Critically ill obstetric patients in Australia: a retrospective audit of 8 years' experience in a tertiary intensive care unit

Shyamala Sriram and Megan S Robertson

Critical illness requiring admission to the intensive care unit is rare in pregnancy and the postpartum period in Australia. Retrospective analyses of hospital admission and complication rates from other developed countries suggest that 0.11%–0.89% of deliveries are complicated by maternal ICU admission.[1-7] The maternal mortality ratio (MMR) in Australia in 1997–1999 was 8.2 deaths per 100 000 confinements,[8] compared with 9.1 per 100 000 in 1994–1996 and 12.7 per 100 000 in 1973–1975. This one-third decrease over the past 30 years means that MMR is now a poor indicator of the quality of maternity care in Australia. In contrast, in countries such as India and South Africa where the MMR is high (440 per 100 000 and 340 per 100 000, respectively), it remains a valid and reliable indicator.[9]

As mere survival rates cannot serve as an indicator of quality of maternity services in Australia, continuing systematic assessment of critical events in pregnancy and childbirth is warranted, with high-level investigation and contemporaneous reporting so that recommendations are relevant to current practice. Maternal mortality rates are significantly higher when pregnant women require critical care, ranging from 5%–20% in different studies.[1-7] Women who need ICU admission postpartum may represent cases of near-miss mortality.[10] Admission of pregnant or postpartum women to the ICU is uncommon but requires specialised knowledge for successful management.

Studies from other developed and developing countries have reviewed the care of critically ill obstetric patients,[1-7] but up-to-date data on these patients in Australia are limited. This study was a systematic critical analysis of the indications for admission, demographics, clinically relevant aspects of medical care and outcomes of critically ill obstetric patients treated at our ICU.

Methods

This audit was approved as a quality assurance project by the Human Research and Ethics Committee of the Royal Melbourne Hospital, Melbourne, Victoria, which waived the requirement for participant consent.

The audit was conducted in the 24-bed general medical and surgical ICU of a tertiary, university-affiliated teaching hospital located in central Melbourne. The ICU operates as a closed unit with specialist intensivists and trainees providing 24-hour on-site medical care. The hospital does not

ABSTRACT

Objective: To review the indications for admission, demographics, clinically relevant aspects of medical care and outcomes of critically ill obstetric patients admitted to a tertiary hospital intensive care unit.

Design: Retrospective review.

Setting and participants: General medical and surgical ICU of a tertiary university-affiliated hospital in central Melbourne, Victoria, Australia. Medical records were reviewed for all women who were admitted to the ICU between January 1998 and June 2006 and were pregnant or within the 6-week postpartum period. All were transferred from other hospitals.

Main outcome measures: Primary diagnoses, clinical indications for ICU admission, ICU interventions, and maternal and fetal outcomes.

Results: Over the 102-month period, 56 obstetric patients were admitted to the ICU (0.38% of all ICU admissions). Their mean (±SD) age was 31.8 (±5.76) years. All but two admissions were postpartum. The most common indications for ICU admission were haemodynamic instability (38%), respiratory complications (29%) and neurological complications (27%). Mechanical ventilatory support was required by 61% (34/56) of the patients, and blood transfusion by 48%. The median length of ICU stay was 45.75 hours (range, 8–281 hours). There were no maternal deaths, but residual functional or physical disability was noted in eight patients. There were four perinatal deaths.

Conclusions: This audit is a reminder that continued vigilance is required to ensure maternal safety. It also emphasises the need to integrate free-standing maternity units with hospital intensive care services.

provide obstetric services but is located within 500 metres of a major public teaching obstetric hospital, which has almost 6000 deliveries per annum but no ICU services. Thus, all obstetric patients admitted to the ICU came via interhospital transfer, and there was no obstetric team on-site for ongoing care.

Table 1. Primary diagnosis at time of ICU admission

Primary diagnosis	No. of patients	Percentage*
Obstetric haemorrhage	15	27%
Antepartum haemorrhage	5	9%
Pre-eclampsia/eclampsia	15	27%
HELLP syndrome	12	21%
Peripartum cardiomyopathy	3	5%
Others	9	16%

HELLP = haemolytic anaemia, elevated liver enzymes, low platelet count.
* Percentages add to more than 100% as some patients had more than one diagnosis.

Table 2. Indications for ICU admission

Indication	No. of patients	Percentage*
Haemodynamic instability	21	38%
Respiratory complications	16	29%
Neurological complications	15	27%
Disordered haemostasis	9	16%
Renal complications	7	13%
Sepsis	3	5%
Others	5	9%

* Percentages add to more than 100% as some patients had more than one indication for ICU admission.

We reviewed records of all women who were admitted to the ICU between January 1998 and June 2006 and were pregnant or within the 6-week postpartum period. The data collected were categorised as obstetric, diagnostic, interventional and outcome data. The primary diagnosis (disease process which caused the critical illness) and the clinical indication that prompted the ICU admission were included in the diagnostic data. Interventional data from the ICU admission included details of mechanical ventilation, monitoring of central venous pressure and arterial blood pressure, transfusion requirement and haemofiltration. Outcome data included maternal and fetal outcome. Maternal outcome was categorised as good, sequelae present, or maternal death. Similarly, fetal outcome was classified as good, requiring neonatal ICU admission or death. We also noted the number of patients reviewed by the obstetric team.

Data were analysed using the Statistical Package for the Social Sciences (SPSS; SPSS Inc, Chicago, Ill, USA). Data are presented as mean±standard deviation or median and range.

Results

Obstetric data

Fifty-six critically ill obstetric patients were admitted to the ICU over the 102 months from January 1998 to June 2006. This represented 0.38% (56/14 732) of total ICU admissions over this period.

Mean age of the obstetric patients was 31.8±5.76 (median, 31.0 years; range, 17–44), with 30% (17/56) classified with advanced maternal age (defined as older than 35 years). There were equal numbers of primigravida and multigravida. Most patients (54/56; 96%) were admitted postpartum, with 34 (61%) patients admitted on Day 0 postpartum, and the remainder admitted between Days 1 and 7. The mode of delivery was caesarean section in 63% (35/56) and vaginal in the remainder.

As expected, all obstetric patients were interhospital transfers to our ICU. More than half (52%; 29/56) were admitted directly from the operating room, 23% (13/56) from the ward, 14% (8/56) from the emergency department, 9% (5/56) from the delivery suite, and 2% (1/56) from the high-dependency area of the obstetric hospital. Median length of stay in the ICU was 45.75 hours (range, 8–281 hours).

Most patients (63%; 35/56) were admitted to our hospital under the care of a medical specialty unit, while 36% (20/56) were admitted under a surgical unit. The remaining patient was admitted directly into the ICU and later referred to a medical team. The obstetric team reviewed the patient in the ICU in 21% (12/56) of cases and provided telephone advice for an additional 11% (6/56).

Diagnostic data

The primary diagnoses leading to ICU admission and the clinical indications for ICU admission are listed in Table 1 and Table 2, respectively. Haemodynamic instability and respiratory complications were the two most common indications prompting ICU admission but, surprisingly, neurological complications requiring ICU care were also responsible for a substantial proportion of ICU admissions. Most patients had more than one system dysfunction identified at the time of ICU admission.

The disease process responsible for the complication requiring ICU admission was directly related to pregnancy in 84% (47/56) of patients. In the remaining 16%, the disease process was not directly related to pregnancy but may have been aggravated by pregnancy.

Haemodynamic instability was caused by postpartum haemorrhage in two-thirds of cases (14/21). Other causes were septic shock (2/21), peripartum cardiomyopathy (2/21), and uterine rupture (1/21); in the remaining two patients, the cause was not determined.

Table 3. Interventions required during ICU admission

Intervention	No. of patients	Percentage
Mechanical ventilation		
≤ 24 h	13	23%
> 24 h	21	38%
Invasive monitoring		
Central venous line	17	30%
Arterial line	50	89%
Pulmonary artery catheter	2	4%
Intervention		
Acute surgery	9	16%
Angiographic embolisation	1	2%
Blood transfusion	27	48%
Inotropic support	8	14%

Table 4. Residual disabilities at discharge from ICU

Neurological
Hemiparesis
Hypopituitarism
Ataxia and dysphasia
Expressive dysphasia and word-finding difficulties
Poor balance and weakness in all four limbs
Retrograde amnesia
Airway
Tracheal stenosis
Renal
Dialysis-dependent

Respiratory complications included acute pulmonary oedema (8/16), pulmonary embolism (2/16) and pulmonary aspiration (1/16); the cause of respiratory failure was unclear in five patients.

Eclampsia was the most common cause of peripartum neurological dysfunction, with patients presenting with multiple seizures (4/9), intracranial bleeds (3/9), or transient neurological symptoms (2/9). Other neurological presentations included aggravation of pre-existing seizure disorder, intracranial haemorrhage due to an arteriovenous malformation and Sheehan's syndrome.

In all seven patients with renal dysfunction (defined as oliguria for > 24 hours, with or without an increased serum creatinine level), it was a result of pre-eclampsia. One patient required haemofiltration and was discharged on alternate-day haemodialysis.

Disordered haemostasis and coagulation resulted from massive blood transfusion in four patients, severe thrombocytopenia as a result of HELLP (haemolytic anaemia, elev-

ated liver enzymes, low platelet count) syndrome in three patients, and disseminated intravascular coagulation due to intra-uterine fetal death in two patients.

Sepsis was the admitting indication in three patients but was a direct complication of pregnancy in only one, who had secondary infection of a lateral pelvic wall haematoma resulting in multi-organ failure. Another patient developed *Klebsiella* sepsis as a result of an infected peripherally inserted central catheter, and the third had *Escherichia coli* sepsis of unknown source.

Two patients had airway complications in the postpartum period: one developed stridor requiring endotracheal intubation on Day 5 postpartum, secondary to tracheal stenosis from prior endotracheal intubation; and the other had angioedema secondary to a diclofenac sodium suppository. Finally, two patients had bowel perforation as complications of caesarean delivery, and another presented with blunt abdominal trauma after falling from bed during a grand mal seizure.

Most obstetric patients presenting to our ICU had no previously identified medical condition (82%; 46/56). Ten patients had chronic illnesses, including asthma (3), irritable bowel disease (2), epilepsy, lymphoma, thalassaemia trait, rheumatoid arthritis and essential hypertension (1 each). In addition, six patients had gestational diabetes.

ICU interventions

Intensive care interventions for all patients are listed in Table 3. Mechanical ventilatory support was required by 34 patients, and non-invasive ventilation by one. The median duration of ventilation was 16 hours (range, 4–87 hours).

Twenty-seven patients required blood transfusion, in over half because of postpartum haemorrhage. The median volume of red cell concentrate transfused was 16 units (range, 2–76 units). Eighteen patients received massive transfusion, defined as more than 10 units of blood and/or blood products in 24 hours, and four patients developed coagulopathy as a result. One patient required activated factor VII to achieve haemostasis.

Patient outcomes

There were no maternal deaths, but eight patients had functional or physical disability as a result of the peripartum complications (Table 4). Fetal outcome was good in 79% (44/56). There were 20 preterm births (36%), including 13 at < 32 weeks' gestation. Eight neonates were admitted to the neonatal ICU, and there were two neonatal deaths and two deaths in utero.

Discussion

Although obstetric cases represented only a small proportion of all patients admitted to our ICU (0.38%), they were

a varied and clinically challenging group. Most of the conditions resulting in ICU admissions were a direct result of pregnancy and parturition, with respiratory and haemodynamic compromise the two most common indications. As expected, there were no maternal deaths in our cohort, but eight women had substantial disability at the time of ICU discharge requiring follow-up.

Obstetric patients requiring ICU admission may reflect near-miss maternal mortality.[10] The provision of maternal intensive care varies considerably worldwide. Some obstetric units have an ICU located within the labour and maternity ward,[10-12] while others have intensive care services provided in another part of a combined general hospital.[5,9] Alternatively, as at our hospital and others such as Halifax Hospital, Canada,[10] obstetric patients requiring intensive care management are transferred to a geographically separate ICU. In most previous studies,[5,8,10] obstetric admissions to the ICU were reported as the number of ICU admissions per 1000 deliveries. However, in our study it was not possible to determine the baseline delivery rate for the obstetric population, as obstetric patients admitted to our ICU were transferred from other hospitals and originated from around the state. In addition, the interhospital transfer of critically ill patients in Victoria is coordinated by a centralised system, which transfers patients according to ICU bed availability. Thus, we reported admissions as a percentage of total ICU admissions.

Obstetric admissions represented 0.38% of all admissions to our ICU over the 102 months surveyed. In contrast, a study from the United Arab Emirates by Mirghani et al[3] found that obstetric patients represented 2.4% of total ICU admissions, and a Turkish study[4] found they represented 2.64% of total ICU admissions. The substantially lower proportion of obstetric admissions to our ICU may be explained by variation in ICU admitting criteria or the lack of in-house obstetric services at our hospital. A diagnosis of pre-eclampsia alone may have initiated the admissions to the ICU in the other studies,[4] but in our cohort patients were admitted only when there was a requirement for either respiratory or cardiovascular support.

The mean age of our patients was 31.8 ±5.7 years, which is older than found in most of the studies reviewed: mean age was 28 ±6 years in the Turkish study,[4] 26 ±6 years in a US study,[5] and 25.5 ±4.6 years in a study in India.[9] This may represent socioeconomic differences between patient groups; early age of marriage and social pressure to have children early may be important contributory factors in Asian countries such as India, while late marriages and reluctance to have children early may contribute to the older obstetric population in Australia. We found that almost a third of obstetric patients admitted to the ICU were of advanced maternal age (over 35 years). No previous study has noted an increased representation of this group, but advanced maternal age is associated with an increased incidence of obstetric complications, including eclampsia, pre-eclampsia and placental problems, delivery by caesarean section, pre-term births and maternal mortality.[13] Thus, in Australia, where maternal age is steadily increasing, this group may represent a potentially growing cohort of critically ill obstetric patients.

Our study also had a disproportionately low antenatal admission rate, with only two patients admitted before delivery (4%). This may have been due to clinician reluctance to transfer pregnant patients to a hospital with no on-site obstetric expertise. This contrasts with the findings of Kilpatrick and Matthay[5] that 34% of patients were admitted antepartum, but their ICU had an obstetric team contributing to overall patient care. Alternatively, 84% of patients in our cohort had a primary obstetric diagnosis, compared with 65.25% in Kilpatrick and Matthay's study,[5] and thus decisions regarding early pregnancy termination with delivery and postpartum transfer to our ICU may have been appropriate.

Studies from India and Sri Lanka have shown that medical conditions such as rheumatic fever, malaria and viral hepatitis contribute significantly to ICU admission rates in pregnant patients,[12,14,15] but in Australia these medical conditions are rare in both the general and pregnant populations. Only a small proportion of our patients had pre-existing medical conditions, and in only one was ICU admission a direct consequence of this condition (epilepsy).

The most common obstetric diagnoses prompting ICU admission were eclampsia and obstetric haemorrhage, findings similar to those of other published studies worldwide.[5,8,9] Complications of these problems can be life-threatening, and early detection and resuscitation are the key to successful management and optimal outcomes.

Specific unique obstetric diagnoses, such as peripartum cardiomyopathy, require specialised skills and knowledge as they have potentially devastating consequences. Three of our patients had this diagnosis. They were investigated and treated promptly, and then followed up over a year with regular echocardiograms that showed return of normal cardiac function within 12 months. Diagnosis of peripartum cardiomyopathy is traditionally based on four clinical criteria: development of cardiac failure in the last month of pregnancy or within 5 months of delivery, absence of an identifiable cause for the cardiac failure, absence of recognisable heart disease before the last month of pregnancy, and left ventricular systolic dysfunction. Most patients present with respiratory distress due to acute pulmonary oedema.[16] In women with peripartum cardiomyopathy and cardiac failure, the goals of medical therapy are similar to those in patients with cardiac failure due to other causes

but, because of the unique issues related to pregnancy and the peripartum period, every therapeutic decision has additional implications. Thus a multidisciplinary approach to management, involving an intensivist, cardiologist and the obstetric team, is mandatory, once again highlighting the importance of having on-site intensive care services.

In our study, only a fifth of patients received obstetric review while in the ICU. Although most of our patients were admitted postpartum, continuing guidance from the obstetric team is beneficial, particularly with regard to uterine involution and breast care. Access to midwives for routine postpartum care and much-needed emotional support for the mother is mandatory.

Another important group of patients were those who had significant postpartum haemorrhage requiring blood transfusion. In our study all patients with postpartum haemorrhage received massive transfusion (defined as more than 10 units of red cell concentrate), and one patient required recombinant factor VII. Although not well established, use of recombinant activated factor VII has significant potential to treat haemorrhage in obstetric patients.[17]

To our knowledge, this is the first study that reports residual disabilities in a cohort of critically ill postpartum patients. The societal impact of these disabilities is likely to be pronounced given the young productive status of these women and the limitations these disabilities place on their maternal role. Most patients had residual neurological disabilities, in all but one as a result of eclampsia. Early admission of high-risk patients with pre-eclampsia to an obstetric high-dependency unit with close monitoring and optimal control of blood pressure may benefit patients by minimising long-term sequelae.

The incidence of preterm birth in our study was 36%, and there were four perinatal deaths. The perinatal mortality rate in Victoria in the year 2005 was 12.7 per 1000 live births.[18] Perinatal mortality in our study was disproportionately high (4/56, 72 per 1000). Mortality during the perinatal period is considered a good indicator of both maternal and newborn health care. The higher perinatal death in our cohort probably reflects the severity of maternal illness. In addition, pre-term neonates require special care. Thus any institution which cares for critically ill pregnant patients should have access to an appropriate neonatology unit. Providing expert neonatal care in the same hospital complex as the ICU would allow the mother to "room in" with her baby, which contributes to the wellbeing of the newborn and to lactation success.[19] It also ensures greater family support to postpartum women, as it eliminates the logistical difficulty of moving between hospitals.

In conclusion, maternal death is infrequent in modern Australian maternity units, and thus attention often focuses on the wellbeing of the neonate. This audit is a timely reminder that continuing vigilance is required to ensure maternal safety. The results highlight the importance of integrating independent maternity hospitals that care for women with high-risk pregnancies with the tertiary hospitals that provide intensive care services.

Author details

Shyamala Sriram, Senior Registrar
Megan S Robertson, Senior Specialist
Intensive Care Unit, Royal Melbourne Hospital, Melbourne, VIC.
Correspondence: megan.robertson@mh.org.au

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