Clinical characteristics and outcomes of pregnancy related patients admitted to the Intensive Care Unit: a 1 year review

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Medicine in Obstetrics and Gynaecology MMed (O&G)

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DECLARATION

I, Emma Pauline Bryant, declare that this research report is my own work.

It is being submitted to the Faculty of Health Sciences for the degree, Master of Medicine in Obstetrics and Gynaecology, at the University of the Witwatersrand, Johannesburg.

It has not been submitted before for any other degree or examination at this or any other University.

Signature:

DEDICATION

I dedicate this research report to my husband Roland for all the help and support, and to the Chris Hani Baragwanath Academic Hospital intensive care unit which works tirelessly to manage our critically ill pregnant women.

May all women in need of critical care have readily available access to a well-staffed ICU.

ABSTRACT

Background and objectives

Pregnancy can be associated with life threatening complications of pregnancy specific disease and delivery, as well as the exacerbation of preexisting comorbid disease, which requires multidisciplinary critical care. Studies have shown that advancement in medical care and access to intensive care units have been instrumental in the global decline in maternal mortality rates, particularly in developed countries. The aim of this study was to describe the admissions to ICU of all pregnant women including those with pregnancy related complications at CHBAH tertiary hospital in South Africa.

Methods

The study was a retrospective review of pregnant women, including pregnancy related complications, admitted to CHBAH ICU for the year of 2012. Baseline demographic data, admission diagnosis, laboratory information and acute physiological and chronic health evaluation score (APACHE II), intervention and outcomes were recorded using ICU records and general hospital records. Descriptive statistical analysis employed.

Results

In 2012 there were 21765 deliveries at CHBAH with 76 pregnancy related admissions to the ICU. Complete ICU data was available in 73 women. The incidence of ICU admission at the hospital was 3.5 per 1000 deliveries. The mortality rate in this group in ICU was 8.2%. The most common indication for admission was haemorrhage (43.8%) followed by medical and surgical disorders (23.3%), then sepsis (21.9%) and hypertensive disorders of pregnancy (11%). The majority of the women (98.3%) were admitted in the postpartum period. Mechanical ventilation was required in 77% of the women, inotropic support in 29% and 59% received blood

transfusion products. APACHE II scoring system overestimated the possible mortality rate giving a predicted mortality rate of 15%.

Conclusion

Haemorrhage was the most common indication for admission to ICU. This does not concur with previous South African studies where hypertension was the most common reason for admission followed by haemorrhage. The study showed an overall mortality concurrent with some first world studies and significantly lower than cited South African studies.

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List of Abbreviations

ALB	Albumin
ARDS	Acute respiratory distress syndrome
ART	Antiretroviral Therapy
AZT	Zidovudine
BP	Blood Pressure mmHg
CARPREG	Canadian prospective multicenter study CARdiac disease in PREGnancy
CHBAH	Chris Hani Baragwanath Academic Hospital
Cryo	Cryoprecipitate
CS	Caesarean section
FFP	Fresh Frozen Plasma
HB	Haemoglobin g/dl
HELLP	Haemolysis Elevated Liver Enzymes Low Platelets
HIV	Human Immunodeficiency Virus
ICU	Intensive Care Unit
iMMR	Institutional Maternal Mortality Ratio

NCCEMD	National Committee for the Confidential Enquiry into maternal deaths
NCCEMD	National Committee for the Confidential enquiry into Maternal Deaths
NPRI	Non pregnancy related infection
NVD	Normal Vaginal Delivery
PET	Preeclampsia
PMTCT	Prevention of Mother to Child Transmission
PRES	Posterior Reversible encephalopathy syndrome
RBC	Packed red blood cells
TAH	Total abdominal Hysterectomy
WCC	White Cell Count $\times 10^9$ cells/l
WHO	World health Organization

Definitions

For the purpose of this study, the following definitions will be used:

1. Pre-eclampsia: Hypertension (Blood pressure > 140/90 mmHg) and proteinuria occurring after the 20 week's gestation and resolving within 6-12 weeks after delivery.
2. HELLP syndrome: the presence of heamolysis (haptoglobin < 0.10g/L or the presence of schistocytes on peripheral blood smear); platelet count <150 x 10^9/L, serum aspartate transaminase or alanine transaminase ≥ 70 IU/L or ≥ 2 x normal range; or pre-eclampsia with 2 of the laboratory criteria used in the afore-mentioned definition of HELLP syndrome.
3. Postpartum haemorrhage: blood loss post-partum of ≥ 500mL following a normal vaginal delivery or ≥1000mL following a caesarean section.
4. Impaired outcome was, for the purpose of the study, defined as residual organ system dysfunction at the time of discharge from ICU
5. Laparotomy – is a surgical procedure making a large incision into the abdominal wall to gain access to the abdominal cavity. It is indicated for major elective operative procedures and in an acute setting for internal haemorrhage or suspected peritonitis from sepsis
6. Planned relaparotomy - planned relaparotomy 24 – 48 hours after previous laparotomy for further therapy
7. Relook laparotomy /on demand relaparotomy: the surgeon completes an operation with the intent to reoperate only if clinically indicated

8. Multi Organ dysfunction –the development of potentially reversible physiological derangement, arising in two or more organ systems, which requires medical intervention to maintain homeostasis.

These are the following markers of organ dysfunction

i) Renal dysfunction – (< 0.5ml of urine/hr or a 1.5 rise in serum creatinine from baseline)

ii) Coagulopathy – (INR > 1.5 or aPTT > 60 seconds)

iii) Hypotension and new inotrope requirements (systolic blood pressure < 90mmHg despite adequate resuscitation)

iv) ARDS (Acute Respiratory Distress syndrome)/ respiratory distress (Pa02/FI02 <300)

v) Central nervous system dysfunction – confusion or deterioration in consciousness or a decline in Glasgow coma scale

9. Acidosis – Ph. $\leq$ 7.2 and HC03 $<$ 18 mmol/L

10. Massive blood transfusion - > than 10units of packed red blood cells transfused in 24 hours.

11. Anaemia – Haemoglobin of <10g/dl

12. Unbooked – No attendance at the antenatal clinic during pregnancy

13. Cardiac monitoring – Continuous monitoring of the cardiovascular system with electrocardiography, invasive blood pressure monitoring and oxygen saturation

14. Renal dysfunction – was described as the presence "Injury" as per the RIFLE criteria (increase serum creatinine $\geq$ 2 times normal laboratory value or glomerular filtration decrease of more than 50%), or a value of $\geq$ 110 umol/L

1 INTRODUCTION

The management of critically ill obstetric Women is a very unique challenge due to the host of profound physiological changes that occur during the course of the pregnancy.[1,2] Pregnancy specific disease, complications of delivery (surgical or non-surgical), exacerbation of co- morbid disease and a society rife with violence and trauma place women at risk of severe morbidity and mortality.[1,3,4] Advances in medical care and the availability of Intensive Care Units (ICU) has been paramount to global decline in maternal mortality, particularly in developed countries.[5, 6] Developing countries lack easy availability to basic health care services and advanced specialist units resulting in the marked discrepancy in maternal mortality rates. Rates vary from as much as 808/100000 in Somalia, 154/100000 in South Africa and as low as 10/100000 in the United Kingdom and 7/100000 in Australia as published by the WHO.[3,6] Countries like South Africa are affected by the shortage of ICU facilities versus the number of high risk Women needing ICU.[7] Various studies have reported an admission rate of critically ill obstetric Women to ICU of 2-4 per 1000 deliveries.[3,4,8,9,5] In developing countries obstetric Women account for 7% of ICU admissions versus the 2% in developed countries.[1,5] Multiple factors like lack of education and transport, social and cultural beliefs, functional and structural problems in the health system and the burden of HIV result in a higher incidence of severe maternal morbidity and mortality in developing countries and hence more pressure on the already limited critical care facilities.[1]

2 LITERATURE REVIEW

2.1 Background

2.1.1 The history of ICU

Over the last 50 years, along with the evolution of western medicine, the concept of Intensive Care Units was created.[10] In 1923 Hilberman described the establishment of ICUs evolving from the need for specialized post-operative care in patients with neurosurgical conditions at the Johns Hopkins Hospital in Baltimore. ICUs were also established in World War II casualties undergoing lifesaving trauma surgery. By 1947 Oschner clinic in New Orleans had created a recovery unit for men and women undergoing high risk surgeries. Recovery units progressed into the Surgical ICUs we know today [11] Respiratory units were opened initially for the management of all individuals in respiratory failure from diseases like polio. Negative pressure ventilation, used to treat the individuals spurred the progression to positive pressure ventilation by Ibsen in Denmark in 1952. In 1958 Baltimore City Hospital opened the first free standing medical ICU[10] Improved survival as a result of mechanical ventilation and other intensive treatment modalities and organ support received in these units was embraced, resulting in the global norm of managing critically ill individuals in an ICU setting.

2.2.2 Obstetric women managed in the ICU

2.2.2.1 Pregnant women admitted to ICU in the global setting

There are a number of retrospective studies from both developed[1,4,5,9,12] and developing areas[7,13,14,16,17] looking at critically ill obstetric women in the ICU setting. It was evident that mortality rate and incidence of ICU admissions varied between developed and developing countries. The magnitude of variables in the studies range from variations in population,

differences in the skill of health care providers, the level of hospital the women were admitted to, specific hospital protocols and the concept of early diagnosis and intervention and availability of resources make it difficult to compare the settings as well as isolate common prognostic factors.

Massive obstetric haemorrhage; caused by placenta praevia, placental abruption, and uterine atony, and hypertensive disorders of pregnancy resulting in eclampsia, intracerebral haemorrhage, pulmonary edema, renal insufficiency and liver rupture are the most common reasons for admission.[3] Most admissions were post-partum with a short length of stay. However in an Australian study at a tertiary hospital ICU – 23% of the women were admitted antenataly and offered induction of labour and intrapartum management within ICU if they were identified as being high risk women, to avoid transfer of the potentially unstable woman after delivery.[5] Due to lack of appropriately skilled obstetricians and midwifes within the ICU setting this practice is not supported by most facilities in general ICUs but would be a consideration in a specialist Obstetric ICU.

There is limited literature on the impact of HIV/AIDS and non-pregnancy related infection on the critically ill obstetric women in the ICU.

Recently, to further increase the demand for high risk obstetric management and indirectly the need for critical care, advanced reproductive technologies, urbanization, better access to health care and a delay in childbearing, have brought upon a new entity of parous women. Those that are older, may be obese and more likely to have associated chronic disease. In the Global status on noncommunicable diseases report 2014 – the WHO states the prevalence of obesity in women

aged > 18 years of age to be as high as 25% in Southern Africa and 30% in America which has significantly increased since 1980.[20] Obesity is directly related to increase risk in heart disease, stroke, complications in pregnancy and diabetes to name a few. The ramifications of obesity on the obstetric women are even more profound with a direct significant risk of thromboembolism particularly after CS. Maternal death due to preexisting medical disease has increased in South Africa in the 2011-2013 triennial report on maternal deaths which may be indirectly related to increase in obesity.[21]

2.2.2.2 Pregnant women admitted to ICU in the South African setting

To date there is limited cited literature on ICU admissions and outcomes of pregnant or postpartum women in South Africa.[14, 16] A retrospective study done by Taylor et al.[17] from 1985 -1996 showed a mortality rate of 36% and incomplete abortion followed by eclampsia as the most common diagnosis at admission to ICU. This study was done before the introduction of choice of the termination of pregnancy Act No. 92 of 1996.Subsequently it had been shown globally that there is a decrease in maternal mortality from abortion wherever TOP has been legalized.[18]

A study done in Durban in 1992 showed Eclampsia as the most common diagnosis accounting for 66.4 % of admissions to ICU with a mortality rate of 21%, possibly a reflection of the prevalence of preeclampsia in this area versus other parts of the world or simply the lack of early detection and early appropriate management.[16]

2.2.2.2.1Data reviewed from the Saving Mothers report

The confidential enquiry into maternal deaths in South Africa is done triennially. All maternal deaths are notifiable and should be reported to the National Committee for the confidential enquiry into Maternal Deaths. From this an institutional maternal mortality ratio (iMMR) is calculated per 100000 live births. Maternal mortality rates are used as an indicator of quality of care delivered to pregnant women. [19] While this report does not demonstrate the incidence of women admitted to ICU it can be deduced that with such a high mortality rate there is an increased need for specialized critical care in comparison to some first world countries where the mortality rate is as low as 9 per 100000.

The sixth report from data captured from 2011-2013 showed a decrease in the iMMR to 154 per 100000. This is largely due to a reduction in deaths due to NPRI – of which 90% comprises of HIV related illness or complications, which fin order of frequency includes Tuberculosis (27%), pneumonia (21%) pneumocystis jiroveci pneumonia PJP (15%) bacterial and fungal meningitis (12%) and death due to complications of antiretroviral therapy use (4%). The reduction in HIV related deaths is largely attributable to improvement in HIV management protocols in the country resulting in an increase in the use of ART and a reduction in antiretroviral associated deaths since the review of the ART guideline and omission of the use of Nevirapine as a first line antiretroviral therapeutic agent. NVP was associated with Stephen Johnson syndrome and Liver failure. Routine prophylaxis for PJP and TB may also be contributing factors.

Death due to hemorrhage has increased since 2005 – which is a cause for concern particularly because of an increase in the number of deaths due to bleeding at CS, which accounts for 32% of

the deaths due to hemorrhage. Lack of health worker training, inappropriate management of bleeding at CS, the performance of unnecessary CS and unavailability of blood products and critical care facilities are all implicating factors in this increase. Late second CS are more likely to result in tearing and difficultly with hemostasis at CS – alarmingly the national assisted or instrumental delivery rate in South Africa is 1% which could also be a contributory factor to the increase in CS morbidity and mortality in SA.[3]Assisted delivery rates should be at around 10%.[3,22]

Deaths due to Hypertension have improved since 2002 due to better antenatal booking, earlier management and referral. Preexisting medical and surgical conditions as a cause of death are starting to increase possibly due to delay in child bearing, increase in maternal age, increase in rates of obesity and its associated comorbidities.[20]

Table 1 Comparisons of causes of death and iMMR for the various triennial reports adapted from the sixth report on the NCCEMD[21]

Cause of death	Triennia			
	2002-2004	2005-2007	2008-2010	2011-2013
NPRI*	37.8%	43.7%	40.5%	34.7%
Obstetric haemorrhage	13.4%	12.4%	14.1%	15.8%
Hypertension	19.1%	15.7%	14.0%	14.8%
Pre-existing medical and surgical conditions	5.6%	6.0%	8.8%	11.4%
Pregnancy related infection	8.3%	5.6%	5.5%	5.3%
iMMR**per 100000 births	145.48	151.77	176.22	154.06

*Non pregnancy related infection

**Institutional maternal mortality ratio

2.2.2.2.2HIV in the ICU setting

Statistics from the UNAIDS 2006 report on global AIDS epidemic stated South Africa as having an HIV prevalence of 18.1% with more women being infected than men, while the national Department of Health showed a seroprevalance in antenatal clinics of 30.2%.[23, 19] Despite the increase of women receiving effective anti-retroviral therapy (ART) and a decrease in hospital admissions, the rate of ICU admissions of people living with HIV has remained the same because of increased life span and a larger number of people living with HIV.[23,24,25] There has been a significant decline in ICU mortality after the introduction of effective ART.[23]The alarming contribution of HIV to maternal morbidity and mortality in South Africa comes with an increased demand for critical care and admission to ICU. With 1:10000 ICU bed to

population ratio in South Africa, ICU resources seldom meet the need. Criteria for ICU admission in the public sector in South Africa are based on the likelihood of reversal of organ dysfunction and the probability of survival.[24] The same criterion are indicated and applied to people living with HIV who require admission to ICU. [25] "Regardless of South Africans legal and human rights policy frameworks it has been stated that widespread anecdotal evidence suggests that HIV status has been used as an exclusion criteria to ICU," in pressured public health settings[24] It must be stated that at CHBAH ICU HIV status is not used as exclusion criteria, but end stage AIDS would fall into the same category as any end stage disease.

2.2.3 Mortality within the ICU

Mortality rates for obstetric women within ICUs range from 3.4 % in the Netherlands to as high as 20% -38% in countries such as India and South Africa.[26] Interventions to reduce mortalities within ICU include identification of women at risk of haemorrhage, correcting iron deficiency anaemia antenatally, identifying women with preexisting medical disease, optimizing health ideally preconception; and the early detection of sepsis If needed early admission to ICU for ventilation, inotropic support and invasive monitoring will prevent progression of organ dysfunction and improve the outcome of the women.[26]

In a review by Rivers E et al on Early Goal Directed Therapy (EGDT) can reduce mortality by 16-18% in individuals presenting with severe sepsis and septic shock. The corresponding table 2 taken from the article by Rivers on EGDT summaries the benefits, principles and applications of EGDT.[29]

Table 2 The benefits and principles of early goal directed therapy

Benefits principles and applications of Early Goal Directed Therapy[29]
Decreases mortality (16-18%) Decreases the progression of organ failure - Decreases the progression of acute kidney injury - Decreases the need for mechanical ventilation Modulates the early inflammatory response Decreases health care costs (20%) Is effective after 18 hour of disease onset in the ICU or Emergency Department Decreases sudden *cardiopulmonary* complications Is effective in community and tertiary hospitals *Diagnostic components(associated with increased mortality)* - Lactate > 4 mm/l - Systolic BP< 90 mmHg *Components associated with an improved outcome* - Antibiotics within 1- 3 hours - CVP > 8 mmHg - MAP > 65 mmHg - Heamatocrit >30% - ScvO2 >70% Threshold for red blood cell transfusion Need for inotropic support Indication for and response to mechanical ventilation

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Important critical care interventions in women who present with massive obstetric haemorrhage include early active fluid resuscitation, contrary to previous publications that blood transfusion was associated with an increased mortality in critically ill women. A recent metanalysis looking at the outcome of postoperative individuals receiving either liberal or restricted blood transfusion in the ICU setting - stated that there was increased survival with liberal transfusion.[27] This may be applicable to the pregnant woman.

2.2.4 Admission criteria to ICU

Admission to ICU is considered in obstetric women, who require,

i. Mechanical ventilation

ii. Two or more organ system support

iii. Chronic system insufficiency and requiring support for acute reversible failure of another organ

iv. Postoperatively (post-delivery) in woman with underlying comorbidity, for monitoring and optimum postoperative fluid and pain management

Women, who are conscious, have single organ dysfunction, require intravenous therapy for blood pressure control; magnesium sulphate for seizure prevention and high risk obstetric women can be managed in an obstetric high dependency unit (HDU) to avoid wasteful use of scarce and expensive ICU beds.[9, 3, 8] However single organ dysfunction requiring specialized critical care interventions such as respiratory dysfunction requiring ventilation and cardiovascular system dysfunction requiring the need for inotropes or invasive pressure monitoring need to be managed in the ICU setting.

Criteria for admission to ICU are largely dependent on the respective health care facility protocols, to date there are no published guidelines by respected obstetrics and gynaecology organisations. Table 3 is the criteria used in a study by Zeeman et al.[26] in a 2 year audit on the obstetric intermediate care unit. The intermediate care or high dependency units result in less admission to the ICU and allows for only transfer of women requiring ventilation, inotropic support, major trauma, cardiothoracic injuries and neurosurgical injuries. Smaller facilities may not have the infrastructure in place for dedicated obstetric high care units and their criteria to ICU admission for intensive monitoring may be more lenient. In the South African setting there

is a shortage of Obstetrics and Gynaecology trained critical care specialists and intermediate units therefore most women are managed in the general ICU setting.

Table 3 Criteria for admission to the obstetric intermediate care unit or medical or surgical intensive care unit [26]
Intermediate care unit
Obstetric complications
Severe preeclampsia or eclampsia or HELLP syndrome
Complicated peripartum hysterectomy
Acute fatty liver of pregnancy
Sepsis
Surgical or aneasthetic complications
Medical or surgical disorders
Diabetic ketoacidosis
Thyrotoxicosis
Heamofiltration/Plasmapheresis
Severe Asthma or pneumonia
Complicated cholecystitis, pancreatitis or appendicitis
Medical-Surgical intensive care unit
Mechanical ventilation
Inotropic drugs
Life threatening arrhythmia
Coma

2.2.5 Scoring systems

Mortality prediction scores are used in ICUs around the world to provide a general measure of severity of disease, to which therapeutic interventions may be directed to reduce morbidity and mortality. To date there are no scoring systems designed specifically for obstetric women and it has been shown that the normal physiological changes of pregnancy lead to overestimation in predicted mortality using conventional scoring systems.[3,7,8,9]

There are a number of studies where scoring systems from the non-pregnant population have been applied to obstetric women in an effort to predict hospital mortality with conflicting results.[5, 8, 14] The most cited is the Acute Physiological and Chronic Health Evaluation APACHE II or III, Mortality Probability Model and the Simplified Acute Physiology Score (SAPS) II. The APACHE III scoring system was able to predicted mortality within 3% in 95% of non-obstetric populations and is used in ICUs globally but overestimated mortality by 13% in pregnant women in a recent Australian study.[5,8] Over prediction of mortality is not exclusive to APACHE II or III but also to the SAPS II.[3,5,7] This is attributed to the fact that normal physiological measurements are scored as abnormal in the obstetric women like increase in respiratory rate and heart rate, lower creatinine and heamatocrit.[3] These scoring systems also lack variables that are important in certain obstetric conditions like liver functions and platelet count. Other scores like the Glasgow Coma Scale (GCS) and other scores related to individual organ dysfunctions used in combination with the above mentioned scoring systems may be better predictors of prognosis and severity.[14]

The APACHE II scoring system is used as an academic tool in studies to evaluate consensus despite the proven over estimation in obstetric women.

2.2.6 Health care providers for obstetric women

Management of the critically ill obstetric women often requires the input of a multidisciplinary team. While most obstetricians do not have the skills required for invasive monitoring and organ support their knowledge of maternal and fetal physiology is essential in the management of the unique needs of the obstetric women in particular diseases specific to pregnancy like preeclampsia.[3,9] Intensivists and surgeons and their respective sub disciplines are also needed in the management of pregnant women with increasing numbers of pregnant women with comorbidities which are exacerbated by pregnancy and complex multiorgan system dysfunction associated with pregnancy complications. Critical care teams are headed by intensivists who are subspecialists with base specialties in disciplines such as general surgery, anaesthesia, internal medicine, and obstetrics and gynaecology. Obstetricians, traditionally, are faced with significant ethical dilemmas of the mother and fetus and have a better knowledge and understanding of management of obstetric conditions. The fascinating presentation of the critically ill obstetric women is, however a conundrum for several specialties to manage, to ensure the best possible outcome.

3 PROBLEM STATEMENT

The decline of maternal mortality rates to 6-20 per 100,000 in developed countries is attributed to the improvement in prenatal and critical care.[1] This illustrates the significant relationship between health care and outcome for the obstetric women. South Africa, like other developing countries is faced with the difficulties of delivering easily accessible and available, safe health care to its women, potentially exposing critically ill obstetric women to the risk of severe morbidity and mortality.

The South African literature on pregnant women requiring ICU is scanty, with little current published evidence on the incidence, indications and outcomes on critically ill obstetric women in the public sector. Studies pre the legalization of Termination of Pregnancy in 1997 demonstrate septic and incomplete abortion as major contributors to ICU admissions and ICU mortality rate as high as 38%.[17] Platteau et al.[16] in 1992 described eclampsia as the most common admission to ICU in South Africa with a mortality rate of 21%. Vincent B et al.[27] stated that between 5-12% of hospital admissions for HIV infected individuals involve ICU care. South Africa has a high prevalence of HIV and it is uncertain whether or not this affects the rate of ICU admissions of obstetric women.

The aim of this study is to gain perspective on critically ill obstetric women in the ICU setting and evaluate the outcomes of such women in the South African public setting.

4 OBJECTIVES

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i. Primary objectives

To describe the clinical characteristics of all pregnant women including pregnancy related complications admitted to the Chris Hani Baragwanath Academic Hospital (CHBAH) ICU from 1 January 2012 – 31 December 2012.

ii. Secondary objectives

a. The outcomes of all pregnant women including pregnancy related complications admitted to the CHBAH ICU from 1 January 2012 – 31 December 2012 in terms of mortality and residual organ dysfunction.

b. The indication for admission of all pregnant women including pregnancy related complications admitted to the CHBAH ICU from 1 January 2012 – 31 December 2012

c. Identify any factors that may contribute to maternal mortality in the women described above.

5 METHODS

5.1 Setting

Chris Hani Baragwanath Academic Hospital is the biggest hospital in the Southern Hemisphere. It is a central hospital and acts as a tertiary care facility. The CHBAH is located in Soweto, South of Johannesburg, South Africa. This institution provides medical care to a feeder population of 1.3 million people. It is the referral center for both primary and secondary health care facilities from Vanderbijl Park in the South of Johannesburg to all medical centers below Main Reef Road, it also drains facilities from the east of Gauteng as far as Heidelberg hospital extending to Leratong hospital in the West Rand. Leratong hospital is a referral center to Rahima Moosa mother and Child district hospital but there are no ICU facilities there and hence women requiring ICU admission are deferred to CHBAH. The hospital has 3200 beds and is financed and managed by the Gauteng Province Department of Health. Women requiring intensive care are occasionally transferred for the soul purpose of that facility for other district hospitals where intensive care beds may not be available at the time they are required. The hospital is affiliated to The University of the Witwatersrand medical school which uses CHBAH as a teaching hospital. The hospital and intensive care is accredited for the training of critical care for both nurses and doctors, including subspecialty training for Critical Care.

5.1.1 Obstetrics and Gynaecology department at Chris Hani Baragwanath hospital:

5.1.1.1 Obstetrics department

The obstetrics department comprises 300 beds, 20 labour ward beds for women in the active phase of labour and 17 first stage beds. There were 21765 deliveries at CHBAH in 2012, with a CS rate of 35%. The unit had 2 operating theaters adjoining the labour ward dedicated solely to obstetrics 24hours a day. There is a 7 bed high care unit adjacent to the labour ward, which allows for management of obstetric near misses, blood pressure control, seizure prophylaxis, and delivery and post-partum management of high risk women.

CHBAH has 64 beds available for antenatal admissions with 124 beds for postnatal care. There is also a 32 bed ward for women with infectious processes from infectious disease pre and post-delivery to puerperal sepsis.

5.1.1.2 Gynaecology unit

The unit comprises 96 beds with 24hr a day gynaecology emergency facilities. 1 operating theater is available for gynaecology emergencies for 12 hours a day and after hours emergencies are done in the obstetric theaters due to staffing constraints. There is however a 24 hr/day Manual Vacuum Aspiration (MVA) service for stable incomplete abortions less than 16 weeks gestation as per CHBAH protocol. The unit performs approximately 400 legal terminations of pregnancy per annum. Critically ill women, when transferred to ICU, are admitted directly from gynaecology admissions area, theatre or gynaecology ward. There is

a short stay ward for the management of acutely ill women who need optimization, and surgical intervention.

5.1.2 Intensive Care Unit at CHBAH

5.1.2.1General ICU

The ICU unit at CHBAH is an accredited Critical Care subspecialty training unit. Obstetrics and Gynaecology women are admitted to the general ICU which is a multidisciplinary ICU for medical and surgical patients. There is a separate cardiac ICU which follows a different admission and management protocol which is not included in the study.

General ICU is a 34 bed unit, with 9 beds reserved for paediatrics and 7 high dependency care beds. It is staffed 24hrs a day by intensivists, registrars from anaesthetics, internal medicine, surgery and obstetrics and gynaecology rotating through the unit for 2-3 month periods and fulltime medical officers. There is 24hour medical cover in the unit Specialists from all medical and surgical disciplines, physiotherapists, microbiologist, pharmacists, dieticians and social services are readily available for multidisciplinary team approach. The ICU is staffed by critical care nurses in a 1:1 nurse to patient ratio and there is daily review of obstetric women by the obstetrics and gynaecology consultant on call. The ICU is located in the main hospital building approximately 800m from the obstetrics and gynaecology building. Women are transported from the department of obstetrics to ICU in an intensive care ambulance.

It must be stated that for part of 2012 ICU at CHBAH was undergoing renovation and critical care was administered in ward 7. There was a decrease in the number of available beds from 18 to 12 ICU beds and from 9 to 4 High care beds.

5.1.3 Admission criteria to ICU at CHBAH

Admission criteria for individuals include the need for mechanical ventilation, inotropic support, and invasive heamodynamic monitoring and multi-organ support. Individuals not requiring ventilation or qualifying for ICU are managed in the obstetric high care unit. As per CHBAH protocol, prospective candidates for ICU admission should have to demonstrate a reversible disease process. Intensive Care Unit admission should not result in action meeting the following description:

i. Unnecessary - admitting low risk or healthy individuals
ii. Unsuccessful – admission of a patient too ill to benefit
iii. Unsafe – risk of treatment outweighing the expected benefit
iv. Unkind – where unacceptable quality of life will result
v. Unwise – resources diverted from more useful admissions

5.1.4 Exclusion criteria for the CHBAH ICU

Patients with end stage organ or neoplastic disease are not considered good ICU candidates but may be accepted for 48hrs of postoperative observations. Trauma patients with head injuries and a GCS of < 8 are not admitted, as are individuals with severe neurological devastation not considered for admission. HIV positive patients are not discriminated against and benefit from admission provided they meet the admission criteria.

5.1.5 The procedure for ICU triage, admission, management and discharge

Once the need for ICU has been identified by the attending Obstetrician and Gynaecologist a request is made to the ICU consultants on call. The patient is then triaged by a team of intensivists and the need for ICU is assessed based on availability of beds in ICU, condition and probable outcome of the patient. Women coming from other facilities are transferred via the obstetrics and gynaecology admissions for assessment and review for need for ICU. Once the patient has been identified an interdepartmental intensive care ambulance service is activated to transport the patient between the 2 departments.

5.1.5.1 On admission to ICU

The following are routinely performed on patients admitted to ICU:

i. Central venous pressure line (CVP) is inserted.

ii. Arterial line is inserted.

iii. Urinary catheter is inserted.

iv. Baseline blood investigations namely: full blood count (FBC) with differentials and platelets; liver function test (LFT); urea and electrolytes (U&E); calcium, magnesium and phosphate (CMP); international normalized ratio (INR) and prothrombin index and time (PI/PTT); and aerobic and anaerobic blood cultures.

5.1.5.2Management in ICU

Arterial blood gases and glucose are monitored 2-4 hourly, vitals hourly. Chest radiographs are done as required, as well as daily FBC and U&E. Blood cultures are done as indicated. Furthermore, there is weekly assessment of LFTs, CMP, INR/PI/PTT.

Daily mulitidiciplinary consultant rounds are conducted and goal directed plans are made for each patient.

5.1.5.3Discharge from ICU

Upon discharge from ICU, women are down referred to the obstetric high care unit for a minimum 6 hour period of observation. Once stable, women are referred to ward 64 (postpartum high risk ward) or to ward 57 (antepartum or postpartum septic patients). All other antenatal women are transferred to the antenatal wards.

5.2 Study Population

All pregnant women admitted to the general ICU during pregnancy irrespective of gestation, at delivery and up to 42 days postpartum.

5.2.1 Inclusion criteria

All pregnant women admitted to the CHBAH ICU. Pregnant women include those that had a positive pregnancy test, at all gestational ages and postpartum women.

5.2.2 Exclusion criteria

Non pregnant women and men admitted to CHBAH ICU and obstetric women admitted to the cardiac ICU. Women that qualified for ICU but did not get admitted due to bed shortages or were sent to alternate ICUs at other hospitals as a result thereof.

5.3 Sample Size

The study included all the pregnant women including pregnancy related complications admitted to CHBAH ICU over 1 year.

5.4 Period

The study was conducted on all pregnant women including women with pregnancy related complications admitted to the ICU at CHBAH from 1 January 2012 – 31 December 2012.

5.5 Study design

Cross sectional analytical and descriptive study on all pregnancy related admissions to CHBAH ICU over 1 year.

5.6 Data collection and Tools

The data was collected retrospectively; the women were identified from the ICU registers from 2012. The ICU summary and the files from the department of Obstetrics and Gynaecology were used to obtain the information and data was recorded on a data sheet created on Microsoft excel. To maintain anonymity the women were given a study number which was on the data sheet

while the patient's details and hospital number and associated study number were be kept separately for use by the researcher only. The variables that were recorded in the study included

i. Age, gravidity and parity.
ii. Gestational age, antenatal booking information, sonar findings and risk factors for that pregnancy.
iii. Primary indication for admission to ICU and diagnosis at admission.
iv. Organ system involvement.
v. Treatment administered in ICU.
vi. Length of stay in ICU.
vii. Outcome.

The variables that were recorded are illustrated on the data sheet. (Appendix 1).

5.7 Data Analysis

All the data was organized systematically in Microsoft Excel and the data was then imported into strata software, subjected to statistical analysis.

Frequencies were expressed in percentages with 95% confidence intervals. Comparisons of frequencies were done using the Chi–squared and Fisher exact tests. Frequency distributions were compared using the Student's t-test for parametric data and the Mann-Whitney test for non-parametric data. A p-value of <0.05 was used to determine statistical significance.

5.8 Ethics

The study began after approval by the Human research and Ethics committee at the University of the Witwatersrand, clearance certificate number M130641. All the women in the study, identities were protected as each patient was allocated with a study number. Research details were only be made available to the researcher and the supervisors.

5.9 Funding

The expenses incurred during the study for data capture and stationary were funded by the researcher.

6 RESULTS

6.1 General information

There were 76 pregnant women admitted to CHBAH ICU in 2012 out of 707 total admissions to the ICU in that year (10.7% of admissions). One patient was a direct transfer in from another central hospital, Ga-Rankuwa due to a shortage of ICU beds at that facility at the time. The remainder were from CHBAH. Of the 76 admissions 73 of the ICU files were found. There were two missing files which were documented as maternal deaths and further patient documentation was not found in the maternal death database or in the Obstetric filing department. They were both confirmed demised on the CHBAH records system. There were 73 complete ICU files found and only 43 (58.9%) of the corresponding obstetric maternity department files were located. Fortunately all of the necessary data to meet the objectives was obtained from the ICU files. There were two readmissions to ICU after initial discharge, one with a nosocomial pneumonia following admission for haemorrhage and one with cardiac failure following admission for known preexisting heart disease after delivery.

The rate of critically ill pregnant women admitted to the ICU was 3.5 per 1000 deliveries in 2012 at CHBAH. There were 10 mortalities. Of the 10 mortalities, 8 ICU files were found and 2 files were unaccounted for. Interestingly 3 of the maternal deaths were not documented in the Maternal Deaths at CHBAH database used for the saving mothers reporting. This is problematic and could result in underreporting. There were 2 deaths post discharge from ICU leaving a total of 8 mortalities within ICU. Of the 2 that demised post discharge, 1 demised in the surgical ward 70 days after delivery after being discharged from ICU with a ventilator myopathy, tracheostomy, reliance on TPN and draining enterocutaneous fistulae. The second post discharge

mortality demised of metastatic choriocarcinoma following admission for a hysterectomy for an ectopic choriocarcinoma requiring massive blood transfusion. The overall mortality rate for all pregnant women admitted to the ICU was 14.1% including those women where the files could not be located and this was in keeping with the overall ICU mortality rate for all patients of 15.5% in 2012.

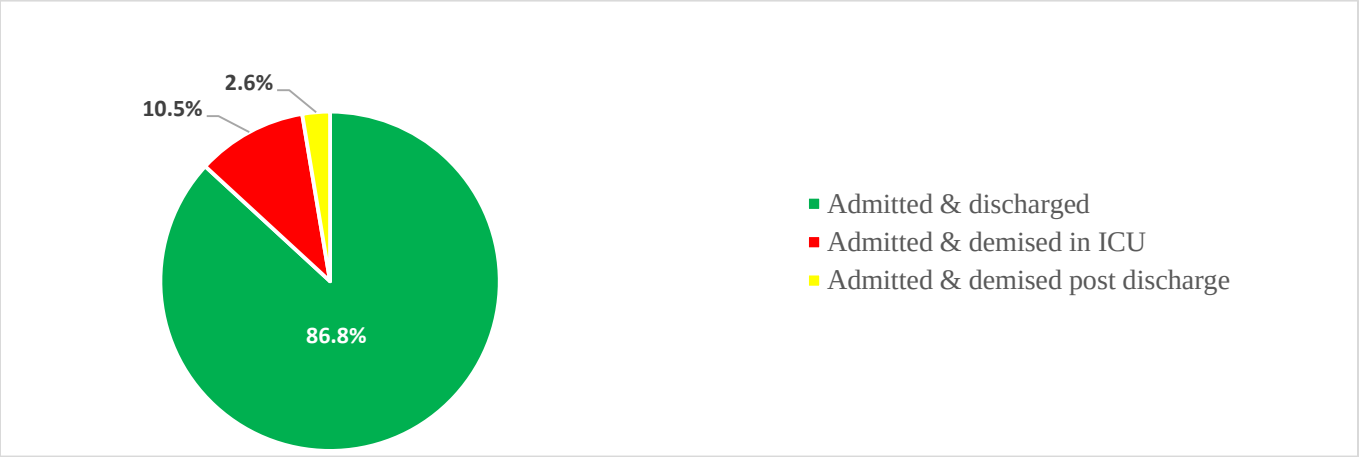

Figure 1 Incomplete data demonstrating ICU admissions and mortalities

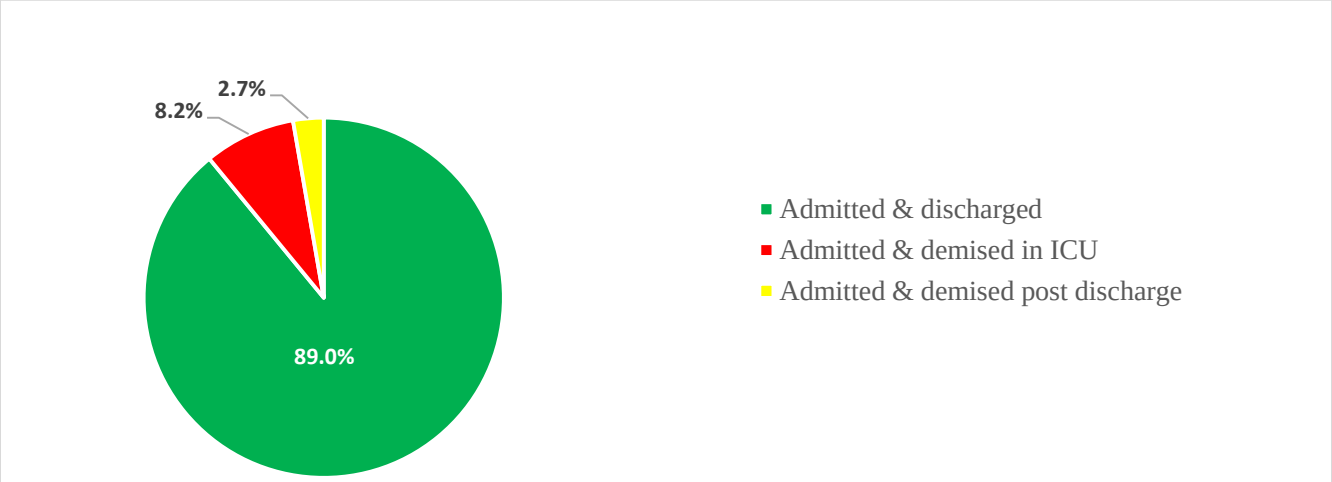

Figure 1 Complete ICU data demonstrating admissions and mortalities in ICU

6.2 Diagnosis on admission to ICU

There were 16 women (21.9%) admitted with dysfunction in one organ system, the remainder had 2 or more systems involved. The various admission diagnosis are summarized in table 4. Haemorrhage was the most common indication for admission.

Table 4 The admitting diagnosis for all the women admitted to ICU

Admission category	n=73	%	Primary diagnosis on admission	no
Haemorrhage	32	43.8	Molar pregnancy	3
			Choriocarcinoma bleeding post ectopic molar	1
			Extra-uterine pregnancy / Ectopic	3
			Ruptured uterus	1
			Abruptio placentae	5
			Placenta praevia	3
			Postpartum haemorrhage	16
Hypertensive disorders	8	11.0	Eclampsia	7
			Preeclampsia	1
Sepsis	16	21.9	Puerperal	9
			Septic abortion	2
			Liver abscess	1
			Respiratory Nosocomial pneumonia n=1 Pneumocystis carinii pneumonia (PCP) n=1 Aspiration pneumonia n=1	3
			Other	1
"Other" Medical and surgical conditions	17	23.3	Pre-existing cardiac disease	8
			Pre-existing pulmonary hypertension	3
			Pre-existing congestive cardiac failure	2
			Myasthenia Gravis	1
			Peripartum Cardio Myopathy	1
			Ludwig's Angina	1
			Organophosphate poisoning	1

6.3 Demographics, laboratory data and pregnancy information

6.3.1 Demographic and laboratory data was taken from the ICU files however HIV information was taken from the women with complete antenatal records. Of the women with complete records15 (34.9%) were HIV positive.

Table 5 Summary of the demographic and laboratory data for all the women with complete data (n=73)

Variable	**Median (range) n=73**
Age in years	29 (17-44)
Parity	2 (0 -5)
Gestational age in weeks	34 (6 -41)
Weight in kilograms	69 (47 -120)
Total length of stay in days	2 (1-61)
Apache score	10 (0-28)
White cell count X 10^9cell/L	15.3 (4.5 -53)
C Reactive Protien	97 (1-365)
Haemoglobin in g/dL	8.6 (4.6-14.7)
Platelets X 10^9platelets/L	123 (19-549)
Creatinine in µmol//L	89 (19 -987)
Urea in µmol/L	5.7 (1.3 -43.9)
Albumin in g/L	22 (10-46)
PH	7.3 (7.1 – 7.6)
Base Excess in µmol/L	-6.9 (-18.6 –3)
Lactate in µmol/L	2.7 (6- 14.8)

6.3.2 Pregnancy status

There were 71 (97.3%) women admitted who had either delivered or had been managed for early pregnancy losses like miscarriage or ectopic pregnancy. Table 7 summarises the percentages and interventions of the subgroups.

Table 6 Descriptive table on the outcome of the current pregnancy on admission

Outcome	**Diagnosis**		**Percentage**
Antepartum women	2	n=1 Ludwig's angina n=1 organophosphate poisoning	2.7
Early pregnancy losses	8	n=3 molar pregnancies n=4 miscarriages n=1 ectopic pregnancy	11.0
Normal vaginal delivery	12		16.4
Caesarean section	51	n=48 caesarean section n=2 extra uterine pregnancies n=1 ruptured uterus	69.9

There were 16 women with viable pregnancies, 51 (80.9%) delivered by CS, and 12 (19.0%) by normal vaginal delivery.

6.4 Monitoring and intervention in ICU

6.4.1 Common interventions received in the ICU

The commonest interventions that were used to stabilise and treat the women admitted in the ICU are depicted in table 7 and the median number of days the modalities were given and the quantity of blood products used was illustrated in table 8.

Table 7 Common interventions received by the women within the ICU n=73

Intervention	Number (%) n=73
Ventilation	56 (76.7)
Inotropic support	21 (28.7)
Blood pressure control	30 (41.0)
Anti-seizure treatment	12 (16.4)
Packed red cell transfusion	43 (58.9)
Fresh frozen plasma transfusion	32 (43.8)
Cryoprecipitate infusion	4 (5.5)
Platelet transfusion	19 (26.0)

Table 8 Description of intervention used

Intervention	Median (range)
Ventilation in days n=56	4(1-50)
Inotropic support in days n=21	2(1-8)
Red cell transfusion in units transfused n=43	6(1-42)
Fresh frozen plasma transfusion in units transfused n=32	5(1-29)
Cryoprecipitate in units transfused n=4	4(2-8)
Platelet unit transfused n=19	1(1-6)

6.4.2 Intervention and information in women in the medical and surgical disease category

6.4.2.1 Cardiac disease n=14

Of the women who presented with cardiac disease there were 8(57.1%) with known valvular heart disease, 2(14.3%) with hypertensive heart disease, 1(7.1%) with a peripartum cardio myopathy. There were also 3(21.4%) women admitted with pulmonary hypertension. The pulmonary hypertensions were secondary to interstitial lung disease, restrictive lung disease from osteogenesis imperfecta and restrictive lung disease from patient with previous lobectomy of the lung respectively. There were 3 mortalities within the cardiac group, giving a mortality rate of 21.4% in the group. There were 8 women that demised in ICU in total, of these deaths 3 demised due to cardiac conditions accounting for 37.5% of total mortalities.

Of the 14 cardiac patients, 13(92.6%) delivered via CS and were admitted to ICU postoperatively for monitoring however the patient with peripartum cardiomyopathy delivered by normal vaginal delivery and was only diagnosed post delivery and sent to ICU. There was documentation showing that 11 (78.6%) of the women were booked early in pregnancy (before 20 weeks gestation) and the remaining 3(21.4%) had incomplete records hence unable to comment on booking status. There were 6 patients who were HIV positive (42.9%) and the remainder were HIV negative. Interventions in this group are summarized in table 9.

Table 9 Intervention in women admitted with cardiac disease

Intervention	Number of patients n=14	Percentage
Cardiac monitoring	14	100.0
Ventilation	9	64.3
Inotropic support	5	35.7
Blood transfusion	0	0
Dialysis	1	7.0
Caesarean section	13	92.9
Relook laparotomy	3	21.4

Relook laparotomies in this group all had negative findings and all the women who had relook laparotomies demised following relook. There were no hysterectomies performed during the relooks. It was suspected in all 3 cases that cardiac instability may have been due to intraabdominal bleeding following CS, but negative findings confirmed an alternate cause of death.

The median length of stay in ICU was 2 days range 1 – 6 days.

6.4.2.2 Other medical disease

There were 3 women who fell into the "other category"

i. There was 1 with Ludwig's angina (submental abscess) at 22 weeks gestation. The patient was unbooked and HIV status was unknown. Incision and drainage was performed and the patient was ventilated for 2 days in ICU due to upper airway compromise. The patient was discharged after 3 days and made a full recovery.

ii. There was 1 patient who was unbooked at 30 weeks gestation and who presented with organophosphate poisoning following an attempted suicide. The patient was ventilated for 1 day, did not received inotropic support. A full recovery was made following administration of atropine and the patient was discharged after 2 days.

iii. There was a patient admitted who was known with Myasthenia Gravis. The patient delivered by CS and was admitted following a myasthenic crisis. She was ventilated for 2 days and given a plasma exchange. She was discharged on day 6.

6.4.3 Intervention and information in the haemorrhage category

Of the 32 women who presented with haemorrhage, 19 (59.4%) had incomplete booking data due to lost antenatal files or being unbooked. Of the 32 women only 24 had their HIV statuses documented on their records. Of the 24 women, 11(45.9%) tested HIV positive.

Low booking heamoglobin (<10g/dl) was present in 6(46.2%) out of 13 women with complete first antenatal booking information. The mean heamoglobin on admission to the ICU was 8.2g/dL range of 4.5g/dL – 13.6g/dL (SD 2.3)

There were 15(46.9%) births by CS, 8(25.0%) by normal vaginal birth, 6(18.8%) had laparotomies for extra uterine pregnancy or ruptured uterus and 3(9.4%) had miscarriages.

A blood loss of more than 1500ml was documented in 28 (87.5%) of the women. Table 10 summarises the common interventions in this group.

Table 10 Intervention in women with haemorrhage admitted

Intervention	**No. of patients n=32**	**Percentage**
Blood transfusion	30	93.8
Massive transfusion > 10units	7	21.9
Ventilation	27	84.4
Inotropic support	12	37.5
Dialysis	4	12.5
Laparotomy	6	18.8
Hysterectomy	15	46.9
Bakri Balloon insertion	0	0
B lynch suture	4	12.5
Repair of tears or bleeding	3	9.4
Systematic devascularisation	4	12.5
Relook laparotomy	9	28.1
Evacuation of uterus	8	25.0

A full recovery by the time they were discharged from ICU was made in 46.9% of women.

There were no mortalities in the haemorrhage category.

The mean length of stay was 3.5 days with a range of 1 day to 16 days (median = 2.5days).

Relook laparotomy was associated with impaired outcome in 4(44.4%) of the 9 patients who underwent relook. The remainder made a full recovery and there were no mortalities associated with relook laparotomy.

6.4.4 Intervention and information in the Sepsis category

In the septic group of women, 10 (62.5%) out of 16 had booked at an antenatal clinic and 11 were HIV positive (68.7%). There were 3 mortalities (18.7%) in the group all of which all were HIV positive. Of the 3 mortalities 2 were on PMTCT AZT only and 1 had no exposure to antiretroviral therapy. The mean WCC was 23.06 with a range of 9.17 – 53.16. All the women admitted had more than 2 organ system involvement.

There were 11 deliveries by CS, 3 by normal vaginal delivery and 2 had had miscarriages. Of those that demised(n=3): 1 was following sepsis after a caesarean for fetal distress, 1 was following sepsis after an assisted forceps delivery and 1 after evacuation of uterus for a septic abortion.

There were 11 women with pregnancy related sepsis, 9 of which underwent hysterectomy for sepsis (81.8%) while the remaining 2 had evacuations of the uterus. There was 1 patient in the non-pregnancy related sepsis group who had a hysterectomy in ICU. She was admitted with an aspiration pneumonia following an eclamptic seizure and developed intraabdominal sepsis whilst in ICU. The total number of hysterectomies done in the sepsis category was 10 out of 16 (62.5%). All women with pregnancy related sepsis had a surgical intervention. The common interventions in this patient group are shown in table 11.

Of the women who had a hysterectomy for sepsis 7 had a relook laparotomy, 2 of which had multiple relooks (4 and 16 relook laparotomies) respectively. Relook laparotomy was associated with impaired outcome and death. A total of 3 (42.8%) of the 7 women who underwent relook

laparotomy demised. There were 3 mortalities in total in the sepsis group, 2 of which demised in ICU and 1 after discharge. The women that underwent relook and were discharged from ICU all had significant impairment following discharge and 3 had a prolonged hospital stay post ICU discharge, 1 had a right hemiplegia and was referred to a rehabilitation center, 1 had multidrug resistant sepsis and complicated with wound sepsis requiring prolonged hospital stay and secondary wound closure 53 days after being admitted in ICU. And 1 patient was discharged from ICU for palliative care and demised in the ward.

Table 11 Intervention in Septic women admitted to ICU

Intervention	No of patients n = 16	Percentage
Ventilation	13	81.3
Inotropic support	7	43.8
Blood transfusion	11	68.8
Dialysis	4	25.0
Hysterectomy	10	62.5
Evacuation of uterus	2	12.5
Relook laparotomy	7	43.8
Antibiotic therapy	16	100.0
Pigtail insertion	2	12.5

The mean length of stay in days was 11.6 (SD 8.2) days with a range of 0 days to 61 days (median = 5days).

6.4.5 Intervention and information in the pregnancy associated hypertensive disease category

There were 8 women admitted with a primary diagnosis of eclampsia. 3 were unbooked, 2 had incomplete records and the remaining 3 were booked antenatal women. There were 5 documented as being HIV negative and the remaining 3 had no record of their HIV status. Of the

8 women 7 were delivered by CS and 1 had a NVD. Information of the interventions received in this group is summarized in table 12.

All 8 women were admitted post-delivery following eclamptic seizures:

i. 2 were acidotic post operatively and were not extubatable;
ii. 2 complicated with (PRES) posterior reversible encephalopathy syndrome;
iii. 2 had upper airway obstruction or compromise from oedema associated with Preeclampsia and " bitten swollen tongue" following eclamptic seizures;
iv. 1 patient developed an iatrogenic pneumothorax following CVP insertion at CS;
v. 1 was complicated by HELLP syndrome and hemorrhaged on the operating table requiring a B lynch suture.

Table 12 Intervention in Hypertensive women in ICU

Intervention	**Number of patients n=8**	**Percentage**
Ventilation	6	75.0
Blood transfusion	2	25.0
Blood pressure control	5	62.5
Anti-seizure treatment	5	62.5

There were 5 women with preeclampsia complicated by HELLP syndrome and renal dysfunction. All 8 women with hypertensive disorder made a full recovery. Mean systolic blood pressure was 155mmHg and mean diastolic blood pressure was 102 mmHG. The mean length of stay in days was 5.5 with a range of 1 to 7 days (median =2 days)

6.5 Outcomes of pregnant women admitted to ICU

Outcome of the women was assessed as either death, residual impairment in any organ or functional system of the body on discharge from ICU or full recovery. Full recovery also included those who returned to baseline function if known with a preexisting medical disorder. Table 13 summarises the outcomes of all the women with complete data.

Table 13 Depicts outcomes of women on discharge from ICU

Outcomes	Number of patients n = 73	Percentage
Impaired	28	38.4
Full recovery	39	53.4
Death	6	8.2

6.5.1 Specific parameters and associated outcomes

Specific parameters like albumin, pH, Base Excess(BE), renal dysfunction and a blood loss of >1500ml were statistically analysed with outcome to see if they had any impact on return to normal function, impaired function on discharge from ICU or death. Table 14 summarizes these findings.

Table 14 Specific parameters and associated outcomes

	Good outcome	Impaired Outcome	Died	P value
Albumin (mean±SD)	17.7±4.1 n=23	26.1±7.2 n=31	28.5±15.9 n=4	P<0.01
pH (mean±SD)	7.33±0.11 n=26	7.34±0.09 n=38	7.25±0.09 n=7	P=0.04
BE (mean±SD)	-8.0±5.3 n=26	-6.7±2.5 n=38	-8.9±4.8 n=7	P=0.52
Renal dysfunction	50% n=26	18% n=39	37% n=8	P=0.02
Blood loss >1500ml	62% n=26	46% n=37	37% N=7	P=0.28

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6.6 Description of mortalities in ICU

There were 2 mortalities listed in the ICU admission books and on the CHBAH patient information system but the files could not be found in both the ICU records department and the maternal deaths database at CHBAH. One patient demised of puerperal sepsis following caesarean delivery. The other patient was listed as death post TAH in a patient known with an intrauterine fetal death. The cause of death or reason for admission was not stated. Both women had a 3 day stay documented in the ICU. The ICU mortality rate was 10.5% if we were to include the 2 women with missing records and 8.2% if only using the records of women with complete data. The APACHE II score for the patients was 11.6, which a predicted a mortality rate of 15% using the APACHE II score calculator. Table 15 summarizes the clinical information of all the mortalities.

Relook laparotomy was performed on a total of 19 patients in the study group. There were 6(31.6%) mortalities in the group following relook laparotomy and 4(21.1%) patients who had residual impaired function. Two of the patients in the sepsis group underwent 4 and 16 laparotomies respectively and demised.

Table 15 – Mortalities of pregnant women at the CHBAH ICU

Age (years)	Parity	Clinical details	Delivery	Complications	Time in ICU (days)	Cause of death	Apache score
27	2	Admitted for Cardiac monitoring post delivery. Know with tight mitral stenosis and mitral regurgitation complicated by pulmonary hypertension Booked and HIV positive on HAART	CS for FD	Developed pulmonary oedema. Had a relook laparotomy as thought to have an acute bleed. Relook – normal findings. Received inotropes ventilation and transfusion 4 u blood	2	Right heart failure and pulmonary oedema due to possible embolism. Upper GIT bleed	9 3% risk mortality
23	1	Known cardiac patient. Mixed mitral valve disease. Booked, HIV negative. Admitted post delivery for monitoring and diuresis	CS for poor progress	Cardiac failure and pulmonary oedema Received dialysis, ventilation, inotropic support	6	Cardio- respiratory arrest	10 7% risk of mortality
28	3	Known HIV positive on PMTCT (AZT) had CS for poor progress and fetal distress. Developed uterine atony and had a blood loss > 1500ml. Was admitted in ICU with Septic shock	CS for FD	Septic shock and severe systemic sepsis. Acute kidney injury, DIC, ARDS Relook laparotomy was done. Received transfusion 3u blood, inotropic support , antibiotics and ventilation	2	Multiorgan failure	17 12% risk of mortality
36	2	Know with biventricular failure and chronic renal disease. And thyroid disease. Booked. HIV negative. Admitted post delivery with Atrial fibrillation and cardiac failure. Discharged and readmitted to ICU 4 days later	CS for previous CS	Admitted following a relook laparotomy for? Sepsis. In cardiac failure Received Ventilation, dialysis, inotropic support and antibiotics	4	Multiorgan failure Cardiopulmonary arrest	25 35% risk of mortality
17	1	Known HIV positive on PMTCT (AZT) only. Presented with puerperal sepsis following an assisted vaginal birth (forceps). Had total abdominal hysterectomy	NVD	Severe metabolic acidosis, Acute kidney injury, ARDS. Was on inotropic support, ventilated, antibiotics Demised after arrival in ICU	0	Multiorgan failure	22 30% risk of mortality
30	2	Known HIV positive not on HAART. Presented with a septic miscarriage Had an evacuation of uterus and hysterectomy		DIC, Acute kidney injury, ARDS. Had a relook. Positive Gram negative and positive blood cultures. Was on inotropic support, ventilation, antibiotic therapy and dialysis.	31	Multiorgan failure Septic shock	11 7% risk mortality

7 DISCUSSION

The incidence of admissions to ICU of pregnant women and those with pregnancy associated complications in the study was 3.5 per 1000 deliveries at CHBAH. This corresponds with findings of incidences in high income countries ranging between 2 – 4 per 1000 deliveries.[3, 4] This does not include the women who qualified for ICU but were denied admission due to bed shortages, or take into account women managed in the maternity high care which should have ideally been managed in the ICU setting or those managed in Cardiac ICU. This would ultimately increase the incidence of women requiring ICU beds in comparison to high income countries. The literature states that the incidence of admission in developing countries is as high as 10% due to preventable morbidities attributed to poor health care systems and services.[1] This may illustrate the need for better access to ICU at CHBAH. However during 2012 there was a need to move to an alternate ward while the CHBAH ICU was being renovated for part of the year. This resulted in fewer beds being available – 12 ICU and 4 HCA. So 2012 is not a true representative of the norm in this case.

The average duration of general ICU stay in the study group of pregnant women admitted to ICU was 5 days. This is slightly longer than the 3.7days quoted in the literature reviewed by Zeeman[3] and 3 days in a large prospective cohort in the Netherlands, both studies looking a pregnant women admitted to ICU.[4] The longer stay could be attributed to delay in admission for reasons such as scarcity of ICU beds, late presentation to hospital and hence patients presenting in ICU with a worse clinical condition compared with those in developed countries thereby requiring a longer return to normal function. The increase in ICU stay could also be due to ongoing need for

organ support such as dialysis which is not readily available in the maternity high care. The average age was 29 years and the median parity was 2 in keeping with other studies.[3,4,5]

Only 2.7% of the women were admitted in the antepartum period which differed greatly to various studies conducted in high income countries where antenatal admissions accounted for 10 - 42% of all admissions. In these settings availability of beds and ICUs consisting of multidisciplinary units with midwives and obstetricians present allow for admission and delivery of high risk or critically ill women within the ICU setting where adequate monitoring and supportive care is available. In the CHBAH setting such multidisciplinary teams and delivery facilities are not available in the main ICU and delivery is usually expedited in the maternity unit before transfer. This is problematic for the patients who require invasive monitoring or ventilation during delivery.

The study reveals that haemorrhage was the most common indication for admission to ICU followed by medical and surgical disorders, then sepsis and finally hypertensive disorders. This interestingly does not reflect the findings in previous South African studies where Hypertension including preeclampsia and eclampsia were the most common reason for admission followed by haemorrhage.[30]

Major obstetric haemorrhage, like many first world and developing countries, was the most common admitting diagnosis. The average length of stay in the study group was 5 days however the haemorrhage group was shorter with a mean length of stay of 3.5 days. This could indicate that the patients respond more rapidly to intervention and critical care than the other sub groups.

This could be because it is acute onset on the background of a previously well patient rather than those with preexisting medical conditions and severe sepsis which has manifested over some time resulting in worse organ systems dysfunction. Interestingly though hysterectomy was the most common surgical intervention to arrest bleeding (46.9%) while primary surgical measures such as the use of balloon tamponade methods (0%), b-lynch brace suture(12.0%)) and systematic devascularization (12.0%) were infrequently performed on review of documented surgical notes. This could be explained by management of these women in the emergency setting often by junior registrars and senior medical officers who are considerably less skilled in retroperitoneal procedures such as ligation of internal iliac arteries versus a standard subtotal hysterectomy. It could also be explained by the lack of equipment such as Bakri balloons in the resource restricted setting. And finally it may describe the severity of the patients who present with haemorrhage – those which are unstable with multiorgan involvement requiring inotropic support and thus not candidates for the more conservative surgical measures.

Anaemia at Antenatal Booking was seen in 46.0% of the women with complete antenatal information in the heamorrhage group – treatment of chronic iron deficiency anaemia is a well described strategy in the prevention of death due to major obstetric heamorrhage.[21] Blood loss of > than 1500ml in the study was not associated with poor outcome p =0.02 There is in fact a better association of severe blood loss >1500ml and survival in the study – it may be that people admitted to ICU for haemorrhage do better than those admitted to ICU for other reasons as they most likely do not have other comorbidities. Liberal transfusion is also associated with better survival in postoperative patients.[27] Patients with a blood loss of >1500ml were likely to receive aggressive transfusion as per ICU protocol.

CHBAH is a referral center which will account for the large proportion of women admitted with medical and preexisting medical and surgical conditions. This was the second most common indication for admission. Waterman et al conducted a multicenter case controlled study determining predictors of severe obstetric morbidity and determined that preexisting or general medical conditions as well as maternal age over 34 years were among the main predictors of severe morbidity.[30] Unlike the previous South African studies where there were few admissions in this subgroup this study seems to follow patterns of some first world studies.[5] This may be due to improved reproductive technology and advancement in medical care, women with known medical problems and advanced maternal age are more likely to fall pregnant. It also mimics the findings in the sixth saving mothers report showing an increase in maternal deaths due to preexisting medical and surgical conditions.[21] This is not reflected in a recent retrospective study done at the Pietersburg tertiary hospital ICU in Limpopo Province which does not list any admissions of women with preexisting medical illness.[31]Limpopo had the highest provincial iMMR in the country in the sixth saving mothers report which could imply a lack of availability of basic health care and antenatal services and hence poor recognition of women with preexisting disease.[21] Or simply as shown in the multicenter Netherlands study, high volume hospitals with high level ICUs treated a greater number of cardiac patients and patients with other preexisting medical disease then low-volume hospitals.[4]

Safe, free and legal abortion has been instituted in South Africa since 1997, as a result there were only 2 admissions with septic abortion.[17] This is a considerable difference to the study conducted at Johannesburg General Hospital between 1985 and 1996 looking at all the obstetrics and

gynaecological patients admitted to the ICU. Incomplete abortion was the most common reason for admission.

Sepsis due to non-pregnancy related infection only accounted for 4 admissions which is alarmingly low considering NPRI is the most common cause of maternal death in the country accounting for 34.7% of maternal deaths in the 2011-2013 Saving Mothers report.[21] The infective nature of some of the diseases, Tuberculosis being the most common, and the often long anticipated stay of such patients within the ICU, may be a likely deterrent for acceptance in a unit that has a high turnover and increased pressure for beds. It is also noted that because NPRI is common in this country protocol based care is instituted at general ward level.

The less frequent diagnosis of hypertensive disorders in this study of 11.0% versus 66 to 73% in previous South African studies is most likely due to the availability of a 7 bed Maternal High Care Unit at the hospital which is equipped to manage common obstetric hypertensive problems and its complications.[14,16,31] Improvements in access to antenatal care due to availability of services and education of patients as well as better management of patients with hypertensive disorders in pregnancy, could be contributing factors to the decline in patients with severe hypertensive disease. This also corresponds to the decline in hypertension related deaths noted in the recent saving mothers report compared with 2002 -2004 report.[21]

Mortality rate was 10.5% with incomplete data and 8.2% with complete ICU record data compared to the 21-38% in the previously cited South African studies.[31] Internationally the mortality rate is about 6.5% in ICUs but has been reported as low as 3.4% in a multicenter study

in the Netherlands.[4] What is of interest is the discrepancy between the recent Limpopo province ICU study conducted from 2009 -2012 which had a mortality rate of 34.8%. The incongruity could be due to a higher threshold for admission at CHBAH due to availability of the maternity high care unit and better selection of appropriate ICU candidates, as well as better availability of resources and multidisciplinary care within the area and province. It is stated that most maternal deaths are potentially avoidable especially those due to hypertension and haemorrhage – there were no mortalities in the women who presented to ICU with hypertension or haemorrhage which could illustrate adequate practice of protocol based management of these two common obstetric complications at the institution.[21] Of the 6 deaths with complete file data in ICU, 50.0% were due to complications associated with preexisting cardiac disease. Cardiovascular disease is the leading cause of maternal death in some high income countries. It is known that mortality risk stratification using the CARPREG and WHO predictive indices in pregnant cardiac patients is beneficial in guiding clinicians with regards to appropriate management antenatally, during delivery and postpartum. Patients with a high risk of mortality can also be offered termination of pregnancy. [32] All of the cardiac patients were booked antenatally and seen at a specialized clinic, however there was no documentation of risk stratification. The other 50.0% n=3 of maternal deaths occurred in women with puerperal sepsis and septic miscarriage. All 3 patients were HIV positive and not on triple therapy ART – this may have contributed to the severity of the sepsis. Current South African guidelines call for the use of combination triple therapy ART in all pregnant women regardless of CD4 count. Mortality associated with possible complications of HIV is likely to decrease in the future and has already decreased dramatically in the past, saving mothers, due to the use of antiretroviral therapy in pregnancy and policies for prophylaxis

against Tuberculosis and PJP. APACHE II scoring over predicted mortality in the study which is in keeping with the finding in other studies using the scoring system in pregnant women.[5,8]

There were no records found for 3 of the maternal deaths that occurred in ICU in the maternal deaths records collection in the maternity unit. The maternal deaths are recorded and contribute to the national confidential enquiry into maternal deaths report. Two of the obstetric medical records, as well as the ICU records, were not located as the patients may have been sent for postmortem, anaesthetic review or the files misplaced. The other patient was a cardiac patient that demised in ICU and was simply not reported. . Systems for reporting of maternal death within the maternity department are in place, but when a patient demises in the general ICU it may go unreported, as files need to be copied and sent across to maternity for reporting. It is recommended that the Obstetrician on call should be notified to ensure adequate reporting.

There were no admissions to the ICU for trauma/or motor vehicle collisions unlike the study conducted by Aldawood in Saudi Arabia where motor vehicle accidents are becoming a significant public health problem.[1] This is surprising considering the high number of road accident deaths on South African roads annually.

Confirmed antenatal booking was most frequently documented in the group of women with medical conditions 78.6% vs 62.5% in the septic group and 40.6% in the haemorrhage group. The reliability of the booking information is questionable due to the retrospective nature of the study and the large percentage of the obstetric files which were not obtainable, thus it is difficult to formulate an accurate opinion on the above. It was however striking how women with

preexisting medical conditions were more likely to be booked, probably because of better health education at medical checkups and awareness of importance of their condition on pregnancy.

HIV seropositivity was 35.6% in the group of women with complete booking information but was 68.7% in the septic group category possibly illustrating the association of HIV with respiratory and puerperal sepsis. This is slightly higher than the national estimated HIV prevalence between 15 -49 year olds of 29.5% in 2012 and greater than the national antenatal population seropositivity in Gauteng of 28.7% .[33]

Of the women admitted in ICU for mechanical ventilation, 77.0% had haemodynamic instability, airway compromise and respiratory distress. This was the most common intervention. This is higher than cited studies in which 19-60% of patients admitted to ICU were mechanically ventilated.[1] Mechanical ventilation was used in the haemorrhage and the septic groups of patients in 84.4% and 81.3% respectively and in only 64.7% of the patients with preexisting medical disease. This is because the women with preexisting medical illness were less likely to be admitted for haemodynamic instability or respiratory distress but rather for invasive monitoring post delivery. The increased likelihood for the use of mechanical ventilation the study, in comparison to a Netherlands study in a tertiary hospital ICU where 50.4% were ventilated or in other first world studies where patients where admitted for monitoring during the antenatal period, once again highlights the severity of the morbidity associated with the patients in our setting.[4,9] This is further illustrated with the use of inotropic support in 28.7% of the women admitted to the CHBAH ICU versus 13.9% in the Netherlands.[4]

In keeping with national data the CS rate of the women who were admitted to ICU post delivery was 76.2% which is higher than the CHBAH institutional norm of around 33.3% as quoted by Nathan et al.[34] The ideal CS rate quoted by the WHO is 10-15% to reduce maternal morbidity and mortality, but it needs to be taken into consideration that CHBAH is a referral center and manages high risk pregnancies therefore resulting in a higher CS rate[34] Death due to bleeding at CS has shown an increase in the 2011-2013 saving mothers report.[21] A relative risk was not calculated for women who delivered by CS as this would be confounded – was the Caesar itself a risk factor for outcome or was the CS a consequence of underlying maternal disease? The high CS rate is most likely due to the higher number of women undergoing CS for maternal indications.

The findings after the intervention of relook laparotomy are in keeping with the study conducted by Morar et al, looking at the outcomes of patients with intra-abdominal sepsis in the Johannesburg general ICU. It was noted that multiple laparotomies are associated with higher mortality and more than 4 relook laparotomies had a zero survival as seen the study.[35] This is likely to be explained by the severity and persistence of disease or the severity of the clinical condition the patient presents in when requiring a relook laparotomy.

Low serum albumin $p \leq 0.01$ and renal dysfunction $p \leq 0.02$ were associated with better outcome. In the Johannesburg ICU study low albumin was seen in both patients who demised and survived. It has been stated that low albumin is associated risk for treatment failure in perioperative patients.[35] It is also well documented that renal dysfunction requiring dialysis is also a poor prognostic indicator. In the index study the patients did well. This is most likely

explained by acute nature of the presentations on the background of a previously well patient, as well as the profound physiological changes and adaptation of pregnancy.

7.2 Limitations of the study

The study was retrospective in nature and thus is known to have inherent information bias. The collection of the retrospective data was problematic as more than 59.0% of obstetric files were not located, however the ICU record keeping was notably superior and 73 records of the 76 women admitted were found. Missing information from the files would most certainly affect the reliability of the data. All the necessary information to meet the objectives however was taken from the ICU files, but these did not contain information on the gestational age and the antenatal booking and antenatal period unless included in the ICU summary. This data was needed from the obstetric files. Outstanding booking blood results if taken were also located on the hospital laboratory system to assist completion of data. The ICU files included handwritten summaries of results, diagnosis and management within ICU – poor handwriting or incorrectly recorded figures could result in some error.

The study was only conducted at one ICU over one year demonstrating a small sample size. As previously mentioned as a result of a temporary move to a smaller ICU with less ICU beds, we may find that a subsequent study in the fully functional 34 bed CHBAH ICU over a longer period of time, may have different outcomes. Multicenter audits of other ICUs would better explain the differences in the findings of our study and the other South African studies, namely the significant difference in mortality rate and admitting diagnosis.

While the study gave us a good retrospective review of pregnant women and women with pregnancy related complications admitted to CHBAH ICU in an urban area in South Africa we are unable to infer the findings to other South African settings as resources, availability of skilled staff and patient populations do vary greatly, let alone to high income settings.[4,5] The significance of the study would have been enhanced if it had compared the findings of the women admitted to ICU and those that were admitted to Maternity High Care Unit as well as included those patients that had been denied access to ICU due to unavailability of beds. It also excluded women transferred to ICU at other hospitals in the province due to unavailability of beds which may have influenced the outcomes.

Due to its retrospective nature and the difficulties with record keeping not all the files were located for data capture. The results may not be a true reflection of the population and the need for ICU. The CHBAH is a tertiary referral center and therefore has a lot of high risk obstetric women as well as women being referred in and therefore outcomes may not apply to other patient populations.

8 Conclusion

The study differed greatly from other South African studies with a significantly lower ICU mortality rate (8.2-10.5%) vs (34.8 -36.0%). The commonest indication for admission was haemorrhage followed by medical and surgical conditions, then sepsis and finally hypertension. This also varies in relation to the South African studies and global studies where hypertension followed by haemorrhage was the most common cause for admission.[31]

Adequate management of the pregnant women and women with pregnancy related complications admitted to ICU requires cooperation of multidisciplinary teams including intensivists' physicians and obstetricians as it is evident that the needs and response to therapy of the pregnant patient vary significantly.

Preexisting cardiac disease and women admitted with sepsis were each responsible for 50% of the mortalities respectively. Better risk stratification of cardiac patients early in pregnancy, and considerations such contraception to prevent pregnancy, prenatal assessment for pregnancy planning and even termination of pregnancy in patients with a high risk of mortality, could reduce maternal mortality in cardiac patients with preexisting heart disease.[32] Further research is needed on cardiac patients in the South African setting to better understand the outcomes and improve management of such patients. Sepsis requires early diagnosis and early goal directed management to reduce death. Relook laparotomy appeared to be associated with increased morbidity and mortality. Senior surgeon supervision at surgeries done for sepsis to ensure better debridement and removal of septic tissue as well as decreased postoperative bleeding may result in a decreased need for relook. [35] While the study did not evaluate the use of protocols, protocol based management of all common obstetric complications should be available at all heath facilities managing pregnant women to reduce maternal mortality. There were no deaths in the haemorrhage and hypertension groups most likely due to adequate resuscitation, organ support and protocol based management instituted in the ICU and labour ward.

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Further multicenter population based studies need to be conducted to compare the findings at different centers across the country, as well as to compare the incidences, indications and outcomes of women admitted to high care maternity units. Further studies also need to illicit if there is a need for increased antenatal management of the complicated obstetric women within the ICU setting in South Africa as majority of the presentations to ICU were in the postpartum period unlike studies in high income areas.

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Appendix 1: Data Sheet
Demographics and History

			(tick)
Study Number		African	
Age		Caucasian	
Parity		Coloured	
Gravity		Indian	
Gestation			

Co morbidity		
Cardiac	0	1
Diabetes	0	1
Thyroid Disease	0	1
Epilepsy	0	1
Chronic Hypertension	0	1
Asthma	0	1
HIV/Aids	0	1
Other	0	1

Antenatal Booking										
Booking Gestation										
Weight when booking										
Booking HB										
RPR	0	1								
RVD	0	1	If "1" then CD4 Count							
			ARV	0	1	PMTCT	0	1		**(tick)**
						ART			AZT	
									3 TC	
									TDF	
									EFV	
									NVP	
									D4T	
									Other	
Sonar	Early Sonar (< 22 weeks)	0	1							
	Latest Sonar (> 22 weeks)	0	1							
Number of antenatal visits										
Risk Factors For Pregnancy	PIH	0	1							
	GDM	0	1							
	Previous Caesar	0	1							
	Grand Multiparty	0	1							
	Multiple Pregnancy	0	1							
	Other	0	1							

Delivery	0	1	If yes, what mode	Assisted	0	1			
				NVD	0	1	Forceps	0	1
							Vacuum	0	1
							Episiotomy	0	1
				Caesar	0	1	FD	0	1
							Poor Progress	0	1
							Delayed 2nd Stage	0	1
							APH	0	1
							Eclampsia	0	1
							Abnormal Lie	0	1
							Multiple Pregnancy	0	1
							Other	0	1

Admission	HPT	Pre-Eclampsia	0	1			
Diagnosis		Eclampsia	0	1			
		PIH	0	1			
		Chronic	0	1			
		PET	0	1			
		Eclampsia	0	1			
		Hellp	0	1			
	Heamorrhage	Early Pregnancy	0	1	Miscarriage	0	1
					Ectopic	0	1
		Antepartum	0	1	Unclassified	0	1
					Placenta Preavia	0	1
					Abruptio Placentae	0	1
					Uterine Rupture	0	1
		Postpartum	0	1	Genital Trauma	0	1
					Uterine Atony	0	1
					Retained Products	0	1
					Bleeding at Caesar/Tears	0	1
					DIC	0	1
				(tick)			
		Blood Loss	< 500ml				
			500ml to 1000ml				
			1000ml to 1500ml				
			> 1500ml				
		Evacuation of Uterus	0	1			
		Repair	0	1			
		Hysterectomy	0	1			
		B Lynch	0	1			
		Bakri Balloon	0	1			
		Systematic Devascularisation	0	1			
		Other	0	1			
	Sepsis	Pregnancy Related	0	1	Choriamnionitis	0	1
					Puerperal	0	1
					Septic Abortion	0	1
		Non-Pregnancy Related	0	1	Respiratory	0	1
					CNS	0	1
					Renal	0	1
					Systemic	0	1
	Other						

Indication For Admission	Ventilation	0	1
	Inotropes	0	1
	Monitoring	0	1
	Analgesia	0	1
	Resuscitation	0	1
	Dialysis	0	1

Investigation						
BP						
Pulse						
Temp						
Septic	0	1	CRP			
			White Cell Count			
			Cultures	G+	0	1
				G-	0	1
				Parasites	0	1
				Anaerobic	0	1
				BD Glucan	0	1
				Organism		

Renal	Creatinine
	Potassium
	Urea
	Sodium
Heamatology	Heamaglobin
	Platelets
	INR
	PI
	PTT
	HCT
Liver Functions	Albumen
	AST
	ALT
	LDH
Arterial Blood Gas	PH
	P02
	PC02
	HC03
	BE
	Lactate

Glasgow	Motor	i
		ii
		iii
		iv
		v
	Verbal	i
		ii
		iii
		iv
		v
	Eye	i
		ii
		iii
	Total	
Other		

Organ system dysfunction prior to admission to ICU					
BIG 5			**FORGOTTEN 4**		
CNS	0	1	HAEMATOLOGICAL	0	1
RESPIRATORY	0	1	ENDOCRINE	0	1
CARDIAC	0	1	GIT	0	1
LIVER	0	1	MUSCULOSKELETAL	0	1
RENAL	0	1			

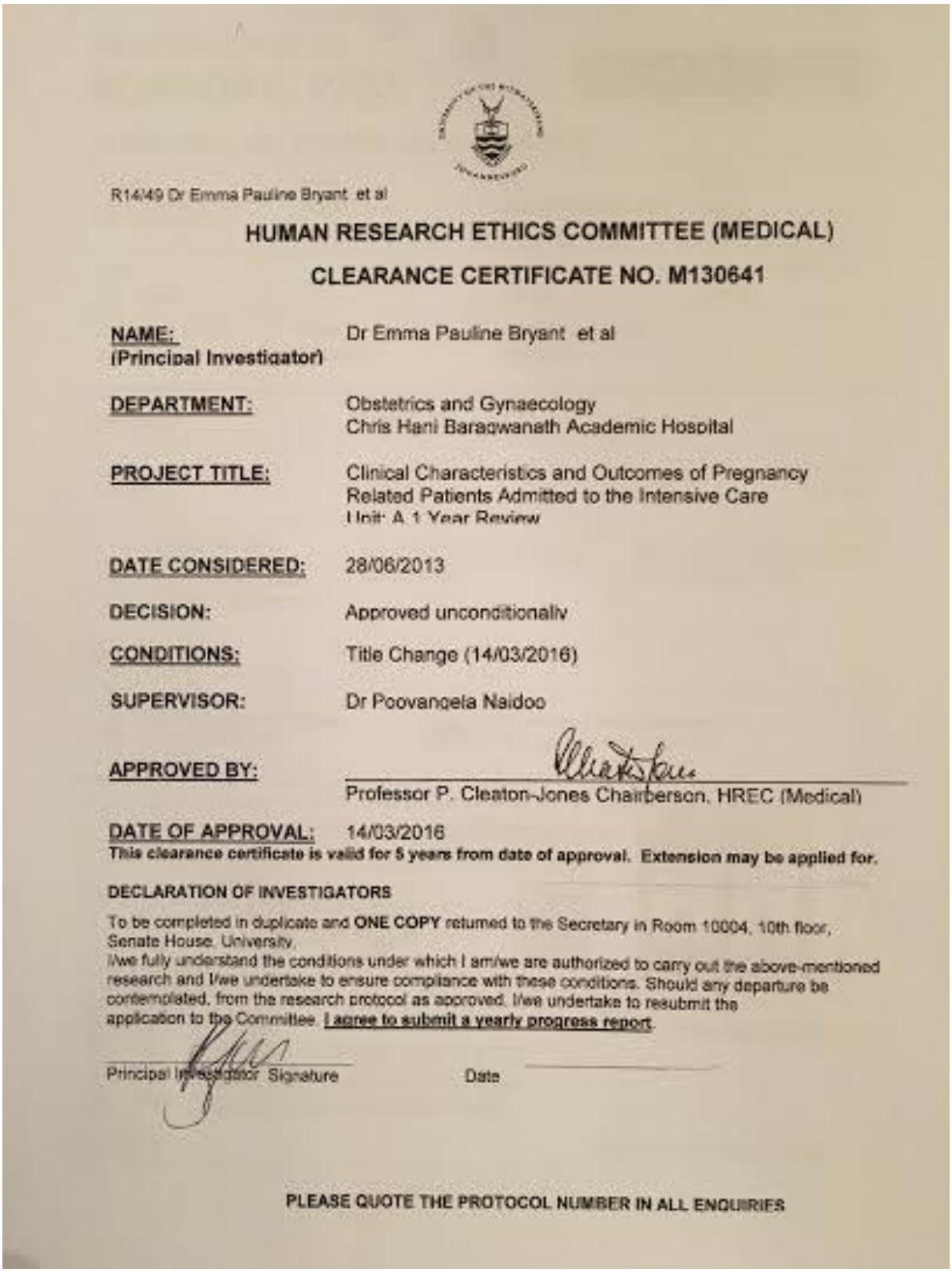
Apache II Score

Physiologic Variable	**High Abnormal Range**					**Low Abnormal Range**				
	+4	**+3**	**+2**	**+1**	**0**	**+1**	**+2**	**+3**	**+4**	**Points**
Temperature - rectal (°C)	≥41°	39 to 40.9°		38.5 to 38.9°	36 to 38.4°	34 to 35.9°	32 to 33.9°	30 to 31.9°	≤29.9°	
Mean Arterial Pressure - mm Hg	≥160	130 to 159	110 to 129		70 to 109		50 to 69		≤49	
Heart Rate (ventricular response)	≥180	140 to 179	110 to 139		70 to 109		55 to 69	40 to 54	≤39	
Respiratory Rate (non-ventilated or ventilated)	≥50	35 to 49		25 to 34	12 to 24	10 to 11	6 to 9		≤5	
Oxygenation: A-aDO2 **or** PaO2 (mm Hg) a. FIO2 ≥0.5 record A-aDO2 b. FIO2 <0.5 record PaO2	≥500	350 to 499	200 to 349		<200 PO2>70	 PO2 61 to 70		 PO2 55 to 60	 PO2<55	
Arterial pH (preferred) Serum HCO3 (venous mEq/l) (not preferred, but may use if no ABGs)	≥7.7 ≥52	7.6 to 7.69 41 to 51.9		7.5 to 7.59 32 to 40.9	7.33 to 7.49 22 to 31.9		7.25 to 7.32 18 to 21.9	7.15 to 7.24 15 to 17.9	<7.15 <15	
Serum Sodium (mEq/l)	≥180	160 to 179	155 to 159	150 to 154	130 to 149		120 to 129	111 to 119	≤110	
Serum Potassium (mEq/l)	≥7	6 to 6.9		5.5 to 5.9	3.5 to 5.4	3 to 3.4	2.5 to 2.9		<2.5	
Serum Creatinine (mg/dl) Double point score for acute renal failure	≥3.5	2 to 3.4	1.5 to 1.9		0.6 to 1.4		<0.6			
Hematocrit (%)	≥60		50 to 59.9	46 to 49.9	30 to 45.9		20 to 29.9		<20	
White Blood Count (total/mm3) (in 1000s)	≥40		20 to 39.9	15 to 19.9	3 to 14.9		1 to 2.9		<1	
Glasgow Coma Score (GCS) Score = 15 minus actual GCS										
A. Total Acute Physiology Score (sum of 12 above points)										
B. Age points (years) ≤44=0; 45 to 54=2; 55 to 64=3; 65 to 74=5; ≥75=6										
C. Chronic Health Points (see below)										
Total APACHE II Score (add together the points from A+B+C)										

Treatment					
				Units	
Transfusion	0	1	RBC		
			Platelets		
			FFPs		
Inotropes	0	1	# of Days		
Ventilation	0	1	# of Days		
Antibiotics	0	1	# of Days		
BP Control	0	1			
Anti Seizure	0	1			
MRI CT	0	1			
Surgery	0	1	Relook	0	1
			Hysterectomy	0	1
			Laparotomy	0	1
			Other	0	1
Dialysis	0	1	Intermittent	0	1
			Continuous (CCVHD)	0	1
Other	0	1			

Outcome		
Impaired	0	1
Full Recovery	0	1
Death	0	1
Death post discharge from ICU	0	1
Length of stay (Days)		

Appendix 2: Ethics



R14/49 Dr Emma Pauline Bryant et al

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

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NAME: (Principal Investigator)	Dr Emma Pauline Bryant et al
DEPARTMENT:	Obstetrics and Gynaecology Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Clinical Characteristics and Outcomes of Pregnancy Related Patients Admitted to the Intensive Care Unit: A 1 Year Review
DATE CONSIDERED:	28/06/2013
DECISION:	Approved unconditionaliv
CONDITIONS:	Title Change (14/03/2016)
SUPERVISOR:	Dr Poovangela Naidoo
APPROVED BY:	Professor P. Cleaton-Jones Chairperson, HREC (Medical)
DATE OF APPROVAL:	14/03/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

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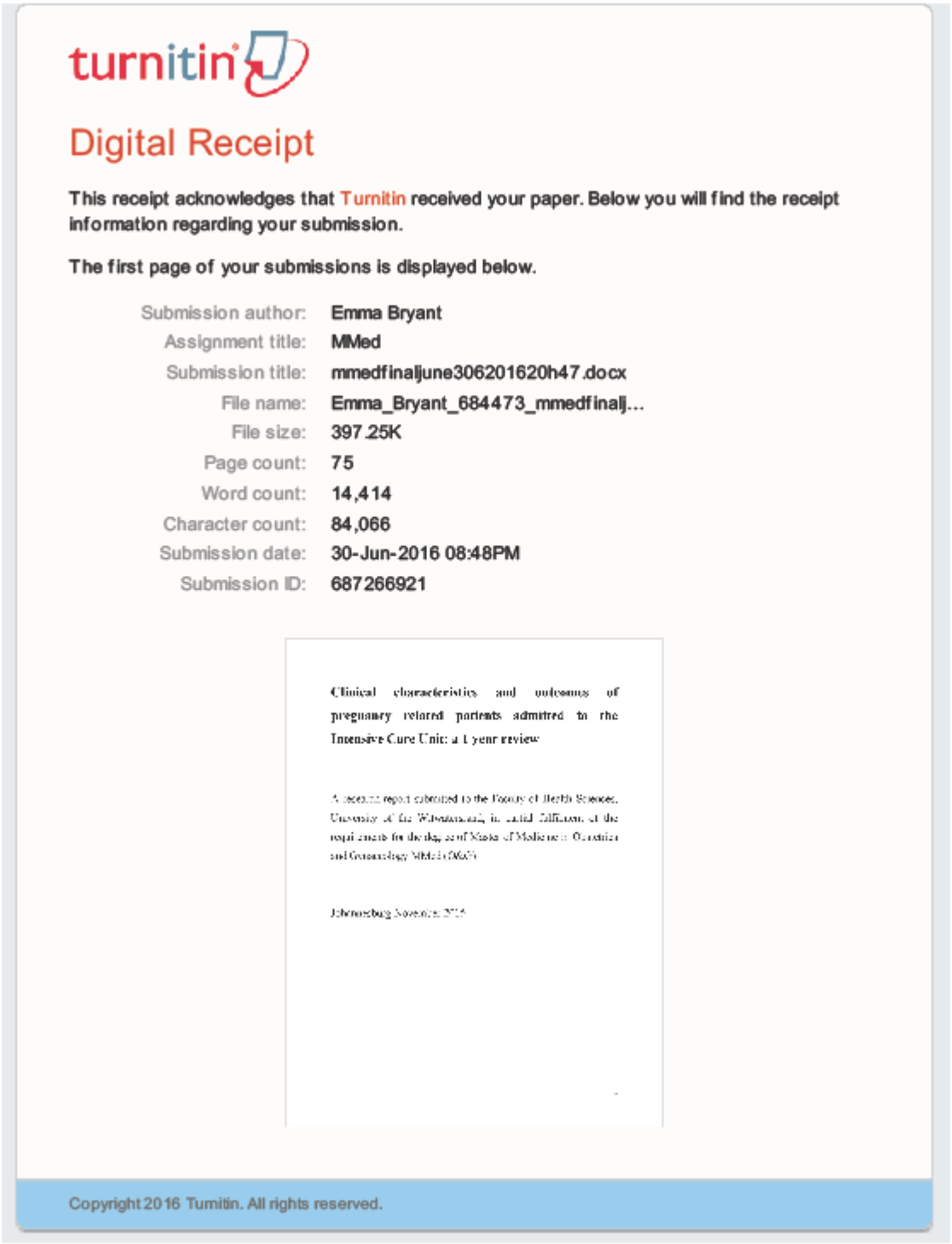

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