A fifteen-year retrospective review of obstetric patients requiring critical care

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Summary

Background: Maternal mortality is a rare occurrence in developed nations. Given the low maternal mortality rate, other markers must be used to assess maternal risk and quality of obstetric care. One such is admission to critical care.

Aims: To determine the rate of admission, diagnosis and management of women from conception and up to 6 weeks postpartum to critical care units including coronary care (CCU), high dependency unit (HDU) and intensive care units (ICU).

Methods: We performed a retrospective review of obstetric patients requiring critical care admission from January 1995 to August 2010. Demographic details, obstetric history, place of admission (CCU, HDU or ICU) and fetal/neonatal outcomes were examined as were initial indication for critical care admission, final diagnosis and treatment administered.

Results: Data were available from 308 admission incidents. There were 259 (84%) admissions to ICU and 49 (15.9%) to CCU. More than a third of women were transferred from another institution. Those women transferred were more unwell and had a higher mortality rate than local women. Primary diagnoses: obstetric haemorrhage (ICU 30.9%), hypertensive disorders of pregnancy (ICU 16.2%, CCU 12.2%), infection (ICU 14.2%, CCU 6.1%), pre-existing cardiac disease (ICU 9.3%, CCU 55.1%).

Conclusions: The obstetric population represents only a small percentage of critical care utilisation and overall morbidity and mortality. However, this population is an important and growing group. Increased surveillance peripartum in a critical care facility allows earlier detection of maternal compromise and detailed management. Analysis of these 'near misses' in obstetrics aims to improve pregnancy outcomes.

Keywords: high-risk pregnancy, intensive care medicine, maternal mortality

INTRODUCTION

Maternal mortality is a rare occurrence in developed nations.¹ The maternal mortality ratio for Australian women for the triennium 2003–2005 was 8.4 deaths per 100,000 confinements.² The primary causes of maternal mortality in Australia include amniotic fluid embolism, pulmonary embolism, hypertensive disorders of pregnancy, massive haemorrhage and cardiac conditions.² The low maternal mortality rate is perhaps not a good indicator for maternal risk and quality of obstetric care in developed nations.

With this in mind, the concept of the maternal 'near miss' as a marker of maternal morbidity has arisen. Major morbidity as reflected by the need for critical care admission^{3–9} could serve as such a marker. Published studies address mortality and intensive or critical care admissions and do not give a clear indication of admissions to or management given in coronary care

as a separate entity. This potentially excludes an important group of women requiring higher level care in the form of coronary care unit expertise during pregnancy as well as the peripartum period.

The purpose of this study was to determine major morbidity as measured by the rate of admission, diagnosis and management of women with obstetric complications from conception and up to 6 weeks postpartum to critical care units including coronary care (CCU), high dependency (HDU) and intensive care units (ICU) in a major tertiary hospital in Australia.

METHODS

The study was performed at the Royal Brisbane and Women's Hospital (RBWH), a major 948 bed tertiary public hospital providing high risk obstetric services to a wide area of Queensland and Northern New South Wales. The hospital has approximately 4,300 deliveries per year (range 3948–4711 since 2001).

Critical care facilities include an 18-bed general intensive care unit (ICU), an 8-bed high dependency unit (HDU), and a 12-bed coronary care unit (CCU). The hospital moved to a new

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location in 2003. At this time the Royal Women's Hospital was amalgamated with the Royal Brisbane Hospital and became the Royal Brisbane and Women's Hospital. Total ICU bed numbers remained unchanged (26 beds) however, the CCU bed numbers increased from 8 to 12 over this period.

We performed a retrospective record review of obstetric patients who required critical care admission from January 1995 to August 2010. Permission for this retrospective review was granted by the Royal Brisbane and Women's Hospital Human Research Ethics committee. Patients were identified by searching the medical record (discharge related group) codes related to pregnancy, postpartum state, critical care, ICU, HDU and CCU admission. Additionally, the ICU database was queried for obstetric admissions. The Royal Women's and Royal Brisbane Hospitals amalgamated in 2003, so Health Information Services undertook the search at both the Royal Women's and Royal Brisbane Hospitals prior to 2003 and the Royal Brisbane and Women's Hospital after 2003. The Royal Women's Hospital used another database – Obicare – for data collection for the years 2000 and 2001 and some data were incomplete during these two years.

Information collected included demographic details, obstetric history, place of admission (CCU, HDU or ICU) and fetal/neonatal outcomes. The admission was categorized as to initial indication for admission as well as final diagnosis. Categories were: cardiac, infection, hypertensive disorders, haemorrhage, amniotic fluid emboli, anaesthetic complications, thromboembolic disease and trauma. Given the complexity of these patients, many had multiple diagnoses and multiple indications for admission to high level care. Thus the chart examiner (obstetric medicine fellow) made a judgment as to the most important indication for admission and diagnosis. Additional data gathered included maternal management in ICU: intubation, invasive monitoring, blood transfusion, inotropic support, hospital of origin, and APACHE II scores. Blood transfusion data were gathered from the laboratory transfusion database for those transfused in our institution. The category 'other' in mode of delivery includes women who miscarried, required D&C or hysterotomy, or were delivered elsewhere and the details unclear.

Our HDU and ICU are co-located and the notes did not differentiate between the two. Therefore we have amalgamated these two areas. Data have been categorized into ICU and CCU.

RESULTS

A total of 335 correctly categorised admission events for ICU and CCU were found. Ten records had been destroyed and a further 17 were unobtainable. Data were available from 308 admissions (91.9%). There were 259 (84%) admissions to ICU and 49 (15.9%) to CCU. Two women were admitted to high level care twice in the same pregnancy, and two women were admitted to high level care in different pregnancies. The majority of admissions were postpartum: ICU ($n = 189$ (72.9%)) and CCU ($n = 34$ (69.4%)). Seven patients required high level care admission both antepartum and postpartum.

Twelve patients were admitted to both ICU and CCU and these were included in the ICU group. Eleven of these 12 women had primary cardiac diagnoses and one a postpartum haemorrhage. Five of these 12 women were antenates and 7 arrived by interhospital transfer. All except one spent longer in CCU than ICU. This group had an average total length of stay of 7.3 days, (range 2–20).

Table 1 Maternal demographic details and delivery characteristics

	ICU ($n = 259$)	CCU ($n = 49$)
Age (years) (mean (SD))	29.9 (7.1)	29.5 (5.94)
Gravidity (median)	2	2
Parity (median)	2	1
Smoking (n(%))	56 (21.6%)	13 (26.5%)
Admission antepartum (n(%))	70 (27.0%) ($\S$, $n = 4$)	15 (30.1%) ($\S$, $n = 3$)
Antenatal gestational age (mean (SD))	25.2 (SD 9.6)	32.3 (SD 6.8)
Admission postpartum (n(%))	189 (72.9%)	34 (69.4%)
Postnatal gestational age (mean (SD))	34.0 (SD 6.3)	35.5 (SD 4.5)
Transferred from another institution (n(%))	100/256 (39.0%) [†]	18/49 (36.7%)
Mode of delivery (n) [‡]	192	37
Vaginal (n(%)) [‡]	34 (17.7)	7 (14.3)
Vaginal instrumental (n(%)) [‡]	11 (5.7)	4 (10.8)
Non urgent caesarean section (n(%)) [‡]	76 (39.6)	19 (51.4)
Emergency caesarean section (n(%)) [‡]	55 (28.6)	6 (3.1)
Other (n(%)) [‡]	16 (8.3)	1 (0.5)

[†] 3 unclear if transferred

[‡] this has been reported for those women admitted postnatally only

$\S$ the patient was admitted both antenatally and postnatally

Maternal demographics

Maternal demographic details and obstetric history are shown in Table 1. The average overall maternal age was 29.8 years (SD 6.91, range 15–52). Thirteen women (5%) in ICU and 2 (4%) in CCU were older than 40 years and there were 24 indigenous women (12.2% (ethnicity clear in $n = 196$)).

Maternal deaths

Over the fifteen-year period, there were eight maternal deaths. All of these were in women admitted to ICU. All were younger than 40 years; half were of non-English speaking ($n = 3$) or indigenous background ($n = 1$). Causes of death included amniotic fluid emboli ($n = 2$), a presumed massive pulmonary embolus, cryptococcal meningitis, subarachnoid haemorrhage, Eisenmenger's Syndrome, metastatic melanoma and severe pulmonary hypertension.

Inter-institution transfers

One hundred women admitted to ICU ($n = 100$ (39%)) and 18 admitted to CCU ($n = 18$ (36.7%)) were transferred from another institution. These women were more unwell than local women admitted to ICU as indicated by a higher average APACHE scores (mean 13.38 (transferred), mean 11.23 (local), P -value = 0.03, unpaired t -Test) and higher mortality rate (six of the eight recorded deaths were amongst the transferred group).

Maternal diagnoses

Overall, 155 (50%) of women admitted to ICU or CCU had a direct obstetric or pregnancy-related condition. This was more common in women admitted to ICU (141(54%)) than CCU (14(29%)). There was a broad range of diagnoses requiring maternal admission to intensive care. The primary categories were haemorrhage (80(31%)), hypertensive disorders (42(16%)), infection (37(14%)), pre-existing cardiac disease (24(9%)) and

Table 2 Primary acute indication for higher level care

	ICU <i>n</i> = 259 <i>n</i> (%)	CCU <i>n</i> = 49 <i>n</i> (%)
Haemodynamic instability	85 (32.8)	16 (32.7)
Respiratory compromise	55 (21.2)	11 (22.4)
Neurological compromise	28 (10.8)	0
Disordered haemostasis	23 (8.8)	0
Renal compromise	8 (3.1)	0
Sepsis	11 (4.2)	1 (2.2)
Existing cardiac disease for monitoring [†]	16 (6.2)	20 (40.8)
Others	33 (12.7)	1 (2.2)

[†] the only indication for admission was for observation

trauma (12(5%)). Acute indications for admission to higher level care are detailed in Table 2. The final diagnosis of admission is explored in Table 3a.

The admissions to ICU with infection (*n* = 37 (14.2%)) were predominantly related to pneumonia (*n* = 18). There were two women with influenza; one with influenza A, and one with H1N1 influenza. The single episode of puerperal sepsis occurred in a woman who delivered vaginally at home and was admitted a week postpartum. The admissions to CCU were predominantly for a primary cardiac problem (*n* = 43 (87.8%)). The final diagnoses of these women are detailed in Table 3b.

Management and interventions during admission to high level care

Management during admission is reported in Table 4. Average length of stay was 3.21 days (SD 3.95) for women in ICU, 4.38 days (SD 4.47) in CCU. Of note, admission duration < 24 hours was common: ICU (51.7%), CCU (18.4%). APACHE II scores were available for 139 of the women who attended ICU. Mean score was 12.17 (SD 6.1, range 2–41, median 16). Mechanical ventilation was required by 106 (45.7%) of women admitted to ICU, most for less than 24 hours (55 of 106 (51.8%)). Ninety of these 106 women received intubation alone, 8 (7.5%) intubation followed by CPAP/BiPAP and the rest CPAP/BiPAP alone. Invasive monitoring including arterial lines, central venous lines and pulmonary artery catheters were used in 167 (72%) women. Inotropes – both positive and negative – were used in 39 (16.8%). The CCU patients required fewer supportive measures. Radiological investigation in CCU included seven ventilation perfusion lung scans and 21 echocardiograms.

Infant outcomes

The infant outcome data include the eventual pregnancy outcomes for those women who were admitted antenatally, where available. Amongst the ICU admissions, there were 43 (16.5%) fetal deaths. Thirty-six of these were intrauterine fetal deaths or stillbirths. There were three neonatal deaths (delivered at 22, 26 and 28 weeks) and four miscarriages or ectopic pregnancies. In the CCU cohort there was one intrauterine fetal death and two neonatal deaths in a pair of twins, born at 24 weeks gestation. For those women who were admitted postnatally to ICU, 91/139 (65.4%) infants were admitted to neonatal intensive care. Amongst those women admitted postnatally to CCU, there were 15/34 (44%) infants admitted to neonatal intensive care.

Table 3a Final maternal diagnoses for women admitted to ICU or to CCU

	ICU (<i>n</i> = 259)	CCU (<i>n</i> = 49)
Intrapartum/postpartum haemorrhage	71 (27.4%)	0
Hysterectomy	36	
Antepartum haemorrhage	9 (3.5%)	0
Ectopic	1	
Placental abruption	2	
Placenta accreta/percreta	2	
'Simple' haemorrhage	4	
Hypertensive disorders	42 (16.2%)	6 (12.2%)
Infection/sepsis	37 (14.2%)	3 (6.1%)
<i>Pneumonia</i>	18	
Community acquired	11	
Aspiration	2	
Influenza	2	
Varicella	3	
<i>Obstetric</i>	9	
Chorioamnionitis	4	
Purpural sepsis	1	
Tubo-ovarian abscess	1	
Septic abortion	1	
Wound infection	2	
<i>Other infection</i>	10	3
Endocarditis	2	
Neurosurgical (shunt related or post operative)	3	
Meningitis	2	
Dental abscess	1	
Gangrenous appendicitis	1	
Small bowel perforation (carcinoid syndrome)	1	
Pre-existing cardiac disease	24 (9.3%)	27 (55.1%)
Trauma	12 (4.6%)	
Motor vehicle accident	9	
Burns	2	
Fall from horse	1	
Thrombosis	6 (2.3%)	
Anaesthetic complications	6 (2.3%)	
Peripartum cardiomyopathy	8 (3.1%)	7 (14.3%)
Amniotic fluid embolism	2 (0.8%)	
Other diagnostic groups	42 (16.3%)	6 (12.3%)
<i>Neurological compromise</i>	12	
Seizures [#]	5	
Malignancy	2	
Subarachnoid haemorrhage	3	
Myasthenia gravis	1	
Others	1	
<i>Metabolic disturbance</i>	5	
Diabetic ketoacidosis	1	
Hyperemesis gravidarum	1	
Hyponatraemia	1	
Carbamyl phosphate synthase deficiency	1	
Undifferentiated metabolic acidosis	1	
<i>Asthma</i>	4	
Newly diagnosed cardiac disease	4	
Anaphylaxis	3	
Drug overdose	2	
Acute renal failure	2	
Non-obstetric surgical injury or haemorrhage	2	
Others	8	6

[#] none secondary to pre-eclampsia/eclampsia

COMMENT/DISCUSSION

The most recent available Australian statistics demonstrate a maternal mortality rate of 8.4/100,000 confinements.² Due to the rarity of maternal death in Australian maternity units, maternal safety is often assumed. Therefore an examination of

Table 3b Final diagnoses of women admitted to coronary care

	CCU (n = 49)
Hypertensive disorders (pre-eclampsia)	6 (12.2%)
Severe hypertension	3
Acute pulmonary oedema	3
Infection/sepsis	3 (6.1%)
Endocarditis (streptococcus viridans)	1
Pericarditis (tuberculosis)	1
Mastitis	1
Valvular heart disease	14 (28.6%)
Congenital heart disease	5
Rheumatic valvular disease	5
Valve disease of unclear aetiology	4
Arrhythmia	11 (22.4%)
Ventricular tachycardia	4
Wolf-Parkinson-White	2
Right ventricular outflow tract ventricular tachycardia	2
Atrial fibrillation	1
Complete heart block	1
Bigeminy	1
Cardiomyopathy	11 (22.4%)
Hypertrophic cardiomyopathy	3
Peripartum cardiomyopathy	7
Unclear aetiology	1
Acute ischaemic coronary event	4 (8.2%)

critical care utilization is relevant in assessing threats to maternal life.

This study reports on a fifteen-year period of obstetric admissions to high level care, including coronary care at our tertiary obstetric and general hospital. The most common indications for critical care admission in our study were obstetric haemorrhage, hypertensive disorders of pregnancy, and maternal cardiac dysfunction. All are well established as leading causes of maternal morbidity and mortality in the developed world. A recent meta-analysis has confirmed haemorrhage and hypertensive disorders precipitate the majority of intensive care admissions for the obstetric population.¹⁰

There have been several recent Australian studies examining severe maternal illness and intensive care admissions.^{3,11–14} In the current study, we found a different case mix, with a lower rate of admission for obstetric or pregnancy-related complications (50% overall compared to between 60–80%). This may be related to our position as a major tertiary referral hospital serving a large area of Queensland.

We had a high rate of admission for pre-existing cardiac disease (17% overall, 9.3% of ICU patients, 55% of CCU patients). A number of factors may have contributed to this. Firstly, Queensland has a high rate of rheumatic heart disease amongst its indigenous population. Rheumatic heart disease accounted for six of our admissions to higher level care. Only two of the women with rheumatic heart disease were Caucasian and all but one were inter-hospital transfers. Secondly, a growing number of women with pre-existing cardiac disease are now embarking on pregnancy. In our institution, we have developed a comprehensive multidisciplinary clinic for the care of women with cardiac disease – including pre-pregnancy and contraceptive counselling, pregnancy management and postpartum review prior to return to their usual treating cardiology team. This has resulted in an increasing number of women with cardiac disease attending our hospital for pregnancy management. A clear outcome in this study is

Table 4 Characteristics of admission

	ICU (n = 259)	CCU (n = 49)
LOS mean(SD)	3.21 (3.95)	4.38 (4.47)
LOS ≤ 24 Hours n(%)	134 (51.7%)	9 (18.4%)
APACHE II score, mean(SD)	12.17 (6.1)	N/A
Information below available in # patients	232 (%)	46 (%)
Observation only	24 (10.3%)	20 (43.5%)
Mechanical ventilation	106 (45.7%)	0
Invasive monitoring #	167 (72.0%)	9 (19.5%)
Central venous line	131 (78.4%)	4 (44.4%)
Arterial line	159 (95.2%)	7 (77.8%)
Pulmonary artery catheter	5 (2.2)	0
Inotropic support	39 (16.8%)	1 (2.1%)
Renal dialysis	10 (4.3%)	0
Radiological investigations	95 (40.9%)	21 (45.6%)
Magnesium sulphate infusion	38 (16.4%)	3 (6.5%)
Blood products administered (ICU n = 248)	127 (51.2%)	5 (10.4%)
> 4 units red cells administered (ICU n = 241)	74 (30.7%)	0

LOS, Length of stay in the unit
This variable indicates whether women had invasive monitoring of any kind. The type of invasive monitoring then listed. Women may have had more than one method used

that women with pre-existing cardiac disease in our population are requiring substantial resources in the form of high level care admission through their pregnancies and the peripartum period.

Our rates of admission for hypertensive disorders appear lower (16.2%) than reported by historic studies: 23.8%¹⁴/48%.¹³ The first possible explanation for this is that the earliest Australian study¹⁴ was published prior to the publication of the MAGPIE trial¹⁵ of magnesium sulphate administration in pre-eclampsia. The use of magnesium sulphate in pre-eclampsia will have resulted in fewer admissions precipitated by seizures. The second may be differing referral patterns to high level care in the context of the obstetric hospital being physically separated from the hospital providing intensive care support.¹³ In the more recent Australian studies, the rates of pre-eclampsia are similar to those we report.^{3,11}

The triennial report identified two groups at highest risk of death.² These were women aged 40 years and older (MMR 23.7 deaths per 100,000 compared with 7.0 deaths per 100,000 confinements for those aged 20–24 years), and the indigenous population (MMR 21.5 deaths per 100,000 compared with 7.9 deaths per 100,000 confinements for non-indigenous). Our data paralleled this showing both these groups as being more likely to require critical care during pregnancy (12.2% of women admitted to high level care in the current study identified as indigenous, compared to 3.36% in our local obstetric population and nationally, 3.6% of deliveries in Australia 2003–2005 were to indigenous women and 3.3% were to women > 40 years of age).² It is also concerning that women for whom English was a second language contributed to over 30% of the maternal mortality in our study. In our institution, only 9.96% of women identify a non-English speaking background.

A key strength of this study is that it provides information from an institution with a co-located maternity hospital and general tertiary hospital, providing a comprehensive case mix of tertiary obstetric care. Various databases were searched to ensure maximal capture of patients admitted to critical care. This should limit the omission of patients admitted under different units. This study is also almost alone in the literature in clearly separating and reporting on maternal admissions to coronary care as distinct from intensive care.

In a study performed in the Dublin maternity hospitals, admissions to coronary care comprised < 2% of high level care admissions.¹⁶ Another recent population level study in Italy included coronary care in its case ascertainment but did not report separately on the outcomes of women admitted to coronary care.¹⁷ It is unclear in the majority of studies whether they include coronary care as part of critical or intensive care or whether they have not assessed maternal admissions to coronary care.

Limitations of the study include: this is a retrospective audit and data collected are limited by the quality of documentation; postpartum events occurring in patients delivered at our institution but presenting to other hospitals have been missed and likewise, for patients transferred from elsewhere, data are only available for their admission at the RBWH, leading to likely underestimation of interventions. The women transferred had higher APACHE scores and included six of the eight women who died. It is quite possible that they had a number of interventions at their original hospital. The large proportion of women transferred from outside our institution skews our dataset and we have been unable to calculate the incidence of high level care admission, or the maternal morbidity and mortality ratios for this cohort. The categorization of indications and diagnosis is difficult to refine to one indication/diagnosis for each patient and this process results in a loss of appreciation for the true complexity of these women. However, reporting on multiple indications/diagnoses for each patient is equally fraught and would obscure the primary diagnoses. The data on interventions performed in high level care are possibly an underestimate (with the exception of mechanical ventilation and blood products) given the documentation and the fact that electronic databases for radiology do not cover all the years of the study. Finally due to changes in medical records coding systems for two years of the study period, data are incomplete for some fields such as ethnicity, and in a further year only data on public patients were coded.

The difficulties inherent in defining maternal outcomes beyond mortality in a retrospective manner have been well illustrated in this study. We would propose the collection of these data in a prospective database which would allow the inclusion of measures of maternal residual disability both at discharge from high level care and discharge from hospital and improve the collection of intervention and investigation data in this group. These data are of vital importance in planning the future obstetric and support services which will result in improved maternal outcomes. The World Health Organisation has proposed the utilization of prospective data cohorts with standardized definitions of maternal morbidity, rather than relying on diagnoses to allow comparison between units.⁷ This is now starting to be collected in Australasia with the Australasian Maternity Outcomes Surveillance System.

In summary, although the obstetric population represents only a small percentage of critical care utilization and overall morbidity and mortality, they are an important and growing group. Increased surveillance peripartum in a critical care facility for these women allows earlier detection of maternal compromise and instigation of management. Prospective analysis of clearly defined endpoints such as described here should provide better understanding of the 'near miss' phenomena, allow comparison of outcomes between units, and reduce maternal morbidity and mortality by improving early recognition of the at risk obstetric patient and planning of service provision.

DECLARATIONS

Competing interests: None declared.

Funding: None.

Ethical approval: Royal Brisbane and Women's Hospital Human Research Ethics Committee gave permission (HREC/10/QRBW/222).

Guarantor: HLB.

Contributorship: HLB reviewed literature, undertook data collection and data analysis, prepared the first draft of the manuscript and obtained ethical approval. KL conceived the study and was involved in protocol development. SC was involved in protocol development and data collection. NF conceived the study and was involved in protocol development. MDN was involved in data analysis. RD and RB were involved in protocol development and data collection. LKC conceived the study and was involved in protocol development. All authors reviewed and edited the manuscript and approved the final version.

Acknowledgements: None.

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(Accepted 21 July 2012)