Original Research

Clinical characteristics and outcomes of obstetric patients requiring ICU admission: a 5-year retrospective review

Min Zhang[1], Zhan-Hong Tang[1], Han-Chun Wen[1], Ying-Lin Wu[1], Xing-Xin Gao[2,*]

[1] *Department of Critical Care Medicine, First Affiliated Hospital of Guangxi Medical University, Nanning, 530021 Guangxi, P. R. China*

[2] *Department of Burns and Plastic, First Affiliated Hospital of Guangxi Medical University, Nanning, 530021 Guangxi, P. R. China*

*Correspondence: 11500315@163.com (Xing-Xin Gao)

DOI:10.31083/j.ceog.2021.01.2124

Submitted: April 29, 2020 Revised: August 09, 2020 Accepted: August 15, 2020 Published: February 15, 2021

Objective: To investigate the clinical characteristics and outcomes of obstetric patients requiring intensive care unit (ICU) admission in a tertiary hospital. *Methods*: We retrospectively analyzed the clinical data of all pregnant/postpartum patients admitted to a tertiary ICU from January 2014 to December 2018. *Result*: One hundred and thirty-three obstetric patients were analyzed. Most patients (114, 85.7%) were admitted postpartum, and 57.9% (n = 77) of ICU admissions were from obstetric causes. The most common obstetric cause of admission was obstetric hemorrhage (32, 24.1%), followed by pregnancy-associated hypertension (25, 18.8%). The most common non-obstetric cause of admission was cardiac disorder (16, 12%). Ninety-eight patients (73.7%) came from non-urban areas. We compared patients from non-urban areas versus urban areas: Acute Physiology and Chronic Health Evaluation (APACHE) II, 8.35 $\pm$ 3.14 versus 6.43 $\pm$ 2.59 (P = 0.002); standard prenatal care, 62.3% versus 90.3% (P = 0.004); transferred from another hospital, 25.5% versus 2.9% (P = 0.004); blood transfusion, 48% versus 22.9% (P = 0.010); plasmapheresis, 11.2% versus 0% (P = 0.039); multiple-organ dysfunction syndrome, 30.6% versus 11.4% (P = 0.026); mortality, 10.2% versus 2.9% (P = 0.176). Total maternal mortality in ICU was 8.3% (n = 11). The fetal mortality rate was 10.9% (n = 15). *Conclusions*: A multidisciplinary team approach is essential to improve the management of obstetric hemorrhage, hypertensive disorders and cardiac disorders, which may in turn significantly improve maternal outcomes. Health disparities existed between patients from non-urban versus urban areas: the former was sicker at admission, received less standard prenatal care, were more frequently transferred from other hospitals, received more interventions, developed more complication, and suffered a higher rate of maternal mortality.

Keywords

Intensive care; Maternal mortality; Obstetrics; Urban areas; Non-urban

1. Introduction

Pregnancy is a normal physiological process, one of whose distinctive features is the presence of the utero-placental complex. Physiological changes associated with pregnancy have been observed to occur in all major systems of the body. These changes may result in strain to organ systems, in particular for those with limited reserve, often accompanied by a deterioration of any pre-existing medical conditions [1]. A pregnant woman may require ICU admission because of diseases specific to pregnancy, diseases that are worsened by pregnancy, as well as diseases co-incidental to pregnancy [1]. The occurrence of disease-related complications during pregnancy or postpartum may significantly increase the risk of maternal mortality. Furthermore, the assessment and management decisions made during pregnancy must also consider that which might be harmful to the fetus. Owing to the numerous factors affecting medical management of pregnancy, critically ill obstetric patients present a particularly great challenge to ICU physicians.

Worldwide, maternal mortality has decreased from 500,000 to 300,000 deaths/year over the past 30 years [2]. Strikingly, these deaths occurred almost exclusively in developing countries, with only 1% occurring in developed countries [2]. In addition, it is estimated that as much as 70% of these deaths occur in hospitals, mainly in ICUs, rather than outside medical care [3].

A first and vital step towards addressing this problem is the collection and analysis of relevant clinical data that could help shed light the high mortality of these patients. Accordingly, to help improve obstetric care in pregnant/postpartum patients requiring ICU admission in the developing world setting, we retrospectively evaluated clinical data collected from obstetric patients admitted to ICU in our hospital.

2. Materials and methods

After approval by the institutional review board of First Affiliated Hospital of Guangxi Medical University, we retrospectively reviewed the medical records of all obstetric patients admitted to ICU either during pregnancy or within 42 days of delivery between January 1, 2014, and December 31, 2018. For each patient, the following data were collected: demographic data, residence, parity, medical and obstetric history, standard prenatal care (at least five visits for term pregnancies) [4], gestational age at ICU admission or at end of pregnancy, mode of delivery, admission diagnosis, cause of admission obstetric (only occurring in pregnant/postpartum patients) versus non-obstetric (also occurring in nonpregnant patients) [5], source of admission to ICU (emergency department/ward/operating room/other hospital), Acute Physiology and Chronic Health Evaluation

Table 1. Patient characteristics (n = 133).

Characteristics	Data
Age (years)	29.87 ± 5.62
Length of stay (days)	
Hospital	14.84 ± 11.59
ICU	5.50 ± 5.40
Gestational age (weeks)	32.86 ± 0.60
Mode of delivery	
Normal vaginal delivery	18 (13.5%)
Caesarean section	98 (73.7%)
Undelivery at discharging of ICU	15
Ectopic pregnancy	2

(APACHE II) score [6] at admission, ICU management (mechanical ventilation, hemodialysis, central catheter, plasmapheresis, and blood transfusions), and length of stay in the ICU and the hospital. The mortality of all the mothers and fetal-neonatal losses were recorded. Any ICU cases in which multiple-organ dysfunction syndrome (MODS) (dysfunction $\geq$ 2 organs according to Sequential Organ Failure Assessment (SOFA)) developed was recorded [7]. ICU admissions were categorized into two main groups based on their place of residence as either urban or non-urban.

3. Data analysis

Data were analyzed using SPSS version 20.0 (IBM SPSS Statistics for Windows, version 20.0, Armonk, N.Y., USA). Continuous variables are presented as mean ± SD or median (interquartile range), according to their distribution. Categorical variables are presented using the composition ratio. Two group comparisons were made using *t*-tests or chi-squared tests, where appropriate. *P*-values < 0.05 were considered significant.

4. Results

4.1. Patient characteristics

During the five-year study period, a total of 133 obstetric patients were admitted, representing 5.9% of total ICU admissions (133/2239, Table 1). The average age of patients was 29.87 ± 5.62 years with a range of 18-47 years. Twenty-five patients (18.8%) were of advanced maternal age ($\geq$ 35 years). Patient locations prior to ICU admission were as follows: operating room (70, 52.6%), ward (26, 19.55%), other hospitals (26, 19.55%), and emergency department (11, 8.3%). Fifty-seven (42.9%) patients had pre-existing medical problems. Thyroid disease (hyperthyroidism, hypothyroidism) was the most common underlying chronic medical condition, followed by thalassemia.

4.2. Admission characteristics

Seventy-seven admissions (57.9%) were for obstetric reasons, and 56 (42.1%; Table 2) were for non-obstetric causes. Postpartum admissions were more frequent than antepartum admissions: 114 (85.7%) vs. 19 (14.3%). In the antepartum admission group, 78.9% of admissions were due to non-obstetric causes (n = 15). Obstetric hemorrhage (32, 24.1%) was the most common cause for obstetric admission, followed by pregnancy-related hypertensive disorders (25, 18.8%). The primary underlying causes of postpartum hemorrhage were placenta previa + placenta increta (n = 16), followed by vaginal/cervical laceration (n = 4), uterine atony (n = 3), placenta previa (n = 3), placenta abruption (n = 2), rupture of uterus (n = 2), and placenta increta (n = 1). Placental abnormalities occurred in 22 (71%) patients with postpartum hemorrhage. The reason for the single case of antepartum hemorrhage was a missed abortion. Cardiac disorders were the most common cause of non-obstetric admission (16, 12.0%).

Table 2. Diagnosis for patients admitted to the intensive care unit (n = 133).

Diagnosis	No. of patients
Obstetric	77 (57.9)
Obstetric haemorrhage	32 (24.1)
Hypertensive disease of pregnancy	25 (18.8)
Acute fatty liver of pregnancy	11 (8.3)
Amniotic fluid embolism	5 (3.8)
Other	4 (3.0)
Non-obstetric	56 (42.1)
Cardiac system	16 (12)
Rhythm disorders	3
Structural/functional	13
Respiratory system	10 (7.5)
Severe pneumonia	6
Other	4
Nervous system	8 (6)
Cerebral haemorrhage	3
Epileptic seizures	2
Other	3
Digestive system	8 (6)
Hepatic failure	6
Other	2
SLE	2 (1.5)
Other	12 (9.0)

Patients belonging to the non-obstetric group had longer hospital and ICU stays than did patients in the obstetric group (17 vs. 12, $P = 0.017$; 6 vs. 4, $P = 0.013$, respectively, Table 3). Non-obstetric group patients developed more MODS ($P = 0.002$) and mortality ($P = 0.032$) than obstetric group patients. Liver dysfunction was the most common organ failure in the obstetric group, while lung dysfunction was the most common organ failure in the non-obstetric group. Non-urban patients were younger and were admitted to the ICU at younger gestational ages than urban patients (Table 4). Standard prenatal care was less frequent among non-urban patients than urban patients ($P = 0.004$). Non-urban patients received more blood transfusion ($P = 0.010$) and cesarean section ($P = 0.001$), while plasmapheresis was limited to the non-urban group ($P = 0.039$).

4.3. Types of interventions

During ICU admission, ventilation was required in 87 (65.4%) patients, while 38 (43.7%) patients underwent ven-

Table 3. Comparison of obstetric and non-obstetric groups.

	Mean ± standard deviation	or No. (%)	*P* value
	Obstetric (n = 77)	Non-obstetric (n = 56)	
Age (years) Length of stay (days)	30.23 ± 5.24	29.37 ± 6.10	*P* = 0.383
Hospital	12.65 ± 8.92	17.86 ± 14.01	*P* = 0.017
ICU	4.48 ± 4.92	6. 89 ± 5.76	*P* = 0.013
Gestational age (weeks)	33.93 ± 0.65	31.51 ± 1.05	*P* = 0.044
APACHE II	6.87 ± 2.60	9.13 ± 3.34	*P* = 0.000
Mode of delivery			
Normal vaginal delivery	11/72 (15.3)	7/44 (15.9)	*P* = 0.091
Caesarean section	58/72 (80.6)	33/44 (75)	*P* = 0.480
MODS	12 (15.6)	22 (39.3)	*P* = 0.002
ICU mortality	3 (3.9)	8 (14.3)	*P* = 0.032

Table 4. Comparison of urban and non-urban groups.

	Mean ± standard deviation	or No. (%)	*P* value
	Non-urban (n = 98)	Urban (n = 35)	
Age (years)	29.24 ± 0.57	31.62 ± 0.87	*P* = 0.031
Gestational age (weeks)	32.04 ± 0.77	34.93 ± 0.67	*P* = 0.028
Length of stay (days)			
Hospital	15.43 ± 1.22	13.20 ± 1.68	*P* = 0.331
ICU	5.857 ± 0.57	4.486 ± 0.80	*P* = 0.199
APACH II	8.35 ± 3.14	6.43 ± 2.59	*P* = 0.002
Prenatal care			
Standard	48/77 (62.3)	28/31 (90.3)	*P* = 0.004
Absent	21 (21.4)	4 (11.4)	*P* = 0.194
Primipara	52 (53.1)	27 (77.1)	*P* = 0.013
Obstetric admission	49 (50)	25 (71.4)	*P* = 0.028
Transfer			
from external hospital	25 (25.5)	1 (2.9)	*P* = 0.004
Caesarean section	59/75 (78.7)	32/34 (94.1)	*P* = 0.044
Ventilation	62 (63.3)	25 (71.4)	*P* = 0.383
Blood transfusion	47 (48)	8 (22.9)	*P* = 0.010
Plasmapheresis	11 (11.2)	0 (0.0)	*P* = 0.039
Hypertensive discords	14 (14.3)	11 (31.4)	*P* = 0.026
MODS	30 (30.6)	4 (11.4)	*P* = 0.026
ICU mortality	10 (10.2)	1 (2.9)	*P* = 0.176

tilation for less than 24 hours. All of these patients were primarily admitted for intensive surveillance. For the remaining 49 patients, the requirement of mechanical ventilation was significantly due to altered mental status (n = 21), followed by pulmonary edema (n = 7), and pneumonia (n = 6). A total of 128 (96.2%) patients received IV antibiotics in the ICU. A central venous catheter was required in 69 patients (51.9%), and transfusion of blood products was required in 55 patients (41.4%). Eleven (8.3%) patients received plasmapheresis with a frequency of 1-4, including five patients with acute fatty liver of pregnancy (AFLP), five with liver failure due to viral hepatitis infection and one due to drug-induced hepatitis.

4.4. Obstetric and neonatal outcomes

During the study period, eleven maternal deaths were recorded, with a mortality rate of 8.3%. Eight deaths out of eleven (72.7%) were due to non-obstetric reasons. Non-urban patients accounted for 90.9% (n = 10) of the ICU maternal mortality. One patient from the urban group died of cerebral hemorrhage. There were 15 intrauterine fetal deaths (IUFD). The perinatal mortality rate was therefore (15/137) 10.9%.

5. Discussion

This is a retrospective study of obstetric patients requiring ICU admission to a tertiary care hospital in a developing country. Critically ill obstetric patients accounted for a small proportion of our ICU admissions. Our data were consistent

with other published studies [8, 9] of the two most common obstetric causes of admission (obstetric hemorrhage and hypertensive diseases from pregnancy). Among the underlying causes of obstetric hemorrhage recorded in our study, placental abnormality was the most common. Notably, placenta previa accounted for as much as 86.4% of the recorded placental abnormalities; our observation is consistent with that reported by Leung *et. al.,* 2010 [8]. We believe that more attention to the management of this population is needed in order to prevent and better treat obstetric hemorrhage. For example, pre-operative ultrasound should be performed to identify the location of the placenta for the purpose of choosing an appropriate uterine incision. Meanwhile, in order to reduce the bleeding of the placental exfoliation surface, oxytocin or massage of uterus could be applied quickly after the delivery of the fetus to promote the uterine contraction; for those with bleeding who do not respond to oxytocin and uterine massage, intrauterine gauze packing, B-lynch suture and uterine artery embolization are effective methods of treatment.

In our study, cardiac disorder was the most common reason for non-obstetric causes of ICU admission, in contrast with the findings of other studies in which sepsis was reported to be the predominant non-obstetric reason for ICU admission [8, 10, 11]. In Belgium, however, pre-existing and acquired cardiopathies were the most common cause for ICU admission and surpassed hypertensive disorders and hemorrhage [12]. In our hospital, the cardiac critical care unit (CCU) is a relatively independent intensive care unit, and this study did not include critically ill obstetric women in the CCU. If included, the proportion of ICU admission due to cardiac events might be higher. Maternal cardiac load increases significantly with increasing gestational age, especially in late pregnancy and the perinatal period, potentially leading to acute left heart failure, acute exacerbation of chronic heart failure, and even cardiogenic shock, particularly in women of advanced age and those with heart-related diseases. It is necessary that obstetricians and cardiologists work together to evaluate the appropriateness of pregnancy for women with cardiac disease, and to strengthen prenatal and postnatal management in these women. Furthermore, more intensive screening, especially for cardiac conditions, may improve pre- or early pregnancy identification of high-risk women and trigger early referral to more experienced medical facilities [12].

In this study, non-urban patients were sicker upon admission, showed a higher incidence of MODS and required more interventions, compared with urban patients. Although not statistically significant, non-urban patients accounted for 90.9% of maternal mortality. According to a recent study, protective factors for maternal mortality included prenatal care and admission to tertiary hospitals, while risk variables included high APACHE II and MODS [4]. While it is unsurprising that disease severity scores are associated with poor outcome, what is perhaps more relevant is that the detection of severe disease in such cases affords an opportunity to intervene [4].

Appropriate prenatal care has been shown to reduce the maternal death rate [13, 14]. In this study, 108 patients (81.2%) received at least one maternal health checkup. Standard prenatal care was followed in 70.4% of all patients (76/108), by 90.3% (28/31) of patients within the urban group and 62.3% (48/77) of patients within the non-urban group (P = 0.004; denominators inconsistent between comparisons due to missing data). Being cared for in a tertiary center improves access to better medical resources, such as well-trained physicians and advanced medical equipment that are essential to preventing maternal death [15, 16].

According to Zeeman G.G. (2006), maternal outcomes are expected to be adversely affected by a delay of more than 24 hours between onset of disease and ICU admission. The delays may be due to (1) a time-lag in seeking care, (2) the ability to access services or (3) the time required to receive appropriate care once the medical facility has been reached [17, 18]. The first such factor may explain our finding that non-urban patients were younger than urban patients (29.24 ± 0.57 versus 31.62 ± 0.87, P = 0.031), and there were more primipara pregnancies among urban patients (77.1% versus 53.1%, P = 0.013). The second cause of delay is related to accessibility barriers, such as healthcare cost, distance and transport [4]. The third possible cause of delay might explain why a higher percentage of non-urban patients had been referred from other less-specialized centers in this study [5].

Non-obstetric causes for admission may be associated with a higher prevalence of comorbidity [19] and greater illness severity [5, 20], which could explain why patients belonging to the non-obstetric group had higher APACHE II scores at admission, experienced longer hospital stays and ICU stays, developed more MODS and suffered higher maternal deaths than did patients in the obstetric group. Moreover, non-obstetric causes of admission were more frequent among non-urban patients, potentially accounting for the worse state of non-urban patients observed in this study. Cesarean section rates are higher among obstetric patients that require admission to ICU during their pregnancy [21]. The rate of cesarean sections of critically ill patients admitted to ICU in our study was 78.4%, in line with most previously reported studies of critically ill obstetric patients [22]. One such study reported that risk factors for requiring cesarean section were prenatal care and presenting with pregnancy-associated hypertension as the reason of admission. This was consistent with our finding that cesarean section was more frequent among urban group patients, who had received more frequent standard prenatal care, than non-urban group patients. For patients with hypertensive disorders, there were also differences between urban and non-urban groups (11/35 versus 14/98, 31.4% versus 14.3%, P = 0.026). Overall maternal mortality in this study was 8.3%. These figures were higher than in studies conducted in other countries [4, 12]. Similar to other studies, non-obstetric causes of death prevailed [11, 23], with eight deaths out of 11 (72.7%) due to non-obstetric reasons. Liver failure was the leading cause of death, followed by cerebral hemorrhage. However, pneu-

monia was the underlying primary cause of death in another study [11].

The main limitations of this study are its retrospective design, the small number of patients, and possible bias in information available from medical records. We were unable to retrieve birth outcomes including Apgar scores or Neonatal intensive care unit (NICU) admission, and the multiple organ dysfunction (MOD) score. Furthermore, patients admitted to the CCU during the study were not included. As, this is a single-center study, any extrapolation and generalization of the findings of these results should be carried out with caution.

6. Conclusions

In summary, we speculate that multidisciplinary team involvement is essential in the management of postpartum hemorrhages, hypertensive disorders and cardiac events. In our study, health disparities existed between patients from non-urban areas and urban areas: the former were sicker upon admission, were more frequently transferred from other hospitals, received less standard prenatal care, received more interventions, developed more complications, and their maternal mortality was higher. To help mitigate these disparities, we suggest that greater focus and resources be invested in obstetric healthcare in non-urban areas.

Author contributions

MZ conceived and designed the study; MZ and XG wrote the manuscript; MZ and YW collected the data; XG and YW analysed and interpreted the data; ZT and HW provided critical revisions; and XG, ZT and HW approved the final version of the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The Medical Ethics Committee of First Affiliated Hospital of Guangxi Medical University had approved the protocol [approval number: 2020(KY-E-021)].

Acknowledgment

This work was supported by Natural Science Foundation of Guangxi Province [grant number: 2017GXNSFAA198045].

Conflict of interest

The authors declare no competing interests.

References

[1] Neligan PJ, Laffey JG. Clinical review: special populations-critical illness and pregnancy. Critical Care. 2011; 15: 227.

[2] WHO, UNICEF, UNFPA. The World Bank: Trends in Maternal Mortality: 1990-2013. http://apps.who.int/iris/bitstream/10665/112682/2/9789241507226_eng.pdf?Ua=1.2014 (Accessed 1 February 2014).

[3] Ramos S, Karolinski A, Romero M, Mercer R; Maternal Mortality in Argentina Study Group. A comprehensive assessment of maternal deaths in Argentina: translating multicentre collaborative research into action. Bulletin of the World Health Organization. 2007; 85: 615-622.

[4] Vasquez DN, Das Neves AV, Vidal L, Moseinco M, Lapadula J, Zakalik G, *et al.* Characteristics, outcomes, and predictability of critically ill obstetric patients: a multicenter prospective cohort study. Critical Care Medicine. 2015; 43: 1887-1897.

[5] Karnad DR, Lapsia V, Krishnan A, Salvi VS. Prognostic factors in obstetric patients admitted to an Indian intensive care unit. Critical Care Medicine. 2004; 32: 1294-1299.

[6] Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Critical Care Medicine. 1985; 13: 818-829.

[7] Bone RC, Sprung CL, Sibbald WJ. Definitions for sepsis and organ failure. Critical Care Medicine, 1992; 20: 724.

[8] Leung NY, Lau AC, Chan KK, Yan WW. Clinical characteristics and outcomes of obstetric patients admitted to the Intensive Care Unit: a 10-year retrospective review. Hong Kong Medical Journal. 2010; 16: 18-25.

[9] Seppänen P, Sund R, Roos M, Unkila R, Meriläinen M, Helminen M, *et al.* Obstetric admissions to ICUs in Finland: a multicentre study. Intensive and Critical Care Nursing. 2016; 35: 38-44.

[10] Cartin-Ceba R, Gajic O, Iyer VN, Vlahakis NE. Fetal outcomes of critically ill pregnant women admitted to the intensive care unit for nonobstetric causes. Critical Care Medicine. 2008; 36: 2746-2751.

[11] Rios FG, Risso-Vázquez A, Alvarez J, Vinzio M, Falbo P, Rondinelli N, *et al.* Clinical characteristics and outcomes of obstetric patients admitted to the intensive care unit. International Journal of Gynecology & Obstetrics. 2012; 119: 136-140.

[12] De Greve M, Van Mieghem T, Van Den Berghe G, Hanssens M. Obstetric admissions to the intensive care unit in a tertiary hospital. Gynecologic and Obstetric Investigation. 2016; 81: 315-320.

[13] Karnad DR, Lapsia V, Krishnan A, Salvi VS. Prognostic factors in obstetric patients admitted to an Indian intensive care unit. Critical Care Medicine. 2004; 32: 1294-1299.

[14] Munnur U, Karnad DR, Bandi VD, Lapsia V, Suresh MS, Ramshesh P, *et al.* Critically ill obstetric patients in an American and an Indian public hospital: comparison of case-mix, organ dysfunction, intensive care requirements, and outcomes. Intensive Care Medicine. 2005; 31: 1087-1094.

[15] Geller SE, Rosenberg D, Cox SM, Brown ML, Simonson L, Driscoll CA, *et al.* The continuum of maternal morbidity and mortality: factors associated with severity. American Journal of Obstetrics and Gynecology. 2004; 191: 939-944.

[16] Knight HE, Self A, Kennedy SH. Why are women dying when they reach hospital on time? A systematic review of the 'third delay'. PLoS One. 2013; 8: e63846.

[17] Zeeman GG. Obstetric critical care: a blueprint for improved outcomes. Critical Care Medicine. 2006; 34: S208- S214.

[18] Thaddeus S, Maine D. Too far to walk: maternal mortality in context. Social Science and Medicine. 1994; 38: 1091-1110.

[19] Lombaard H, Pattinson RC. Underlying medical conditions. Best Practice & Research: Clinical Obstetrics & Gynaecology. 2008; 22: 847.

[20] Mhyre JM, Bateman BT, Leffert LR. Influence of patient comorbidities on the risk of near-miss maternal morbidity or mortality. Anesthesiology. 2011; 115: 963-972.

[21] Zwart JJ, Dupuis JR, Richters A, Ory F, van Roosmalen J. Obstetric intensive care unit admission: a 2-year nationwide population-based cohort study. Intensive Care Medicine. 2010; 36: 256-263.

[22] Pollock W, Rose L, Dennis CL. Pregnant and postpartum admissions to the intensive care unit: a systematic review. Intensive Care Medicine. 2010; 36: 1465-1474.

[23] Gilbert TT, Smulian JC, Martin AA, Ananth CV, Scorza W, Scardella AT. Critical Care Obstetric Team. Obstetric admissions to the intensive care unit: outcomes and severity of illness. Obstetrics and Gynecology. 2003; 102: 897-903.