5 (7.1)  | 4 (8.1)  | 0.691      |
| Pre-gestational BMI ≥ 28kg/m² n (%) | 25 (5.6) | 2 (3.8)  | 5 (8.9)  | 3 (2.6)  | 4 (3.9)  | 6 (8.6)  | 5 (10.0) | 0.209      |
| GA at delivery           |         |       |       |       |       |       |       | 0.145      |
| < 28 wks n (%)           | 63 (14.2) | 5 (9.6)  | 14 (25.0) | 12 (10.3) | 13 (12.7) | 8 (11.6) | 11 (22.0) |            |
| 28–31+6 wks n (%)        | 86 (19.3) | 8 (15.4) | 11 (19.6) | 21 (18.1) | 24 (23.5) | 11 (15.9) | 11 (22.0) |            |
| 32–36+6 wks n (%)        | 174 (39.1) | 17 (32.7) | 16 (28.6) | 51 (44.0) | 40 (39.2) | 32 (46.4) | 18 (36.0) |            |
| ≥ 37 wks n (%)           | 122 (27.4) | 22 (42.3) | 15 (26.8) | 32 (27.6) | 25 (24.5) | 18 (26.1) | 10 (20.4) |            |
| Cesarean deliveries n (%)| 383 (85.7) | 45 (86.5) | 45 (80.4) | 104 (88.9) | 89 (87.3) | 60 (85.7) | 40 (80.0) | 0.662      |
| Postpartum admission n (%)| 394 (88.1) | 49 (94.2) | 52 (92.9) | 108 (92.3) | 94 (92.2) | 57 (81.4) | 34 (68.0) | < 0.001    |
| APACHE II score (mean ± sd) | 10.5 ± 5.6 | 6.8 ± 3.6 | 9.4 ± 8.1 | 11.3 ± 5.0 | 10.9 ± 4.8 | 10.9 ± 5.3 | 12.3 ± 5.2 | < 0.001    |
| Length of ICU stay (d) (mean ± sd) | 4.5 ± 6.6 | 1.7 ± 1.6 | 3.3 ± 4.5 | 3.7 ± 4.2 | 5.2 ± 8.6 | 5.9 ± 7.4 | 7.1 ± 8.5 | < 0.001    |

* Two cases of maternal death before delivery in 2016 and 2018 respectively.
|                          | Overall | 2014   | 2015   | 2016   | 2017   | 2018   | 2019   | P      |
|--------------------------|---------|--------|--------|--------|--------|--------|--------|--------|
| In-hospital stay (d)     | 11.7 ±  | 8.4 ±  | 10.4   | 10.8   | 12.5   | 13.8   | 14.1   | 0.002  |
| (mean ± sd)              | 8.8     | 3.6    | ± 6.9  | ± 6.9  | ±10.1  | ±11.5  | ± 9.8  |
| ICU mortality rate n (%) | 9 (1.9) | 0 (0)  | 1 (1.8)| 2 (1.7)| 3 (2.9)| 1 (1.4)| 2 (4.0)| 0.802  |

* Two cases of maternal death before delivery in 2016 and 2018 respectively.
Table 2
Indications for Pregnancy-Related ICU Admissions*

|                      | Overall | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | P trend |
|----------------------|---------|------|------|------|------|------|------|---------|
| No. of ICU admission | 447     | 52   | 56   | 117  | 102  | 70   | 50   |         |
| Obstetric Indications |        |      |      |      |      |      |      |         |
| Hemorrhage           | 56 (12.5) | 13 (25.0) | 3 (5.4) | 18 (15.4) | 13 (12.7) | 7 (10.0) | 2 (4.0) | 0.015   |
| Hypertensive disorders | 178 (39.8) | 24 (46.2) | 26 (46.4) | 45 (38.5) | 46 (45.1) | 23 (32.9) | 14 (28.0) | 0.034   |
| Obstetric infections | 11 (2.5) | 1 (1.9) | 3 (5.4) | 2 (1.7) | 2 (2.0) | 3 (4.3) | 0 (0) | 0.609   |
| Amniotic fluid embolism | 4 (0.9) | 2 (3.8) | 0 (0) | 1 (0.9) | 0 (0) | 0 (0) | 1 (2.0) | 0.319   |
| Acute fatty liver of pregnancy | 17 (3.8) | 2 (3.8) | 0 (0) | 5 (4.3) | 6 (5.9) | 3 (4.3) | 1 (2.0) | 0.740   |
| Other obstetric complications | 6 (1.3) | 1 (1.9) | 2 (3.6) | 1 (0.9) | 1 (1.0) | 1 (1.4) | 0 (0) | 0.272   |
| Non-obstetric Indications |        |      |      |      |      |      |      |         |
| Cardiac diseases     | 111 (24.8) | 14 (26.9) | 12 (21.4) | 20 (17.1) | 23 (22.5) | 21 (30.0) | 21 (42.0) | 0.024   |
| Non-obstetric infections | 16 (3.6) | 0 (0) | 1 (1.8) | 3 (2.6) | 6 (5.9) | 4 (5.7) | 2 (4.0) | 0.071   |
| Pancreatitis         | 26 (5.8) | 0 (0) | 2 (3.6) | 7 (6.0) | 7 (6.9) | 5 (7.1) | 5 (10.0) | 0.024   |
| Other medical disorders | 96 (21.5) | 16 (30.8) | 12 (21.4) | 26 (22.2) | 20 (19.6) | 9 (12.9) | 13 (26.0) | 0.190   |
| Organ Dysfunctions    |        |      |      |      |      |      |      |         |
| Cardiovascular dysfunction | 83 (18.6) | 3 (5.8) | 5 (8.9) | 14 (12.0) | 23 (22.5) | 22 (31.4) | 16 (32.0) | < 0.001 |
| Respiratory dysfunction | 130 (29.1) | 6 (11.5) | 16 (28.6) | 40 (34.2) | 24 (23.5) | 22 (31.4) | 22 (44.0) | 0.007   |
| Renal dysfunction     | 40 (8.9) | 0 (0) | 7 (12.5) | 8 (6.8) | 15 (14.7) | 5 (7.1) | 5 (10.0) | 0.170   |
| Hematological dysfunction | 112 (25.1) | 12 (23.1) | 14 (25.0) | 31 (2.6) | 26 (25.5) | 14 (20.0) | 15 (30.0) | 0.832   |

*Patients can have more than one indication.
Overall 2014 2015 2016 2017 2018 2019 P trend

| Condition                | Overall | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |  P trend |
|--------------------------|---------|------|------|------|------|------|------|---------|
| Hepatic dysfunction      | 17 (3.8) | 2 (3.8) | 1 (1.8) | 7 (6.0) | 6 (5.9) | 0 (0) | 1 (2.0) | 0.420    |
| Neurological dysfunction | 20 (4.5) | 0 (0) | 3 (5.4) | 6 (5.1) | 5 (4.9) | 1 (1.4) | 5 (10.0) | 0.182    |
| Uterine dysfunction      | 13 (2.9) | 2 (3.8) | 2 (3.6) | 5 (4.3) | 1 (1.0) | 2 (2.9) | 1 (2.0) | 0.366    |

*Patients can have more than one indication.

**Decrease in ICU admission after introduction of HDU**

From 2017 to 2019, HDU amounted to 7.1% of total obstetric admissions. The most common obstetric reasons for admission to HDU were hypertensive disorders of pregnancy (46.5%) and obstetric hemorrhage (43.0%). Heart diseases (4.7%) and other medical disorders (10.2%) accounted for the majority of non-obstetric causes (Table 3).

| Table 3 | Characteristics of Women with Pregnancy-Related HDU and ICU admissions in 2017–2019 |
|---------|--------------------------------------------------------------------------------------|
|         | HDU admission | ICU admission | P          |
| n = 1575 | n = 222       |              |            |
| Age (mean ± sd) | 31.1 ± 4.9 | 29.7 ± 5.5 | < 0.001 |
| Gestational age (mean ± sd) | 36.2 ± 3.0 | 32.1 ± 6.2 | < 0.001 |
| Indications for admission* n (%) | | | |
| Obstetric hemorrhage | 678 (43.0) | 22 (9.9) | < 0.001 |
| Hypertensive disorders | 733 (46.5) | 83 (37.4) | 0.010 |
| Obstetric infections | 2 (0.1) | 5 (2.3) | < 0.001 |
| Other pregnancy complications | 16 (1.0) | 13 (10.7) | < 0.001 |
| Cardiac diseases | 74 (4.7) | 65 (29.3) | < 0.001 |
| Non-obstetric infections | 3 (0.2) | 12 (5.4) | < 0.001 |
| Pancreatitis | 6 (0.4) | 17 (7.7) | < 0.001 |
| Other medical disorders | 161 (10.2) | 42 (18.9) | < 0.001 |

*Patients can have more than one indication.
The rate of ICU admission reduced by 17.9% after introduction of HDU (12.3‰ in 2014-16 vs. 10.1‰ in 2017-19) despite an increased rate of high-risk pregnancies. In the obstetric population, the incidence of maternal age $\geq$ 35 years (10.5% – 14.3%, $P < 0.001$), multiple pregnancies (3.9% – 5.0%, $P < 0.001$), pre-gestational hypertension (1.2% – 1.8%, $P = 0.001$) and preeclampsia (4.9% – 6.3%, $P < 0.001$) increased significantly from 2014 to 2019 (Table 4). After adjusting for the proportion of high-risk pregnancies, the establishment of HDU was related to 20% reduction of ICU admission ($aOR = 0.804, 95\% CI = 0.666–0.972$, Table 5).

### Table 4
Temporal Trends in the proportion of women with high-risk pregnancies*

|                  | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | P trend |
|------------------|------|------|------|------|------|------|---------|
| No. of deliveries | 5737 | 5269 | 7357 | 7428 | 7107 | 7514 |         |
| Maternal age $\geq$ 35 years | 603 (10.5) | 741 (14.1) | 1068 (14.5) | 1387 (18.7) | 1119 (15.7) | 1071 (14.3) | $< 0.001$ |
| Multiple pregnancies | 224 (3.9) | 282 (5.4) | 342 (4.6) | 413 (5.6) | 442 (6.2) | 377 (5.0) | $< 0.001$ |
| Pre-gestational BMI $\geq$ 28kg/m2 | 24 (0.4) | 110 (2.1) | 140 (1.9) | 134 (1.8) | 187 (2.6) | 265 (3.5) | $< 0.001$ |
| Pre-gestational hypertension | 71 (1.2) | 72 (1.4) | 119 (1.6) | 142 (1.9) | 128 (1.8) | 138 (1.8) | 0.001 |
| Pre-gestational diabetes | 92 (1.6) | 62 (1.2) | 76 (1.0) | 71 (1.0) | 90 (1.3) | 117 (1.6) | 0.768 |
| Placenta previa | 115 (2.0) | 155 (2.9) | 176 (2.4) | 211 (2.8) | 193 (2.7) | 172 (2.3) | 0.519 |
| Gestational diabetes | 1107 (19.3) | 527 (10.0) | 779 (10.6) | 930 (12.5) | 763 (10.7) | 798 (10.6) | $< 0.001$ |
| Preeclampsia | 280 (4.9) | 279 (5.3) | 444 (6.0) | 468 (6.3) | 437 (6.1) | 475 (6.3) | $< 0.001$ |

*Values are given as number (percentage).

**Contribution of maternal co-morbidities to ICU admission**

Maternal age $\geq$ 35 years, pre-gestational diabetes, pre-eclampsia and placenta previa were associated with ICU admissions. Women with pre-eclampsia were found to have the highest adjusted odds of ICU admission ($aOR = 7.735, 95\% CI = 6.147, 9.733$), followed by placenta previa ($aOR = 3.866, 95\% CI = 2.659–5.622$) and pre-gestational diabetes ($aOR = 2.515, 95\% CI = 1.630–3.879$). Pre-gestational obesity,
multiple pregnancy, pre-gestational hypertension and gestational diabetes were not associated with ICU admission when adjusting for all other factors in the model.

Table 5
Maternal risk factors for ICU admission

| Risk Factor                   | Crude OR (95% CI) | Adjusted OR (95% CI) |
|-------------------------------|-------------------|----------------------|
| Maternal age ≥ 35 years       | 0.983 (0.961–1.006) | 0.968 (0.947–0.990) |
| Multiple birth                | 1.679 (1.206–2.339) | 1.172 (0.832–1.652) |
| Pre-gestational BMI ≥ 28kg/m² | 2.409 (1.561–3.718) | 1.069 (0.671–1.703) |
| Pre-gestational hypertension | 5.406 (3.828–7.634) | 1.181 (0.795–1.754) |
| Pre-gestational diabetes      | 4.744 (3.162–7.116) | 2.515 (1.630–3.879) |
| Placenta previa               | 2.952 (2.050–4.253) | 3.866 (2.659–5.622) |
| Gestational diabetes          | 0.793 (0.580–1.084) | 0.744 (0.541–1.025) |
| Preeclampsia                  | 8.025 (6.559–9.819) | 7.735 (6.147–9.733) |
| Establishment of HDU          | 0.823 (0.683–0.991) | 0.804 (0.666–0.972) |

**Discussion**

This is the first study analyzing HDU in management of severe maternal morbidity in China. In this study from a large referral center in China, the ICU admission rate decreased by 20%, whereas the severity of the cases increased after introduction of obstetric HDU. Nonetheless, the maternal mortality rate remained stable. Hypertensive disorders in pregnancy was the most common cause for ICU and HDU admission, while cardiac diseases and hemorrhage accounted for the second largest proportion in ICU and HDU cases respectively.

The research showed a rising trend of high-risk pregnancies in our population, which resulted in an increased demand for higher level of care. It is notable that, after the establishment of HDU, there was a shift of women with obstetric complications to HDU, while women with severe medical co-morbidities were still referred to ICU. The rate of HDU admission in this study was 7.1%, which was higher than the UK survey (4.2%) [8] and lower than two single center reports from India (11.1% and 11.2%) [9–10]. The variations were likely to be influenced by annual birth rate, characteristics of the population, and criteria for transferring women to ICU. Similar to the literatures [9–10], which showed the main indications for high dependency care were obstetric reasons, our research found that 46.5% of women were admitted for hypertensive disorders and 43.0% were for obstetric hemorrhage, as most women with severe obstetric complication might require close support and monitoring instead of invasive treatment such as mechanical ventilation.
A cross-sectional study performed by the World Health Organization reported that 1.0% women developed a severe maternal morbidity (SMM) outcome and the leading causes were postpartum hemorrhage (26.7%) and preeclampsia or eclampsia (25.9%) [11]. In the current study, hypertensive disorders in pregnancy accounted for 39.8% of the ICU admission and postpartum hemorrhage accounted for 12.5%. It is worth noting that there is a decreasing annual trend in both hypertensive disorders and postpartum hemorrhage. If one adds the number of parturient admitted to ICU to that of those admitted to an HDU, then the overall rate is increasing; a trend which aligns with international data. It is likely that this shift toward admission to HDUs will continue.

The present study showed a significant association between pre-eclampsia and SMM, which was similar with previous researches [12, 13]. Hatti found a dose-dependent relationship between hypertensive disorders in pregnancy and SMM, with the strongest association noted for preeclampsia with severe features (OR, 5.4; 95% CI, 3.9–7.3), followed by preeclampsia without severe features and chronic hypertension [13]. It is interesting that in this study women with preeclampsia had an even higher risk of SMM (OR, 7.735; 95% CI, 6.147–9.733), while chronic hypertension was not. The reason for this disparity might be related to our referral system, where women with chronic hypertension were referred to tertiary care in early pregnancy, whereas women with pre-eclampsia were often late-referrals with delayed diagnosis and suboptimal management [14]. Management of maternal hypertension is a potentially modifiable risk factor for SMM, so earlier detection and tighter blood pressure control among hypertensive pregnant women might mitigate risk for SMM at delivery [15, 16].

Generalizability and Limitations

The findings in this paper are based on a tertiary care, university-based hospital that cares for a higher percentage of medically complicated pregnancies. The high medical acuity of this population lends itself to a close evaluation of the changes in the characteristics of ICU admissions after introduction of obstetric HDU. A major limitation of our study is that it relies a single center data. The outcomes would be fairly comparable with referral centers and may not be representative to population of our region. Therefore, it is possible that the increased trend in medical co-morbidities this study is caused by an increased number of referral and not a reflection of trend in the population.

Conclusions

Our study highlights the increasing role of HDU in management of severe maternal morbidities. Shifting of care for women with severe postpartum hemorrhage and hypertensive disorders in pregnancy to HDU may spare the ICU service for the more complex medical conditions.

Abbreviations

HDU: High dependency unit; ICU: Intensive care unit; OR: odds ratios; CI: confidence intervals; aOR: adjusted odds ratios; BMI: body mass index; SMM: severe maternal morbidity
Declarations

Ethics approval and consent to participate

The research has been approved by the Ethical Committee of Nanjing Drum Tower Hospital and a waiver of individual informed consent was granted. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not required.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors have no conflicts of interest.

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Authors’ contributions

Study concept and design: NG. Acquisition of data: NG, YZ. Analysis and interpretation of data: NG. Drafting of the manuscript: NG; YD. All authors have read and approved the manuscript.

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