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Risk factors of obstetric admissions to the intensive care unit

An 8-year retrospective study

Lin Lin, MD, Yan-Hong Chen, MD, Wen Sun, MD, Jing-Jin Gong, MM, Pu Li, MM, Juan-Juan Chen, MD, Hao Yan, MD, Lu-Wen Ren, MM, Dun-Jin Chen, MD*

Abstract

The aim of this study was to identify risk factors among obstetric patients admitted to the intensive care unit (ICU).

The study was conducted in Third Affiliated Hospital of Guangzhou Medical University during January 1, 2009 and December 31, 2016. A total of 44,817 pregnant women ≥20 weeks of gestational age were scanned. Demographic characteristics, perinatal outcomes, and risk factors among participants were analyzed.

A number of factors (21) were more prevalent in the ICU admission group. The greatest for admission to the ICU occurred with amniotic fluid embolism, heart disease, acute fatty liver, and referral for care. The incidence of postpartum hemorrhage, hysterectomy, organ failure, and method of delivery differed significantly between groups ($P < .05$). Adverse neonatal outcome differed significantly between groups ($P < .05$).

Complications of pregnancy are risk factors for referral to the ICU and may increase risk for unexpected outcomes among mothers and neonates.

Abbreviations: HTN = hypertension, ICD = International Classification of Diseases, ICU = intensive care unit.

Keywords: ICU admission, maternal outcome, pregnancy, risk factor

1. Introduction

Maternal mortality and morbidity remains a challenging problem in developing countries.[1] China has seen a baby boom since the 2-child policy was carried out in 2014. Scarred uterus and advanced maternal pregnancy are closely associated with pregnancy complications, which may have a correlation with improved assisted reproductive technology and alteration of concepts related to childbearing.[2] In China, maternal mortality rate in 2013 was 17.2 per 100,000 live births.[1] Although maternal mortality has significantly decreased in the past few decades, improvements are still needed to decrease the pregnancy-related deaths in China due to the increase in the population of newborns, especially those critically ill patients.

The physiological changes that occur during pregnancy include effects on the cardiovascular, endocrine, urinary, and respiratory systems. These changes may lead to severe pregnancy-related complications, resulting in adverse outcomes for the pregnant woman and the fetus.[3] Given the low number of pregnant women admitted to the ICU,[4] knowledge on the optimal approach to management of critically ill pregnant mothers is limited.

To the best of our knowledge, few studies have investigated risk factors among obstetric patients admitted to ICU in China, whereas most of the publications now mainly focus on the analysis of the demographic characteristics and clinical features.[2] The purpose of this study was to analyze basic characteristics, outcomes, and possible risk factors among obstetric patients admitted to the ICU.

2. Materials and methods

The 8-year retrospective study was conducted by the obstetric center at Third Affiliated Hospital of Guangzhou Medical University during January 1, 2009 and December 31, 2016 with the consent of the institution. The study was approved by the research ethics committee of hospital. Patient data were obtained from the Gestational and Perinatal Medical Database. Clinical diagnoses were based on the 10th clinical modification revision of International Classification of Diseases (ICD-10-CM). A total of 44,817 pregnant women ≥20 weeks of gestational age were scanned and 3,095 cases were excluded for incomplete data. Pregnant women ≥20 weeks of gestational age entered the perinatal period, according to the American Association of Obstetricians and Gynecologists.[5]

Demographic data were collected from the Gestational and Perinatal Medical Database and included age, education, hospital stay, admission type, obstetric history such as gravidity, parity, scar uterine pregnancy, natural conceive, cesarean delivery, and prenatal care.

Patients were transferred to the ICU when advanced life support was needed for any of the following reasons[6,7]: respiratory failure requiring intubation and mechanical ventilation; pulmonary embolism; requirement for heart failure or vasoactive drugs to maintain stable hemodynamics; pulmonary catheter placement and maintenance; arrhythmia requiring treatment (e.g., cardioversion, defibrillation); continuous venovenous hemofiltration or plasmapheresis; cerebral hemorrhage or cerebral infarction; disseminated intravascular coagulation or shock; poor control of hypertension (HTN) in pregnancy; and postpartum hemorrhage with unstable vital signs.

To assess outcomes of pregnant women, the incidence of postpartum hemorrhage, hysterectomy, and organ failure was collected from the database. Data on complications of pregnancy were also retrieved. Complications documented in the medical record included multifetation, hypertension in pregnancy, gestational diabetes mellitus, oligohydramnios, placenta previa, placenta abruption, placenta accreta, thrombopenia, surgical disease, and heart disease. The manifestations of heart disease observed in this patient population included rheumatic heart disease, congenital heart disease, hypertension, myocarditis during pregnancy, acute fatty liver, intrahepatic cholestasis, and amniotic fluid embolism. Data including gestational age, sex, occurrence of preterm birth, neonatal asphyxia, fetal growth restriction, fetal distress, stillbirth, and mortality were collected for the purpose of neonatal outcome assessment.

Statistical analysis was performed with Statistical Package for the Social Sciences software for Windows, version 16.0 (IBM, Armonk, NY). Gaussian distribution data were described as mean $\pm$ standard deviation, whereas abnormal distribution data as median and interquartile range. Student t test and Mann–Whitney U test were performed to analyze continuous variables, whereas χ^2 test and Fisher exact test were used to test categorical variables. Binary logistic regression analyses were used to identify risk factors. Univariate logistic regression analysis was performed first. $P < .1$ was considered statistically significant. Multivariate analysis was performed to identify risk factors. $P < .05$ was considered statistically significant.

3. Results

A total of 41,722 pregnant women were enrolled in the study eventually. They were divided into ICU group and non-ICU group. The 2 groups were compared with age, gestational age, gravidity, parity, numbers of cesarean section, fertilization way, hospital stay, admission type, education, and production inspection (Table 1). All of them except age showed statistical significance in our study.

3.1. Risk factors for ICU admission

A number of factors (21) were more prevalent in the ICU admission group than in the non-ICU group. Multivariable logistic regression analysis of the 21 factors that reached statistical significance identified 15 factors with a significant independent association. Risk factors were as follows: amniotic

Table 1

Characteristics of obstetric patients.

	ICU (n = 426)	Non-ICU (n = 41,296)	Statistical value	P
Age, y	29.78 ± 5.87	29.49 ± 4.59	$Z = 0.911$	.362
Gestational age, wk	32.8 ± 4.61	37.97 ± 3.30	$Z = -24.825$	<.001
Hospital stay, d	12.07 ± 8.10	5.77 ± 4.48	$Z = -24.446$	<.001
Migrant population, n (%)	332 (77.9%)	19,607 (47.5%)	$\chi^2 = 156.7$	<.001
Natural conceive, n (%)	18 (4.2%)	3,490 (8.5%)	$\chi^2 = 9.777$	.002
Gravidity, n (%)				
1	122 (28.6%)	18,269 (44.2%)		
2	109 (25.6%)	12,017 (29.1%)	$\chi^2 = 82.428$	<.001
≥3	195 (45.8%)	11,010 (26.7%)		
Parity, n (%)				
0	200 (46.9%)	28,957 (70.1%)		
1	168 (39.4%)	10,621 (25.7%)	$\chi^2 = 151.7$	<.001
≥2	58 (13.6%)	17.7 (4.2%)		
Scar uterine pregnancy, n (%)	103 (24.2%)	2,742 (6.6%)	$\chi^2 = 204.1$	<.001
Cesarean delivery				
0	314 (73.7%)	36,252 (87.8%)		
1	89 (47.5%)	4,564 (11.1%)	$\chi^2 = 108.9$	<.001
≥2	23 (5.1%)	480 (1.2%)		
Admission type, n (%)				
Outpatient	72 (16.9%)	19,220 (46.5%)		
Emergency	88 (20.7%)	19,797 (47.9%)	$\chi^2 = 2,386$	<.001
Referral	266 (62.4%)	2,279 (5.5%)		
Education, n (%)				
College and above	73 (17.1%)	24,153 (58.5%)		
High school	72 (16.9%)	6,444 (15.6%)	$\chi^2 = 499.7$	<.001
Middle school	217 (50.9%)	9,625 (23.3%)		
Primary school and below	64 (15.0%)	1,074 (2.6%)		
Prenatal care, n (%)				
Regular	81 (19.0%)	21,136 (51.2%)		
Irregular	269 (83.1%)	18,868 (45.7%)	$\chi^2 = 392.1$	<.001
None	76 (17.8%)	1,292 (3.1%)		

Table 2

Logistic regression analysis.

	Odds ratio	95% CI Lower	95% CI Upper
Demographic data	1.703	1.316	2.205
Migrant population			
Assisted reproductive technique	0.632	0.357	1.116
Gravidity	—	—	—
1	—	—	—
2	0.836	0.599	1.166
≥3	0.898	0.624	1.292
Parity	—	—	—
0	—	—	—
1	0.955	0.677	1.346
≥2	0.843	0.507	1.404
Cesarean delivery	—	—	—
0	—	—	—
1	1.182	0.856	1.631
≥2	2.055	1.093	3.861
Education	—	—	—
College and above	—	—	—
High school	1.846	1.292	2.637
Middle school	2.177	1.598	2.965
Primary school and below	2.497	1.626	3.834
Admission type	—	—	—
Outpatient	—	—	—
Emergency	1.310	0.943	1.821
Referral	7.347	5.439	9.924
Prenatal care	—	—	—
regular	—	—	—
irregular	2.192	1.663	2.890
None	3.145	2.156	4.586
Pregnancy complication	1.402	0.923	2.129
Multifetation			
Hypertension in pregnancy	3.824	2.985	4.898
Gestational diabetes mellitus	0.561	0.375	0.840
Oligohydramnios	0.534	0.324	0.882
Placenta previa	2.056	1.432	2.951
Placenta abruption	2.373	1.456	3.869
Placenta accreta	2.570	1.779	3.712
Thrombopenia	2.098	1.064	4.135
Surgical disease	5.154	3.344	7.943
Heart disease	11.095	8.452	14.566
Acute fatty liver	16.233	4.125	63.880
Intrahepatic cholestasis	3.937	2.042	7.592
Amniotic fluid embolism	183.071	47.577	704.434

fluid embolism (odds ratio [OR] = 183.071), pregnancy with acute fatty liver (OR = 16.233), pregnancy complicated by heart disease (OR = 11.095), admission by referral (OR = 7.347), pregnancy with surgical disease (OR = 5.154), intrahepatic cholestasis of pregnancy (OR = 3.937), hypertension in pregnancy (OR = 3.824), no prenatal care (OR = 3.145), placenta accreta (OR = 2.570), placental abruption (OR = 2.373), irregular prenatal care (OR = 2.192), pregnancy with thrombocytopenia (OR = 2.098), placenta previa (OR = 2.056), undergraduate education (high school [OR = 1.846], junior high school [OR = 2.177], primary school [OR = 2.497]), immigrating population (OR = 1.703), gestational diabetes mellitus (OR = 0.561), oligohydramnios (OR = 0.534) (Table 2).

3.2. Adverse maternal outcome by ICU admission

During the hospital stay, 11 pregnant women died, with a mortality rate of 26.36/100,000 in our study (11/41,722). The

Table 3

Pregnancy outcomes.

	ICU (n = 426)	Non-ICU (n = 41,296)	Statistical value	P
Postpartum hemorrhage, n (%)	58 (13.6%)	2,449 (5.9%)	$\chi^2 = 44.089$	<.001
Hysterectomy, n (%)	52 (12.2%)	131 (0.3%)	$\chi^2 = 1,338$	<.001
Organ failure	45 (10.6%)	68 (0.2%)	$\chi^2 = 1,650$	<.001
Method of delivery, n (%)				
Vaginal delivery	50 (11.7%)	24,682 (59.8%)	$\chi^2 = 403.0$	<.001
Cesarean	376 (88.3%)	16,614 (40.2%)		

comparison of incidence of postpartum hemorrhage, hysterectomy, organ failure, and method of delivery differed significantly between groups (P < .05) (Table 3). Hypertension in pregnancy, gestational diabetes mellitus, oligohydramnios, placenta previa, placenta abruption, placenta implantation, thrombopenia, surgical and heart disease, acute fatty liver, intrahepatic cholestasis, and amniotic fluid embolism were found statistically significant in the study (P < .05) (Table 4).

3.3. Adverse neonatal outcome by ICU admission

A total of 40,464 newborns ≥28 weeks of gestational age were born in the study. Between the 2 groups, gestational age, premature birth, neonatal asphyxia, fetal growth restriction, stillbirth, and mortality rate were statistically different (P < .05) (Table 5).

4. Discussion

The rate of referral to the ICU among mothers was used as an index for maternal morbidity.[8–11] Studies on risk factors for obstetric admission to the ICU are crucial to improve maternal and fetal outcomes. The purpose of this study is to identify risk factors for admission to the maternal ICU, to improve the prognosis of critically ill obstetric patients.

The incidence of placenta accreta was already as high as 1/533 between 1982 and 2002. Placenta accreta can increase the incidence of organ and vascular injury, adult respiratory distress syndrome, electrolyte disturbances, renal failure, uterus resection, and blood transfusion, resulting in increasing risk for referral to the ICU. The mortality rate was as high as 7% in pregnant women of placenta accrete.[12]

A typical manifestation of amniotic fluid embolism is a sudden onset of postpartum hypoxia and hypotension, followed by coagulation disorders. Cascade reaction of the immune system generates a series of manifestations similar to systemic inflammatory response syndrome.[13] Multidisciplinary teamwork is needed in the treatment of amniotic fluid embolism, which is one of the important risk factors of referrals to the ICU.

The occurrence of gestational diabetes mellitus in China is approximately 17.5%.[14] The occurrence of hypertension, amniotic fluid abnormalities, postpartum hemorrhage, and stillbirth is greatly increased in pregnant women with diabetes. Poor glycemic control during pregnancy can lead to diabetic ketoacidosis, as a result of an increased incidence of ICU referrals.[15,16] Thrombocytopenia, surgical, or heart diseases may worsen the condition of patients during pregnancy,[15,17] which may be the cause of referral.

Previous studies have shown that multiple pregnancies are risk factors for referral to ICU in pregnant women.[9,15] Multiple pregnancies increase the incidence of pregnancy-related compli-

Table 4

Pregnancy complications.

	ICU (n = 426)	Non-ICU (n = 41,296)	Statistical value	P
Multifetation, n (%)	38 (8.9%)	2,483 (6.0%)	χ^2 = 6.278	.012
Hypertension in pregnancy, n (%)	191 (44.8%)	2,670 (6.5%)	χ^2 = 971.9	<.001
Gestational diabetes mellitus, n (%)	30 (7.0%)	4,876 (11.8%)	χ^2 = 9.227	.002
Pregnancy in diabetes, n (%)	1 (0.2%)	52 (0.1%)	—	.420
PROM, n (%)	25 (5.9%)	3,135 (7.6%)	χ^2 = 1.788	.181
Polyhydramnios, n (%)	4 (0.9%)	318 (0.8%)	χ^2 = 0.157	.418
Oligohydramnios, n (%)	18 (4.2%)	4,346 (10.5%)	χ^2 = 17.861	<.001
Placenta previa, n (%)	68 (16.0%)	1,791 (4.3%)	χ^2 = 133.9	<.001
Placenta abruption, n (%)	24 (0.8%)	335 (0.8%)	χ^2 = 109.373	<.001
Placenta implantation, n (%)	62 (14.6%)	1,442 (3.5%)	χ^2 = 148.5	<.001
Thrombopenia, n (%)	11 (2.6%)	320 (0.8%)	χ^2 = 15.277	.001
Surgical disease, n (%)	36 (8.5%)	918 (2.2%)	χ^2 = 73.194	<.001
Heart disease, n (%)	122 (28.5%)	780 (1.9%)	χ^2 = 1,426	<.001
Hepatitis B, n (%)	16 (3.8%)	2,273 (5.5%)	χ^2 = 2.485	.115
Acute fatty liver, n (%)	5 (0.2%)	10 (0.0%)	—	<.001
Intranhepatic cholestasis, n (%)	13 (3.1%)	223 (0.5%)	χ^2 = 42.931	<.001
Amniotic fluid embolism, n (%)	5 (0.01%)	7 (0.0%)	—	<.001

PROM = premature rupture of fetal membranes.

cations such as preeclampsia, gestational diabetes, and postpartum hemorrhage, leading to referral to the ICU. However, our study did not find the same result, which may be on account of the regular prenatal care of patients in the reproductive pregnancy center of our hospital. Most of them are well aware of the importance of regular prenatal care, especially pregnant women with multiple pregnancies. Timely detection of risk factors and prenatal intervention could improve the maternal prognosis significantly.

Migrant population is one of the risk factors that may be on account of the unstable income, lake of medical insurance, and irregular prenatal care of this population. Women with higher education attach more importance to self-care and regular prenatal care. High-risk factors were identified by regular prenatal care. Timely prenatal intervention could remarkably improve the prognosis of obstetric patients. There is controversy about if age has impacts on the referral to ICU.[18] Statistically significant difference was found in patients <18 years or >35 years.[15] Age >35 years, black ethnicity, treatment at small hospitals, and referral from a primary hospital were all predictive factors for referral to the ICU [19]. There was no significant difference in age between groups, which is consistent with a report by Selo-Ojeme et al.[20]

Hypertension leads to decreased systemic organ perfusion and multiple organ failure, which threatens the survival of mother and fetus.[21] A prospective cohort study by Hannah et al demonstrated that systolic blood pressure >160 mm Hg or diastolic blood pressure >110 mm Hg in patients with preeclampsia increased the risk for referral to the ICU.[7]

No previous study has investigated the association between oligohydramnios and referral to the ICU. It is speculated that the cause of oligohydramnios may be the reason for referral. The reason for the increased rate of cesarean section in ICU group may be that referral patients were in critical condition and unable to tolerate vaginal delivery. Cesarean section—especially multiple cesarean sections—increased the occurrence of amniotic fluid embolism, postpartum hemorrhage, and hysterectomy, thus increasing the risk for referral.[11,15] The placental blood perfusion was affected in critically ill patients, resulting in increased adverse outcomes in newborns. Neonatal outcome is closely related to gestational age, which directly affects fetal development. The maternal mortality rate was 26.36/100,000 in the study, which was higher than the average rate in China in 2013. Many patients were admitted to our hospital after multiple referrals, and the best time for treatment was delayed. Critically ill patients were transferred to our hospital. The patients were usually in the terminal phase when they came to our hospital. Maybe that is the reason why the mortality rate is higher than average.

Our study analyzed risk factors among obstetric patients admitted to the ICU, which is complementary in this research

Table 5

Disease spectrum of newborns.

	ICU (n = 358)	Non-ICU (n = 40,106)	Statistical value	P
Gestational age, wk	34.15 ± 3.30	38.35 ± 2.37	Z = −22.747	<.001
Preterm birth, n (%)	270 (75.4%)	6,358 (15.9%)	χ^2 = 919.2	<.001
Sex, n (%)				
Male	192 (53.6%)	21,197 (52.9%)	χ^2 = 0.086	.769
Female	166 (46.4%)	18,909 (47.1%)		
Neonatal asphyxia, n (%)	1,213 (42.2%)	151 (3.0%)	χ^2 = 1,670	<.001
Fetal growth restriction, n (%)	32 (8.9%)	1,226 (3.1%)	χ^2 = 40.750	<.001
Fetal distress, n (%)	32 (8.9%)	2,122 (5.3%)	χ^2 = 9.367	<.001
Stillbirth, n (%)	26 (7.3%)	529 (1.3%)	χ^2 = 88.318	<.001
Mortality, n (%)	30 (8.4%)	563 (1.4%)	χ^2 = 119.6	<.001

field. The entire data came from the perinatal medical database, which is representative in Guangzhou area. However, there are a few limitations about this study. All data were input manually. There might have some individual data errors. As all data came from the database, biases may be existed. This is a single-center clinical study with sample sizes insufficient, lack of representation, and other issues. In the future, multicenter clinical cohort studies can be further undertaken with more impact factors included.

In conclusion, pregnancy complications are risk factors for referral to the ICU and may increase the risk of unexpected outcomes among mothers and neonates.

Author contributions

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