An Observation of the Caesarean Section Rate at a Teaching Hospital in Johannesburg

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Declaration

I, Rizwana Ayob, declare that this research report is my own work (except where acknowledgements indicate otherwise).

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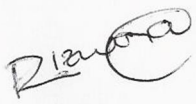
Signature 

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Dedication

I dedicate this research report to my fellow clinicians. Public service is more than doing a job efficiently and honestly. It is a complete dedication to people and to the nation. May we dedicate our careers to ensuring safe childbirth and motherhood.

Abstract

Background

In 1985, the WHO stated: ñThere is no justification for any region to have caesarean section rates higher than 10-15%ò. Almost three decades later, the optimal caesarean delivery rate remains a topic of controversy in the developed and developing worlds.

Caesarean births are on the rise globally. Although caesarean sections have a crucial life-saving role in modern day obstetrics and are safer than ever before, they still remain a major surgical intervention that is not without risk. This is particularly prudent to South Africa where obstetric haemorrhage, most importantly bleeding at or after caesarean section, is the commonest direct cause of maternal death. Therefore, in the South African setting, minimising caesarean delivery is an essential strategy to reduce maternal mortality.

Caesarean section audits are an important tool to understand and make recommendations for a possible reduction in caesarean delivery rates. The Robsonôs Ten Group Classification System is such a tool and allows auditing, analysis and comparisons of caesarean delivery rates in a standardised manner.

Methods

A prospective observational study was conducted over a two month period at Chris Hani Baragwanath Academic Hospital in 2013.

Chris Hani Baragwanath Hospital is a tertiary hospital located south of Johannesburg. The hospital services 2 million people, mainly of low-income, and the maternity unit delivers in excess of 23 000 babies each year. Most patients are high-risk and are referred by midwife managed obstetric units (MOU)

Demographic, obstetric and delivery outcome data of women who delivered by caesarean section during this period were collected and captured onto a data sheet. Each delivery was also categorised according to the Robsonôs Ten Group Classification System. The data was entered onto an excel spread sheet and analysed using the STATA statistical program.

Results

There were 3898 deliveries during the two month period, of which 1534 were caesarean sections resulting in a caesarean delivery rate of 39.4%.

The majority of patients underwent emergency caesarean sections after the onset of spontaneous labour (60.9%). Fetal distress, previous caesarean section and dystocia were the commonest indications for caesarean section in order of frequency.

In terms of the Robsonôs Ten Group Classification System, the high caesarean section rate in our institution is attributed to the women with previous caesarean deliveries at term (group 5) and nulliparous patients in spontaneous labour at Ó37 weeks (group 1). Groups 3 and 10 are also responsible for a significant amount of caesarean sections performed in this population.

The near-miss ratio was 24.7 cases per 1000 deliveries. The rate of comorbid disease amongst patients that experienced near-miss was 84.6% and most (61.5%) patients required a preterm delivery due to comorbid disease. Hypertension was the most commonly occurring comorbidity (69.2%). Only 23.1% of near-miss was due to caesarean section. In most cases, morbidity was due to the indication for caesarean delivery rather than to the operation itself. The results demonstrate that pre-eclampsia and postpartum haemorrhage are the most important initiating factors of near-miss occurring in 76.9% of patients.

Conclusion

Defining an optimal caesarean delivery rate in our setting may not be realistic, as CHBAH is a tertiary, referral centre, with a wide range in the health status of patients. The World Health Organisations recommendations of 15% for caesarean delivery rates globally may need to be adapted to take into account the patient profile and morbidity in South Africa. Ensuring equal access to good quality, medically appropriate obstetric care should be our primary concern.

Table of Contents

List of Tables

List of Abbreviations

APH	Antepartum Haemorrhage
BBA	Born Before Arrival
CHBAH	Chris Hani Baragwanath Academic Hospital
CPD	Cephalopelvic Disproportion
CTG	Cardiotocograph
ECV	External Cephalic Version
EFM	Electronic Fetal Monitoring
GDP	Gross Domestic Product
HCA	High Care Area
HIV	Human Immunodeficiency Virus
ICU	Intensive Care Unit
IUGR	Intrauterine Growth Restriction
LNMP	Last Normal Menstrual Period
MOU	Midwife Obstetric Unit
NCCEMD	National Committee for the Confidential Enquiries into Maternal Deaths
NICE	National Institute for Health and Clinical Excellence
NICU	Neonatal Intensive Care Unit
PPH	Postpartum Haemorrhage
SAMM	Severe Acute Maternal Morbidity
TGCS	Ten Group Classification System
VBAC	Vaginal Birth After Caesarean
WHO	World Health Organisation
WHOGS	World Health Organisation Global Survey on Maternal and Perinatal Health

Definition of Medical terms[1, 2]

Medical Term	Definition
Anaemia	Haemoglobin < 11.0g/dL
Dystocia	Abnormal progression of labour
Grand Multiparity	Five or more pregnancies reaching gestational viability
Macrosomia	Birth weight Ó4500g
Multiparous	A woman who has given birth to at least one child at or beyond viability
Nulliparous	A woman who has never completed a pregnancy beyond 20 weeks.
Postpartum Haemorrhage	Blood loss Ó500ml at vaginal delivery or Ó1000ml at caesarean delivery
Post dates	Pregnancy with gestational age Ó41 weeks
Preterm labour	Labour before 37 weeks
Primigravid	A woman in her first pregnancy
Near-miss or Severe Acute Maternal Morbidity	Severe life-threatening obstetric complication necessitating urgent medical intervention in order to prevent death of the mother

Introduction

Birth may be a natural process but sometimes even low-risk pregnancies can give rise to complications and a caesarean delivery may be required for optimum outcomes.

There is no dispute that caesarean sections are imperative in obstetrics but it is of concern that they may be done unnecessarily. This is of concern, especially in a low and middle-income country like South Africa, where haemorrhage at or during caesarean section is the most important cause of direct maternal death.

The trends in caesarean section rates and the reasons for the increase in caesarean delivery will be explored in this study as well as the potential benefits and risks associated with caesarean birth.

1. Literature Review

1.1 Caesarean Section: A Historic Perspective

Caesarean section may be defined as the ñsurgical termination of pregnancy or delivery by operative opening of the uterus.ò [3]

The origin of the term ñcaesarean sectionò was believed to be from the birth of well-known Roman dictator, Julius Caesar. This speculation is false. More correctly, the term is derived from the Latin word ñcaedereò which means ñto cutò.[4, 5]

Caesarean sections have been practiced for ages with the very first documented evidence of caesarean delivery as early as 1795 BCE. Originally caesarean delivery was a universally post-mortem procedure which had its origins in social and religious requirements that mother and infants are buried separately.[4]

The Law of the Kings or *"Lex Regia"* which forbid the burial of a pregnant woman until the child was removed from her womb. Therefore, in the ancient times, the objective of caesarean section was a cultural rather than a medical event and was undertaken as part of the burial procedure.[4, 5]

Caesarean sections came to have medical implications upon realisation that the shorter the interval between maternal death and caesarean delivery, the better the chance for infant survival. Therefore the original medical objective for post-mortem caesarean section was delivery of a living child upon death of its mother.

During the Renaissance the concept of caesarean section shifted from a cultural to a medical procedure, with an emerging awareness of maternal and fetal safety. However until the 18th century, the mortality rate from caesarean sections was nearly 100%. The mortality rate then gradually declined as advances were made in the fields of anaesthesia, antiseptic and

antibiotic measures, blood transfusion policies and surgical technique which refined the procedure of caesarean section. By the early 1900ôs, maternal mortality from caesarean section had decreased to around 3 -4%.[4, 5]

Caesarean sections continued to evolve during the 20th century and beyond with the objective shifting towards saving the lives of mothers and infants. The associated morbidity and mortality also decreased dramatically. Today an operation which began due to cultural and religious reasons and then later as a vain attempt to rescue a fetus is now not only undertaken for the health and safety of mother and infant, but also takes into consideration the mothers desires, preferences and rights of the child.[4, 5]

1.2 The Optimal Caesarean Section Rate

In 1985, the World Health Organisation (WHO) stated: ñThere is no justification for any region to have caesarean section rates higher than 10-15%ò.[6]

Almost 3 decades later, the optimal caesarean section rate remains a topic of controversy in the developed and developing worlds. There is no consensus about the ideal rate. In theory, it is possible to calculate the caesarean section rate associated with minimal maternal and foetal risk. In practice however, this may be difficult to quantify.

To avoid maternal morbidity and mortality, studies carried out by the WHO and others recommend a minimum necessary caesarean section rate of between 1-5%.[6, 7] However, rates as high as 10% result in an improvement in neonatal outcomes.[7-9] It is for these reasons that the WHO has suggested an upper limit of 15% for caesarean section rates globally.[6]

These figures are theoretical estimates and were based on caesarean section rates in countries with the lowest maternal and neonatal mortalities which were approximately 10%. As these estimates were not validated with data from developing countries, the WHO suggested an

upper limit of 15% for caesarean section rates worldwide, taking into account poorer countries with higher risk populations that may necessitate higher caesarean delivery rates.[10]

Many studies support the WHO recommendation. Research demonstrates an inverse association between caesarean section rates and maternal and neonatal morbidity and mortality in low income countries, but also proves that caesarean section rates above a certain limit do not confer any additional benefit but may rather cause harm.[11]

The 15% suggested by the World Health Organisation in 1985 may be less valid today considering the changes in population dynamics. An ñoptimalò caesarean section rate may not exist but rather ñappropriateò rates for different populations. The appropriate rate should be defined through an outcome-based approach for individual countries and should be a rate that is associated with minimal adverse outcomes for mother and fetus.[7] The appropriate rate should also take into account various factors regarding the population concerned for example, general health, nutritional status and social security. Higher caesarean section rates may be more appropriate in impoverished countries, where a large proportion of the population have poor general health resulting in a greater proportion of high-risk pregnancies, which ultimately necessitates more caesarean sections.[12]

1.3 Caesarean section trends

Caesarean section rates are on the rise globally.[13] According to the World Health Report Background Paper, 18.5 million caesarean sections were performed worldwide in 2008, of which 6.20 million were ñmedically unnecessaryò.[7] Unnecessarily high rates of caesarean sections are not confined to the developed world. Developing countries have also demonstrated significant increases.

Although very unevenly distributed, the global caesarean section rate reached 25.7% in 2010 and the trend is steeply increasing.[14] The rates vary across different birth settings and are generally higher in developed countries. This steeply increasing trend reflects an increase in the primary caesarean rate together with a decline in the vaginal birth after caesarean section (VBAC) rate. Repeat caesarean section rates are as high as 91% in some settings.[8, 14]

The caesarean section rate in Africa is 3.5%, which is the lowest average rate worldwide. This ranges from 15.4% in South Africa to 0.4% in Chad. Latin America and the Caribbean have the highest rates of caesarean section with an average caesarean birth rate of 29.2%. The average caesarean section rate in Asia is 15.9%, with a range between 40.5% in China to just 1% in Nepal and Cambodia. In Europe the average rate of caesarean delivery is 19%, with the highest rate in Italy (36%) and the lowest in Moldova (6.2%).[8, 14]

The pattern of caesarean section follows the worldwide trend of unequal distribution of healthcare, with poor access in low income countries versus adequate to even excessive intervention in higher income countries.[8] Access to this life-saving obstetric surgery which is necessary to achieve low levels of maternal mortality varies substantially between and within countries and across different socio-economic groups. In many developed countries caesarean section rates are on the rise and attention is being focused on strategies to reduce the rate, whereas in the developing world lack of availability and access to essential maternal health services is an important factor contributing to the high maternal and perinatal mortality rates. These inequalities within countries are often masked by national caesarean section rates.[15]

1.4 Rising Rates of Caesarean Sections...Reasons.

Numerous studies have been conducted to determine the causes of the dramatic increase in the number of caesarean sections being performed. Various reasons have been cited which may be grouped into medical, socio-economic and physician-related factors.[12]

1.4.1 Socio-economic factors

a. Patient characteristics and demographic changes

A study conducted in Washington demonstrated that changes in population demographics like maternal age and parity may have accounted for an 18% increase in caesarean section rates[16, 17] Caesarean section increases with age and is shown to be 20% higher in nulliparous patients. The pattern of childbearing is shifting towards a greater proportion of elderly primigravid patients who may be more likely to require a caesarean section. Furthermore, women are not only delaying their first pregnancies but also limiting the number of pregnancies they have. These factors can account for some of the increases noted in caesarean deliveries.[18]

b. Patient preferences

Many women prefer caesarean delivery due to the belief that caesarean section is safer for the baby. At the same time, the increase in womenôs dissatisfaction with long labours as well as growing awareness about the possible adverse impact of vaginal delivery on urogynaecological and sexual function may reduce the threshold for caesarean section.[19] Also the care women want in labour may have changed from the common ñdemedicalisationò of childbirth in the 1980s to the increased desire for the most sophisticated medical technology in the twenty-first century.[19-21]

An article entitled ñToo Posh to Pushò appeared in tabloids in the United Kingdom many years ago, explaining the high caesarean section rate there to be due to: tocophobia (fear of labour & delivery), convenience, control & preservation of the pelvic floor. As more women enter the workforce, more control is being exerted in daily living and so an elective caesarean section with a specific date and time may be more acceptable to the woman concerned.[21]

c. Media Articles in leading journals support caesarean section on demand i.e.) offering women without medical indications the right to choose the mode of delivery. The Changing Childbirth Report also conveys womenôs right to be involved in decisions regarding mode of delivery. This may put further upward pressure on the already increasing caesarean section rate.[21-23]

1.4.2 Medical reasons

In the last 50 years, there has been an increasing medicalization of birth with a huge increase in the use of technologies to augment, accelerate, regulate & monitor labour. As highlighted previously, the enhanced safety of caesarean sections was associated with an increased usage of the procedure. Concurrent with increased safety & better maternal outcomes was an increasing expectation regarding fetal outcomes. With techniques for fetal monitoring advancing as well as the survival of very small infants, the fetus became the focus for improving obstetric care.

Three specific indications for caesarean section namely, fetal distress, dystocia and previous caesarean section account for most caesarean deliveries worldwide.

The use of electronic foetal monitoring which has a high false positive rate has been implicated as a reason for the increase in caesarean birth.[19, 23] Randomized control trials have been conducted comparing deliveries that have been monitored electronically with those

not monitored. Continuous fetal monitoring (CFM) during labour was associated with an increased incidence of caesarean section without improving neonatal outcomes.[16, 22]

Dystocia may be defined as abnormal progression of labour. In terms of primary caesarean delivery, dystocia is the single most important contributor to the increase in caesarean births.[14] Caesarean section may also be replacing operative vaginal delivery, for example high forceps delivery, in patients with abnormal labour progression.[16, 22]

Elective caesarean section in patients with a previous caesarean delivery has been a major contributor to the increase in caesarean section rate. The traditional belief ñonce a caesarean, always a caesareanò is still practiced by many.[16] In 2001, 91% of women with a previous caesarean section underwent repeat caesarean section. Risk of uterine rupture in subsequent pregnancies and concerns over medical malpractice issues are suggested to be responsible for the low Vaginal Birth After Caesarean Section (VBAC) rates.

There has also been a significant increase in the use of caesarean section for breech presentation following studies like the Term Breech Trial.[24] However, as breech presentation is uncommon, accounting for only 3-4% of all births, the overall contribution of caesarean section for breech presentation to the overall increase in caesarean section rate is minor. Also the increasing use of caesarean section as the delivery method of choice for breech presentation has resulted in difficulties for health care providers to acquire the skills for vaginal breech delivery.[16, 22]

1.4.3 Physician-related factors

Physician-related factors are important determinants of the caesarean section rate. These are factors resulting in physicians' preferences for caesarean section namely: fear of litigation; lower risk-taking and practice of ñdefensive medicineò. The threat of malpractice is an

important factor responsible for increasing caesarean birth rates. Defensive obstetrics is being practiced to avoid suboptimal outcomes and the subsequent risk of medico-legal action.

Financial incentives and convenience may also make physicians more likely to perform caesarean sections enabling them to schedule elective procedures resulting in more effective time management and less ñafter hoursò deliveries. Lack of skills for various procedures which may promote vaginal delivery like external cephalic version in the case of breech presentation, or assisted vaginal delivery may also promote high caesarean rates. The casual attitude of many physicians toward caesarean delivery with a false perception of safety and limited awareness of the possible harm also contributes to the increase in caesarean birth.[19, 22]

1.5 Indications for caesarean section

The clinical indications for caesarean section are important tools to determine why the rates of caesarean birth have changed. It is important to identify between an increasing incidence of a particular indication for caesarean section as opposed to an increase in the use of caesarean section as the intervention of choice for that indication.

Leitch et al compared the indications for caesarean section at the Glasgow Royal Maternity Hospital, a large teaching hospital, in the years 1962 and 1992. Although they demonstrated a significant increase in the caesarean section rate for all indications, the main indications for caesarean section were similar between the years, namely: failure to progress and fetal distress. However the largest increases were noted in the indications: previous caesarean section and malpresentation. The study concluded that the rise in caesarean delivery is due to a general lowering of the threshold for carrying out caesarean sections rather than changes in the management of labour.[25]

The ñBreakthrough Seriesò on caesarean section, which was organised in Norway, analysed approximately 3000 caesarean births. The most common indications for caesarean sections in this study were: fetal distress, prolonged labour, previous caesarean section, breech presentation and elective caesarean section by patient request.[26]

In South Africa, research conducted at private institutions, which cater to patients from middle to high socio-economic groups, demonstrates that 74.5% of caesarean sections are elective. Indications for elective caesareans sections are previous caesarean section, doctorôs choice and patientôs choice. The latter two indications represent new, non-classic indications. In contrast, at a state owned, tertiary teaching hospital in Durban, South Africa, fetal distress and CPD are the most common indications for caesarean section. This is followed by hypertension-related complications like eclampsia and intrauterine growth restriction.[27-29]

A systematic review of caesarean sections conducted between 1970 -2000 in sub-Saharan Africa indicated that 75% of caesarean sections were done for maternal rather than foetal indications. The 6 main indications for caesarean section were: protracted labour, antepartum haemorrhage due to placenta praevia and placental abruption, previous caesarean section, hypertensive disorders particularly eclampsia and malpresentation.[30]

The observed rise in caesarean delivery rates seems to be due to both an expansion of medical indications for caesarean section and liberalization of the threshold for these indications.[31]

1.6 Why is the Caesarean Section Rate Important?

Caesarean sections have a crucial life-saving role in modern day obstetrics and are safer than ever before. However, it remains a major surgical intervention that is not without risk. In many parts of the world, maternal and neonatal morbidity and mortality resulting from

caesarean sections remain a serious problem. Similarly, failure to perform a timely caesarean section may also carry a significant risk.

1.6.1 Implications of caesarean sections on maternal health:

a. Maternal Advantages

The most important long-term benefit of caesarean sections is potential protection of the pelvic floor. Fear of perineal trauma is often cited as the reason for maternal requests for caesarean section.

Vaginal delivery may be associated with an episiotomy or perineal tear which, if inadequately repaired, may cause dyspareunia. Other complications of episiotomies include haemorrhage and infection as well as the possibility of extension into the anal sphincter. Trauma to the pelvic floor, urethral and anal sphincters may subsequently result in pelvic organ prolapse, urinary and anal incontinence.[20, 32]

Elective caesarean section may prevent the above complications by avoiding the need for episiotomies, as well as the possibility of prolonged labour and instrumental delivery.[33]

A systematic review of 79 studies demonstrated that caesarean section was associated with reduced incidence of urinary incontinence and perineal pain three months postpartum when compared with vaginal delivery. Other studies also demonstrate an immediate protective effect but report that these effects dissipate by three months, suggesting that postpartum urinary incontinence is transient in nature.[34]

The evidence for the protective effects of caesarean section on pelvic floor function is incomplete. Many of the studies conducted are compromised by small numbers, lack of long-term follow-up and failure to consider the impact of other risk factors for pelvic floor dysfunction such as connective tissue disorders, lifestyle and family history. A population-

based survey conducted in Australia showed that pelvic floor disorders are associated with ageing, pregnancy and instrumental delivery, and that caesarean section is not associated with a reduction in pelvic floor disorders in the long-term.[20]

However, most observational studies continue to support the protective effects of caesarean delivery on the pelvic floor with maximal benefit for caesarean sections conducted before the onset of labour.

b. Maternal Disadvantages:

Caesarean sections have an overall complication rate of between 11-14 %.[35] The complications associated with caesarean delivery range from minor complications to major complications which include near-miss (to be discussed later) and even maternal mortality.

Short-term complications include intraoperative injury to the ureters, bladder and bowel, lacerations to the cervix, vagina and broad ligaments and haemorrhage caused by injury to blood vessels. Post-operatively, infection is the commonest complication and may range from endometritis to urinary tract and wound infection.[36] In the long-term, caesarean sections predispose to adhesion formation, bladder injury, placenta praevia and uterine rupture in subsequent pregnancies.[32]

Major complications of caesarean sections are post-partum haemorrhage, need for re-look laparotomy, sepsis and pulmonary embolism.[33, 35, 36] The risk of hysterectomy is 10 times greater after caesarean section compared to vaginal delivery and the relative risk of maternal mortality associated with caesarean section as opposed to vaginal delivery is 5:1.[37] Causes of death after caesarean section are similar for other types of abdominal surgery namely: haemorrhage, sepsis, pulmonary embolism and anaesthesia related complications.[36]

The psychological and emotional impact of caesarean delivery should not be underestimated. For many women, vaginal delivery is the cornerstone to the achievement of motherhood. Caesarean birth may thus be associated with feelings of inadequacy, guilt and failure.[32]

c. Near-miss or Severe Acute Maternal Morbidity (SAMM)

ñNear-missò and ñSevere Acute Maternal Morbidity (SAMM) are two terms often used interchangeably. They may be defined as: ña severe life-threatening obstetric complication necessitating an urgent medical intervention in order to prevent likely death of the motherò.[38] In other words, they refer to a woman who has organ failure during pregnancy, labour or the puerperium that could have resulted in death but did not.[39] The term ñnear-missò better reflects the concept of nearly dying but surviving and therefore, the World Health Organisation recommends the use of this term instead of SAMM.[38]

Traditionally, auditing maternal deaths was used to assess quality of care and identify potential opportunities for improvement in maternal health care. For each maternal death, there are large numbers of women that suffer severe illness or long-term disability. Women who survive life-threatening complications related to pregnancy have many similarities to women who die of these complications. Because they occur more frequently than maternal deaths, near-miss or SAMM cases therefore provide a supplementary maternal outcome measure and enable an understanding of the determinants of maternal mortality. They can therefore provide valuable information regarding the quality of obstetric care in a particular setting.[40-42]

Routine implementation of near-miss as a standard tool for evaluating the quality of obstetric care has been limited traditionally by the lack of a standard definition and uniform case-identification criteria.[40, 41] The World Health Organisation (WHO) conducted a systematic

review of the literature in 2004. This systematic review found a wide variation in the methods used to identify near-miss. Three different methods were identified, namely:[40]

1. Defining clinical or disease-specific criteria e.g. cyanosis or seizures.
2. Identifying organ dysfunction e.g. shock.
3. Intervention based criteria e.g. hysterectomy.

The WHO recognised the importance of developing a uniform set of identification criteria for near-miss cases in order to facilitate the use of near-miss reviews for monitoring and improving the quality of maternal health care. In 2007, the WHO established a working group of experts to examine the existing literature and produce a standard definition and identification criteria for maternal near-miss cases. A standard definition was developed, tested and validated. The WHO working group defined maternal near-miss as: ña woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancyò. [38,39, 40]

Similarly uniform identification criteria were developed. The criteria used to identify near miss are based on markers of organ dysfunction. This is shown in Appendix 1. The WHO has recognised that these markers are not part of the traditional, routinely collected information. Raising awareness and motivating health care professionals to contribute to the identification of near-miss cases is essential.[38, 39, 40,]

The WHO near-miss approach has been implemented and validated in numerous studies. The WHO Multicountry Survey on Maternal and Newborn Health (WHOMCS) is the largest study to date assessing the management of severe maternal complications and the prevalence of maternal near-miss. It was implemented in 359 hospitals from 29 countries located in the 5 WHO regions.[43] A multicentre cross-sectional study which was carried out in 27 referral maternity hospitals in Brazil, found the WHO criteria for maternal near-miss to be highly

associated with maternal death. Near-miss cases were accurately identified using the WHO near-miss approach. [44]

d. Caesarean sections and Near-miss

Caesarean sections are more commonly associated with near-miss when compared to vaginal deliveries. A study conducted in the Netherlands found that 19.3% of women who had experienced SAMM had a prior caesarean section, but more importantly 43.6% of these women had delivered via caesarean section in the index pregnancy.[45]

However, it is important to bear in mind that maternal morbidity and mortality after caesarean section is not always directly attributable to the procedure. The caesarean section may indeed save many lives. The intrinsic risk of caesarean sections may not be easy to separate from the medical and obstetric indications that lead to the procedure being performed.[36, 46, 47] Furthermore, the risks of caesarean section are also associated with surgical skill, quality of care from support staff e.g. nursing and anaesthesia and characteristics of the patient. This complicates attempts to define a mortality risk: benefit ratio for caesarean sections.[36]

The use of a randomised controlled trial to compare the benefits and harms of caesarean section compared to spontaneous vaginal delivery is prevented by ethical and practical constraints. Several large studies have been conducted in order to more accurately define the relationship between mode of delivery and maternal outcomes while taking into account confounding factors like maternal diseases.

The World Health Organisation Global Survey on Maternal and Perinatal Health (WHOGS) is a multi-country, facility-based survey with the aim of determining the rates of the different modes of delivery and examining the association between mode of delivery and maternal and

perinatal outcomes across 24 countries. It was conducted in three phases between the years 2004-2008 across three continents: America, Asia and Africa.

The third phase of the WHOGS, conducted in Asia, is one of the largest observational studies examining the risks and benefits associated with caesarean section. This study demonstrated that caesarean sections were associated with an increased risk of adverse maternal outcomes namely maternal death, hysterectomy, blood transfusion and ICU admission. Even though these adverse outcomes occurred with low frequency, they were still more common with caesarean section when compared to vaginal delivery.[46]

Similarly, the first phase of the WHOGS which was conducted in Latin America also demonstrated a positive association between caesarean section and severe acute maternal morbidity and mortality even after adjustment for demographic characteristics, risk factors and general medical and pregnancy associated complications.[9]

Souza et al merged the data from the three-continent analysis conducted by the WHOGS in order to study the association between mode of delivery and severe maternal and perinatal outcomes. In this study, severe maternal outcome was defined as the occurrence of any of the following: death, ICU admission, blood transfusion or hysterectomy within 7 days of delivery. The overall prevalence of severe maternal morbidity was 37 per 1000 deliveries. In addition, all other modes of delivery, besides spontaneous vaginal delivery, were associated with an increased risk of severe maternal morbidity. Also, it was found that this association was stronger in Africa as compared to Asia and Latin America.[48]

Similarly, Villar et al conducted a prospective cohort study within the WHOGS in Latin America in order to evaluate the benefits and risks of caesarean versus vaginal delivery. They concluded that both elective and intrapartum caesarean sections doubled the risk for SAMM even after adjustment for confounding factors.[49]

In an attempt to isolate maternal mortality due to caesarean delivery, Lilford et al conducted a study in South Africa between 1975 -1986. In this study an attempt was made to identify attributable risks of caesarean section compared with vaginal delivery by excluding patients with pre-existing medical or obstetric complications that may necessitate a caesarean section. They demonstrated that the risk of maternal mortality is five times greater for caesarean section compared to vaginal delivery. Intrapartum caesarean section is four times more likely to result in maternal mortality when compared to antepartum caesarean section.[37] Several other publications demonstrate congruent results in that caesarean sections are more commonly associated with near-miss when compared with vaginal delivery and that adverse outcomes occur more commonly with emergency rather than elective procedures.[50, 51]

It is thus evident that caesarean sections should only be conducted when they are medically indicated in order to improve maternal outcomes. Prophylactic caesarean sections should still be considered unjustifiable due to the considerable maternal morbidity and mortality that is associated with them. It is only when clear benefit is anticipated that a caesarean section may justify the additional risks.

1.6.2 Implications of caesarean section on fetal well-being

a. Perinatal Advantages

Elective caesarean section performed at 39 weeks of gestation may prevent several adverse neonatal outcomes. The risk of intrauterine fetal death after 39 weeks is approximately 2 in 1000 which could be prevented by elective caesarean section. Other adverse outcomes such as meconium aspiration and the need for neonatal intubation, which increase after 39 weeks, may also be prevented.[20]

Furthermore, in the event of poor progress during labour, women who attempt vaginal birth may be subjected to assisted delivery which is associated with intracranial injury to the fetus. By obviating the possibility of assisted delivery, caesarean section reduces the rates of intracranial and other birth injuries.[20]

The risk of mother-to-child transmission of various infections e.g. HIV, Hepatitis B and C and Human Papillomavirus may be minimised by caesarean delivery. However, with the introduction of anti-retroviral therapy to all HIV-infected pregnant women in the public health sector in South Africa, appropriate prevention of HIV transmission does not include elective caesarean section.[20]

Caesarean delivery cannot guarantee normality, but it can avoid problems associated with labour and prolonged pregnancy. However, these advantages do not support routine recommendation of caesarean section because the overall incidence of these adverse events is low and do not justify the risks that are associated with prophylactic caesarean section.

b. Perinatal disadvantages

Caesarean delivery rates of greater than 10% are not associated with any additional benefit for the baby but have been shown to increase neonatal morbidity and mortality**.** Morbidity and mortality in the neonatal period are largely due to respiratory and cerebral complications especially when associated with preterm birth.[49, 52]

Caesarean delivery before 39 weeks of gestation is associated with increased risk of neonatal pulmonary complications especially respiratory distress syndrome and transient tachypnoea of the new-born. This is thought to be due to the lack of mechanical compression of the fetal lungs during labour which is necessary for neonatal adaptation to life. Caesarean section is

also associated with reduced release of catecholamines and prostaglandins which may contribute to respiratory distress syndrome.[20, 52]

Fetal injuries including scalpel lacerations, brachial plexus palsy, fractures and blunt intra-abdominal injury are other potential complications of caesarean birth. Also the need for resuscitation at birth is more commonly associated with caesarean delivery.[32]

The WHOGS in Latin America and Asia demonstrated an association between caesarean delivery and adverse perinatal outcomes. These outcomes included admission to neonatal ICU (NICU), preterm delivery and neonatal death.[9, 46]

After reviewing approximately 97000 deliveries within the WHOGS, Villar et al concluded that both elective and intrapartum caesarean sections were associated with an increased risk of neonatal morbidity and mortality. Caesarean section almost doubled the risk of admission to NICU for 7 or more days. The preterm delivery rates were also higher in the caesarean groups. On the other hand, for breech presentation, caesarean birth was associated with a significant reduction in the risk of intrapartum fetal death.[49]

In a prospective survey, caesarean delivery was shown to double the risk of admission to NICU as well as the risks of pulmonary disorders already mentioned. No significant improvements were noted in neurological outcomes or Apgar scores which is often cited as a justification for elective caesarean section.[52]

From the above, it may be concluded that high caesarean delivery rates do not improve perinatal outcomes neither do they indicate good quality of care.

1.6.3 Socioeconomic Implications

Caesarean sections increase the cost of health care as compared to vaginal deliveries. This includes direct costs namely the use of theatre facilities, anaesthesia, human resources and

postoperative care as well as indirect costs: maternal and neonatal morbidity and mortality, implications on future pregnancies and future health of patients undergoing caesarean section.

Excessive, unnecessary caesarean sections may represent a burden to countries with health systems that need to function within a limited budget and it is therefore important to limit caesarean delivery to medical indications and avoid unnecessary use so that resources are not taken from other parts of the health system.[53]

1.7 Classification of caesarean sections

Rising caesarean sections rates have become a public health concern. The disparities in caesarean rates across various settings and the reasons for the increase in caesarean delivery are not well understood. Most obstetric facilities can report their caesarean delivery rates. However this information in isolation is of limited value. Obstetric facilities differ in terms of the characteristics of the patients they care for and the services they provide for instance tertiary referral hospitals versus primary health care clinics.

Systematic collection of further data, aside from the caesarean section rate, and the subsequent classification of caesarean sections is valuable to gain a better understanding of the underlying determinants of the caesarean birth rate.[54, 55]

Several caesarean section classification systems exist. These may be divided into 4 categories:

- Indication based classification systems

  These are the most common classification systems and are easy to implement but are not mutually exclusive, totally inclusive or reproducible.

- Urgency based classification systems

Caesarean deliveries are categorised according to the degree of urgency e.g. emergency, urgent, elective, peri-mortem. These type of classification systems are easy to understand and use but they are poorly reproducible and have limited utility in clinical practice.

- Woman-based classification systems

  Caesarean sections are classified according to the characteristics of the pregnancy and the patient. These classification systems are easy to use, mutually exclusive, totally inclusive and reproducible. The weakness of these systems however, is that the indications for the caesarean section and the degree of urgency are not included.

- Other systems

  Many of the classification systems that fall into this category are only theoretical and have never been tested in clinical practice.

A systematic review of the literature conducted by Torloni et al critically evaluated the various existing caesarean section classification systems. Although they noted that there exists no single ideal classification system for all settings, the study concluded that Woman-based classification systems, particularly the Robson Ten Group Classification System (TGCS), is optimally suited to fulfil current needs.[54]

The systematic review acknowledged that although the TGCS identified where the difference in caesarean section rates lay, it did not explain the reason for the differences. It was suggested that a hybrid model based on the woman-based classification systems be used with additional layers from other classification systems within the individual categories.[54]

1.7.1 The Robson Ten Group Classification System (TGCS)

In 2001, Robson proposed the Ten Group Classification System based on 4 key obstetric concepts: the category of the pregnancy, previous obstetric record, current course of labour and delivery and the gestational age as shown in Tables 1-4 of Appendix 2. These 4 concepts were then combined to create ten well-defined, clinically relevant groups which are described in Appendix 3.[55]

For many of the ten groups, further analysis is required in order to interpret the caesarean section rate in that particular group. It is for these reasons that Farine et al proposed a modification to the Robsonôs criteria in which the ten groups are further sub classified according to the course of labour. The resulting modified Robson classification assists to identify reasons for the variations in caesarean section rates within each of the ten groups.[56]

The Robson classification system provides a framework for auditing, analysing and monitoring caesarean sections. It gives an initial overview of caesarean birth rates, allows for comparisons of the caesarean section rate within a particular facility over time or between health facilities nationally, internationally and globally. Each of the ten groups may then be studied further which will enable identification of the determinants and implications of caesarean sections. The TGCS may thus be used to analyse the current trends in caesarean sections with the impetus to improve health care.[55, 57]

1.7.2 The Ten Group Classification System in Practice

The TGCS has already been shown to be useful in monitoring caesarean sections globally. It has been introduced in a number of institutions worldwide and incorporated into their respective audit processes in order to monitor trends in caesarean section over time.[58]

Application of TGCS in a variety of institutions across the world has yielded similar results with some significant differences. This includes studies done in Australia, Singapore, Brazil, Oman, Egypt and South Africa.[31, 57, 59-63] Larger studies include the application of the TGCS to a multi-country dataset of 97 095 women across 120 facilities in 8 different countries as part of the WHOGS in Latin America.[64] Also Brennan et al collated data from 9 obstetric facilities across 9 countries and classified the resulting study group consisting of 47 402 deliveries according to the TGCS. The countries involved in this study were Ireland, New Zealand, Australia, Canada, Belgium, Norway, Sweden, Iceland and the United Kingdom.[58]

In most general obstetric populations, as evidenced by the above research, group 5 makes the largest contribution to the caesarean section rate. Group 5 consists of pregnant women at term who have had at least one previous caesarean section. The size of group 5 also indicates the magnitude of caesarean delivery within a particular setting.

Group 1 and 3 are very important because they are usually the 2 largest groups in most obstetric populations. Group 1, which consists of nulliparous patients with term pregnancies in spontaneous labour, is traditionally a low risk population. Because this group accounts for a large proportion of the obstetric population, it makes a significant contribution to the caesarean delivery rate. In the research undertaken as described, group 1 is usually the second largest contributor to the caesarean section rate.

Group 3 is made up of multiparous patients with singleton pregnancies at term in spontaneous labour. These patients are usually of low risk and require standard management. Group 3 is the most consistent of the ten groups and the caesarean section rate in this group should not be higher than 1 -2%.[55] Auditing groups 1 and 3 is a useful tool for assessing how a maternity unit manages labour.

Group 2 is the third most significant contributor to the caesarean rate in most of the facilities analysed. This group is made up of nulliparous patients, with term pregnancies, who either had an induction of labour or a caesarean section before the onset of labour. Groups 2 and 4 have been subdivided into induction of labour and caesarean delivery before labour in the modified Robson classification. This provides useful information regarding the success of induction of labour in a particular facility.[56]

Groups 6-9 generally have high caesarean section rates which are anticipated due to the obstetric conditions in these groups. However, as the size of these groups is usually small, their contribution to the caesarean section rate is not significant.

Group 10 includes all preterm deliveries with a singleton cephalic presentation, irrespective of previous obstetric record. The contribution of this group to the caesarean section rate depends on the size of the group because management practices tend to be consistent in this group. Group 10 is cited as the reason for the high caesarean section rate at tertiary referral hospitals. In the study conducted at a University Hospital in Singapore, group 10 made the third largest contribution to the caesarean delivery rate.[60]

In South Africa, the TGCS was also applied to a dataset at Kalafong hospital in 2005 and compared to results from the National Maternity Hospital in Dublin, Ireland. Both Kalafong and Dublin identified group 5 as the major contributor to the caesarean delivery rate. However, in South Africa the caesarean section rate in group 5 was 85.2% which is very high compared to Ireland at 50.4%. This high caesarean rate seemed to be associated with an inability to offer adequate analgesia to labouring patients as well as the lack of proper monitoring for patients attempting VBAC.[31]

Groups 1 and 3 had demonstrated the lowest caesarean delivery rates but nevertheless the caesarean section rates in these groups were still much higher when compared to caesarean

rates in Dublin i.e. 15.1% and 8.3% compared to 7.3% and 1.1% respectively. The relatively high caesarean delivery rates in these traditionally low risk groups indicate that an improvement in the diagnosis of labour and monitoring during labour is required at Kalafong Hospital. Group 9 in contrast had a caesarean delivery rate of 30% at Kalafong compared to 100% in Dublin. This may suggest that obstetric skills in assessing the lie of the fetus may need improvement.[31]

Most of the research discussed above concluded that the TGCS was practical, easily applicable and allowed identification of specific groups of women as the main contributors to the caesarean section rate. The TGCS also assisted in the formulating and planning of interventions to improve maternal and perinatal health care.[58, 59]

1.8 Strategies for decreasing caesarean delivery rates

To decrease the caesarean delivery rate, a clear perception regarding the various contributing factors is critical. Caesarean sections have a self-perpetuating effect. The most common contributing factor to caesarean delivery is a prior caesarean section. Nulliparous patients are the next most important contributory group. Therefore, programs designed to reduce caesarean rates must address both primary and repeat caesarean sections.

Several countries have attempted to contain the use of this procedure using various strategies with varying degrees of success. Walker et al conducted a literature review on the success of strategies to reduce caesarean section rates between 1985 and 2001. Interventions that have been used in an attempt to reduce caesarean sections can be categorised into psychosocial, clinical and structural strategies. Structural strategies include education of local opinion leaders, development of practice guidelines and quality improvement strategies, midwifery care and financial incentives. Clinical and psychosocial strategies will be discussed below. Strategies that were effective in some settings were not beneficial in others. VBAC,

supportive care during labour and ECV were shown to have level 1 evidence for reducing the caesarean section rate.[65, 66]

1.8.1 Clinical and Psychosocial Strategies

a. Active management of labour

Active management of labour was developed for nulliparous patients with term, singleton, cephalic pregnancies. The basic premise is strict criteria for the management of labour and aggressive response to dystocia. The protocol includes appropriate diagnosis of labour, amniotomy, early recognition of dystocia and treatment with oxytocin. A meta-analysis of 18 studies found active management of labour resulted in a 34% reduction in caesarean delivery for dystocia amongst nulliparous patients. Other studies however, noted only a modest impact and found supportive care in labour to be more effective at reducing caesarean delivery.[67]

A randomised controlled trial conducted by Pattinson et al in Pretoria in South Africa at 2 hospitals: Pretoria Academic Hospital and Kalafong Hospital demonstrated that aggressive management of labour is associated with a significant reduction in caesarean delivery without impacting adversely on neonatal outcomes. However, aggressive management was noted to be more labour intensive and difficult to conduct in facilities where staffing shortages are a reality.[68]

b. Supportive care

A Cochrane review of 15 trials found that women who had one-to-one supportive care during labour were less likely to require analgesia, anaesthesia, caesarean or operative vaginal delivery.[65] Supportive care was also found to be more beneficial in settings where epidural analgesia was not routinely available. Brown et al conducted a pilot randomised, controlled

trial to promote childbirth companions in South African state hospitals. The study found that most women in South Africa are not allowed companions during labour. Despite a general willingness by the health care team to implement supportive care, introduction of birthing companions required a substantial level of organisation leading the authors to conclude that introduction of supportive care during labour is difficult especially in under resourced health systems.[69]

c. Induction of Labour

Induction of labour is associated with an increased risk of caesarean section in nulliparous women. Studies show that nulliparous patients who undergo elective induction of labour are 1.5 to 2.5 times more likely to deliver via caesarean section than women in spontaneous labour even when birth weight, maternal age and gestational age are controlled. In South Africa, ñfailed induction of labourò is a common indication for caesarean section. Induction of labour should therefore only be considered when the benefits of delivery outweigh potential maternal & fetal risks and policies and practices to reduce induction of labour should be put into place.[67, 70]

d. Encouraging Vaginal Birth after Caesarean Section (VBAC)

A meta-analysis of VBAC has provided level 1 evidence that VBAC is a safe alternative to repeat caesarean section for both mother and infant. The major risk of trial of labour is uterine rupture and haemorrhage and possible hysterectomy. The risk of uterine rupture is 1% but this can be reduced by careful patient selection.[65, 71, 72]

A systematic review of the literature from the year 2000 until 2007 assessed maternal morbidity after VBAC compared to elective caesarean section. VBAC was successful in 73% of patients and the outcomes of patients with successful VBAC were more favourable.

Maternal morbidity was similar in both groups of patients but uterine rupture or scar dehiscence was more common after failed VBAC.[71]

It may thus be concluded that the famous dictum, ñonce a caesarean, always a caesareanò be changed to ñonce a caesarean, a trial of labour should precede a second caesarean except in the most unusual circumstancesò.[16, 73]

e. External Cephalic Version (ECV)

Vaginal breech delivery is a contested issue since the initial results of The Term Breech trial were published in the year 2000. This trial showed that planned caesarean delivery is safer, for the fetus, than planned vaginal delivery at term. Elective caesareans section for breech presentation is therefore accepted practice at many institutions, including South African hospitals, with up to 80% of breech presentations delivered by caesarean section. This has resulted in a diminishing skill base for vaginal breech delivery.[70, 74]

External cephalic version is a well-researched intervention that demonstrates level 1 evidence to reduce the caesarean section rate in patients with breech presentation.[74]

f. Electronic Fetal Monitoring (EFM)

Fetal distress is a common indication for caesarean section. The use of continuous electronic fetal monitoring (EFM) during labour to detect fetal distress is widespread. In South Africa, cardiotocography (CTG) is the predominant method for fetal monitoring during labour, even in low-risk patients. However EFM without fetal blood pH sampling has been shown to increase caesarean delivery rates without improving maternal or perinatal outcomes. Ideally low-risk patients should be monitored by intermittent auscultation of the fetal heart or intermittent doptone. EFM should only be carried out in carefully selected patients with high risk for perinatal mortality.[70]

In order to make a significant impact on caesarean delivery rates, multiple strategies which address various aspects contributing to caesarean section rates are required. Most importantly the culture of promoting vaginal delivery needs to be instilled in all members of health care team, patients, families and communities at large.

1.9 A South African perspective

The WHOGS in Africa noted marked inter-country differences in caesarean section rates in sub-Saharan Africa.[75] Caesarean delivery rates ranged from between 5 -21.8% with significant socio-economic differences. Elective caesarean sections were uncommon and maternal indications were most often the reason for caesarean delivery. A similar situation exists in the public health system in South Africa.

In South Africa, health care is delivered through public and private sectors. A gross dichotomy exists between the two with obvious social and economic disparities in access to healthcare. The public health system delivers health care to about 80% of the population and is stretched and under resourced. On the other hand, the private health sector is utilised by members of the population who can afford to pay for these services and are mainly members of private medical aid schemes.[76]A similar pattern is emerging in South Africa as in the rest of the world, in that the private health sector has a much higher caesarean section rate compared to their publicly funded counterparts.

The World Health Report (2010) Background Paper, cites an overall caesarean section rate of 20.6% in South Africa for the year 2008, which includes caesarean sections done in private and public hospitals.[7] However, there is a wide variation in caesarean delivery rates between facilities as well as provinces. In terms of the public health sector, in 2011/2012, the national average for district hospitals was 18.4%, 29% in regional hospitals and as high as 37% for tertiary hospitals. This ranges from as low as 3.2% in some settings to 32.5% in others.

Rates as high as 40.7% have been quoted in specialist maternity hospitals. On the other hand, the private health sector rates have been cited at 57%. It may therefore be appreciated from the above figures that national caesarean delivery rates are often misleading and may mask inequalities in access to health care and unequal allocation of resources.[76, 77]

In the public health sector in South Africa, vaginal deliveries are carried out at a network of various primary health care clinics with minimal intervention. Medium and high-risk patients are referred to secondary and tertiary hospitals as appropriate. Caesarean sections are performed at every hospital level in the public sector. Primary caesarean sections are not carried out upon request. Even patients who require elective caesarean sections may wait many days for the procedure. HIV infection is not an indication for caesarean section. The private health sector, on the contrary, is well equipped and offers caesarean sections on demand.[78]

The South African National Committee on Confidential Enquiries into Maternal Deaths (NCCEMD) was established in 1997. The committee publishes triennial Saving Mothers Reports. Despite a high average caesarean section rate, the maternal mortality ratio in South Africa is 176/100 000 live births as compared to just 17/100 000 in the United States.[55, 79]

According to the recent Saving Mothers Report, obstetric haemorrhage has overtaken hypertensive disorders and is now the commonest cause of direct maternal deaths in South Africa. Amongst the 688 maternal deaths, bleeding at or after caesarean section, was the commonest cause accounting for 26.2% of deaths due to obstetric haemorrhage. Of these deaths, 80.1% were probably or, at least, possibly avoidable. They occurred as a result of inadequate post-operative monitoring, failure to recognise PPH timeously, lack of appropriate re-look laparotomy, and inappropriate management of uterine atony.[79]

This has prompted the NCCEMD to release an ñAlert on Maternal Deaths due to Obstetric Haemorrhageò which focuses on particular aspects in order to reduce maternal mortality from haemorrhage. These include: health facility requirements for safe caesarean delivery, surgical technique, postoperative care as well as algorithms for managing bleeding.[80, 81]

Due to the massive problem of haemorrhage at caesarean section in South Africa, high caesarean section rates represent a burden to the already struggling public health system, without improving maternal mortality. The high caesarean section rate may also function as a barrier to necessary health services and therefore affect health equity within the country. Reducing caesarean delivery rates is an important strategy to reduce maternal mortality.

Action therefore needs to be taken to offer timely, safe caesarean sections to women in need and advocate for rational use of caesarean sections in institutions with excessive use of this procedure.

2. Problem Statement

Caesarean section is a vital tool in modern day obstetrics and although it is often life-saving, each caesarean delivery represents a risk to both mother and new-born.

This has prompted the WHO, in 1985, to provide recommendations regarding caesarean delivery rates. National caesarean section rates in South Africa are acceptable according to the World Health Organisation. However the burden of maternal mortality in South Africa remains unacceptably high.[6]

The triennial Saving Mothers Reports published by the National Committee for Confidential Enquiries into Maternal deaths (NCCEMD) has identified obstetric haemorrhage, particularly at caesarean section, as an important preventable cause of maternal death. This has led the NCCEMD to release an ñAlert on Maternal Deaths due to Obstetric Haemorrhageò which includes recommendations to prevent haemorrhage-related maternal deaths in South Africa. One of the recommendations is that strict indications for caesarean section are followed.[80, 81]

In most of the developed world, caesarean section is a relatively safe mode of delivery. However, in the South African setting, with the unacceptably high rates of maternal mortality, minimising caesarean delivery is an essential strategy to reduce maternal mortality.

The caesarean section rate at CHBAH is in excess of 30%. With the view to advocating ñSafe Motherhoodò in South Africa, this study aims to identify the common indications for caesarean section at CHBAH. This may stimulate debate as to whether these indications for caesarean delivery are valid as well as aid discussion into potential strategies to reduce the caesarean section rate for these indications. The study also aims to audit morbidity and mortality arising from caesarean delivery.

3. Aims and Objectives

3.1 Aims:

This study aims to identify the common indications for caesarean section at CHBAH as well as audit the maternal morbidity and mortality arising from caesarean delivery. The above findings will aid identification of strategies to reduce caesarean section rates.

3.2 Objectives:

1. To determine the caesarean section rate at Chris Hani Baragwanath Academic Hospital.
2. To classify the caesarean sections done according to the Robson Ten Group Classification System.
3. To determine the most common indications for caesarean section at Chris Hani Baragwanath Academic Hospital.
4. To describe severe acute maternal morbidity associated with caesarean section within 48 hours.

4. Methods

Study design

This was a prospective, observational study carried out over a two month period.

Setting

Chris Hani Baragwanath Academic Hospital is a tertiary hospital located south of Johannesburg, in the Gauteng Province. The largest proportion of the South African population, approximately 11.9 million people, resides in Gauteng. The province has a 22.3% unemployment rate and almost a quarter of households are informal dwellings. The hospital services 2 million people, mainly of low-income, and the maternity unit delivers in excess of 23 000 babies each year.

Most of the patients are high-risk and are referred by midwife managed obstetric units (MOU). However about 20% of patients are low-risk, self-referrals.

The maternity department at Chris Hani Baragwanath Academic Hospital is staffed by midwives, intern doctors, medical officers, registrars and specialists. The labour ward has 20 beds. There is an area for patients that are in early labour, which compromises 16 beds as well as an admission ward. The department is also equipped with a 7 bed High Care Area (HCA) which has one ventilator. There are 2 operating theatres for obstetrics which are available 24 hours a day. The maternity department is well-supported by a tertiary level neonatal unit. A blood bank is located on the premises.

Study population

All patients with viable pregnancies (i.e. Ó24 weeks gestation) who delivered at Chris Hani Baragwanath Academic Hospital via caesarean section during a fixed period of two months,

July and August 2013, were included in this study. Fetuses less than 500 grams or 24 weeks gestation were excluded as these are considered non-viable in our setting.

Inclusion criteria

All women with viable pregnancies (Ó24 weeks gestation) who delivered at Chris Hani Baragwanath Academic Hospital by caesarean section were included in the study.

Exclusion criteria

Patients that had spontaneous or assisted vaginal deliveries were not included in this study. Non-viable pregnancies (< 24 weeks gestation) and patients who presented already delivered i.e. born before arrival (BBA) were excluded.

Sample size

The study intended to include approximately 500 participants. Approximately 500 caesarean sections are performed at Chris Hani Baragwanath Academic Hospital each month. A sample size of 500 patients was chosen due to the expected period of the study as well as the historical numbers of caesarean sections done at CHBAH. The researcher sampled patients every alternate day over a two month period to ensure that there was no overlap of patients. The study was therefore intended to be conducted over 2 months but 500 participants were obtained by 7 weeks and therefore data collection was stopped at that point.

Data collection

Before proceeding, necessary permission was obtained from the hospital, as well as the relevant ethics and research committees. The researcher collected data from the post-caesarean section wards every alternate day. The researcher also collected data from the high care and intensive care areas. Once informed consent was obtained, patientôs case files were

perused. Demographic, obstetric and delivery outcome data of women who have delivered by caesarean section was collected and captured onto a data sheet (Appendix 4) and then transferred to a computer database for analysis. In the case of patients who were unable to give informed consent, e.g. patients admitted to ICU, consent was obtained from the next of kin. In the case of minors, parental consent was obtained. Patients were followed up for a period of two days after caesarean section in order to identify SAMM. In addition to patient-specific data, the researcher determined the total number of caesarean sections and vaginal deliveries during the study period by examining the theatre and labour ward registers respectively. In this way the caesarean section rate was determined.

Data Analysis

The data was captured on a data sheet and then tabulated into a Microsoft Excel spread sheet. The data was then exported for analysis into Stata 11 statistical software package. Results were calculated at the end of the period. Continuous data was described using means ± standard deviation. Categorical data is reported in terms of frequencies and percentages with a 95% confidence interval. Data was also categorised according to the Robson Ten Group Classification System (as shown in Appendix 3).

Ethics Approval

Ethics approval was obtained from The University of the Witwatersrand Health Science Research Ethics committee (HREC), approval number M130521, attached as Appendix 5.

5. Results

There were 3898 deliveries during the two month period. There were 1534 caesarean sections resulting in a caesarean delivery rate of 39.4%.

A total of 533 caesarean sections were performed on the data collection days. However, 6 patients were excluded. Four patients declined participation in the study, 1 patient refused hospital treatment post-caesarean section and was therefore lost to follow-up and in one case involving a minor, the parents could not be contacted to obtain informed consent. Finally 527 participants were included in the study.

Table 1: **Age range in years:**

Age	Number of women (N= 527)	Percentage
Ò19	52	9.9
20 ï 24	143	27.1
25 ï 29	152	28.8
30 ï 34	100	19.0
35 ï 39	59	11.2
40 ï 44	20	3.8
45 ï 49	1	0.2

The youngest patient in the study population was 14 years old and the oldest patient was 47 years old. The mean age of women in the study was 27.4 years (SD ± 6.45). The most frequent age in years was 24. Most patients (56.0%) were between the ages of 20 to 29 years. The teenage pregnancy rate in this population was 9.9%.

Table 2: Frequency distribution of parity before delivery of patients who had caesarean sections at CHBAH

Parity	Number of patients (N= 527)	Percentage
0	183	34.7
1	174	33.0
2	115	21.8
3	36	6.8
4	12	2.3
5	3	0.6
6	3	0.6
7	1	0.2

In this study, 34.7% of patients were nulliparous. The mean parity was 1.1 (SD ± 1.2). The highest parity was 7. The mean gravidity was 2.4 (SD ± 1.3).

Table 3: Gestational age, at time of delivery, in weeks:

Gestational age	Frequency (N= 527)	Percentage
24 ï 36	131	24.9
37 ï 40	313	59.4
41-42	82	15.6
>42	1	0.19

The gestational age was determined by one of the following: last normal menstrual period (LNMP), early ultrasound (Ò24 weeks), late ultrasound (> 24 weeks) or first palpation. In

this study population, 225 (42.7%) patients expressed certainty about the LNMP and 117 (22.2%) patients had an early ultrasound.

The mean gestational age was 37.5 weeks (SD ± 3.4). The most frequent gestational age was 38 weeks. There were 131 (24.9%) preterm deliveries (< 37 weeks) and 83(15.8%) patients were postdates (Ó41 weeks). The shortest gestational period was 24 weeks and the longest pregnancy was 43 weeks.

Table 4: Classification of categories of the pregnancies:

Number of foetuses	**Frequency (N = 527)**	**Percentage**
Single cephalic pregnancy	467	88.6
Single breech pregnancy	27	5.1
Single oblique or transverse lie	9	1.7
Multiple pregnancy	24	4.6

Breech presentation occurred in 5.1% of singleton pregnancies and 1.7% of patients had an abnormal lie. There were 24 patients with twin pregnancies in the study population. There was no triplet or other higher order pregnancies. In terms of multiple pregnancies, data was analysed using the presentation of the leading twin. There were 8 twin pregnancies with breech presentation and one abnormal lie.

Table 5: Previous obstetric history

Number of previous caesarean sections	Frequency (N= 527)	Percentage
0	362	68.7
1	123	23.3
2	37	7.0
3	5	1.0

One hundred and sixty-five patients (31.3%) had previous caesarean sections. Of the patients with previous caesarean sections, 74.5% had one previous caesarean section.

Table 6: Total number of comorbidities:

Comorbid disease	Frequency	Percentage
Hypertension	102	19.4
Imminent Eclampsia	6	1.1
Eclampsia	9	1.7
HELLP syndrome	8	1.5
Abruptio Placentae	4	0.8
Diabetes Mellitus	14	2.7
Epilepsy	3	0.6
Asthma	3	0.6
Anaemia	5	0.1
Other Comorbidities	12	2.3
No Comorbid disease	406	77.0

One hundred and twenty-one (23.0%) patients had comorbid disease. Hypertension was the most frequently occurring comorbid disease occurring in 19.4% of patients. Eight patients had intrauterine fetal deaths due to various causes. Other comorbidities found in the study population include stroke, venous thromboembolic disease, myasthenia gravis, poliomyelitis, cardiac disease, ruptured appendicitis and spinal muscular atrophy.

Table 7: Labour and delivery data resulting in caesarean section:

Labour	Frequency (N =527)	Percentage
Spontaneous Labour	321	60.9
Elective Caesarean Section	62	11.8
Induced Labour	54	10.2
Emergency Caesarean Section Before Labour	90	17.1

The majority of patients (60.9%) underwent emergency caesarean section after the onset of spontaneous labour. Sixty-two patients had an elective caesarean section. Fifty-four patients who had induced labour required caesarean delivery.

Table 8: Indications for caesarean section:

Indication for Caesarean Section	Frequency (N=527)	Percentage
Fetal Distress	236	44.8
Dystocia	67	12.7
Failed Vacuum Delivery	2	0.4
Previous Caesarean Section x 1	50	9.5
Failed Vaginal Birth After Caesarean Section (VBAC)	32	6.1
Previous Caesarean Section x 2	36	6.8
Previous Caesarean Section x 3	5	0.9
Breech Presentation	19	3.6
Other Presentation (includes Oblique, Transverse Lie)	8	1.5
Multiple Pregnancy	22	4.2
Failed Induction Of Labour	5	0.9
Chorioamnionitis	6	1.1
HELLP syndrome	7	1.3
Eclampsia	9	1.7
Fetal Abnormalities	5	0.9
Antepartum Haemorrhage	12	2.3
Cord Prolapse	1	0.2
Grand Multiparity	2	0.4
Ruptured Uterus	1	0.2
Poor Obstetric History	2	0.4

Upon analysis of indications for caesarean section, there were patients with more than one indication for caesarean birth. In this instance, the indication chosen was the one that most urgently required caesarean delivery. Fetal distress accounted for 44.8% of caesarean sections. A history of a previous caesarean section was the second most common indication for caesarean delivery. This includes caesarean sections done for one, two and three previous caesareans, failed vaginal birth after caesarean section (VBAC), as well as patients who presented in labour but requested caesarean section. Dystocia was the third commonest indication for caesarean section and included patients with the indications: cephalopelvic disproportion (CPD), failed augmentation of labour and poor progress. Antepartum Haemorrhage (APH) accounted for 2.3% of the indications for caesarean section. This includes APH due to placental abruption, placenta praevia as well as antepartum haemorrhage of unknown origin.

Robson's Ten Group Classification System

Table 9: The distribution of caesarean deliveries across the Robson's Ten Groups:

Robson's Category	Frequency (N= 527)	Percentage
1	89	16.9
2	44	8.3
3	84	15.9
4	42	8.0
5	125	23.7
6	9	1.7
7	18	3.4
8	24	4.6
9	9	1.7
10	83	15.8

Table 10 shows the total number of caesarean deliveries distributed across the Robsonôs Ten Groups as well as the contribution of each group to the overall caesarean section rate. It can be appreciated that group 5, which consists of multiparous patients with at least one previous caesarean section and singleton cephalic pregnancies at term, is the largest contributor to the overall caesarean section rate. This is then followed by groups 1 and 3.

Group 1 and 3 consists of nulliparous and multiparous patients respectively with singleton, cephalic pregnancies at Ó37 weeks in spontaneous labour. Group 3 does not include women with previous caesarean sections. Both groups 1 and 3 generally represent uncomplicated labour and are the largest groups in most obstetric populations.

Group 10 also makes a significant contribution to the caesarean section rate. This group consists of patients with singleton cephalic pregnancies at Ò36 weeks and includes patients with previous caesarean sections.

Further analysis of each group:

Table 10: Indications for caesarean section in Robson's groups 1 - 4:

Indication	Group 1	Group 2	Group 3	Group 4	Total
Fetal Distress	52 (58.4%)	33 (75%)	60 (71.4%)	30 (71.4%)	175 (67.6%)
Dystocia	32 (36%)	9 (20.5%)	21 (25%)	2 (4.8%)	64 (24.7%)
Failed Vacuum Delivery	2 (2.2%)	0	0	0	2 (0.8%)
Chorioamnionitis	3 (3.4%)	0	0	0	3 (1.2%)
Failed Induction of Labour	0	1 (2.3%)	0	4 (9.5%)	5 (1.9%)
Antepartum Haemorrhage	0	0	2 (2.4%)	1 (2.4%)	3 (1.2%)
Uterine Rupture	0	0	0	1 (2.4%)	1 (0.4%)
Poor Obstetric History	0	0	0	2 (4.8%)	2 (0.8%)
Grand Multiparity	0	0	0	2 (4.8%)	2 (0.8%)
Fetal Reasons	0	1 (2.3%)	1 (1.2%)	0	2 (0.8%)
Total (N=259)	89 (34.4%)	44 (17%)	84 (32.4%)	42 (16.2%)	259 (100%)
Contribution to Caesarean Section Rate	16.9	8.3%	15.9%	8.0%	49.1%

Groups 1 and 2 consist of nulliparous patients with singleton cephalic pregnancies at Ó37 weeks, whereas groups 3 and 4 consist of multiparous patients with similar characteristics. The difference between the groups is that the patients in groups 1 and 3 are in spontaneous labour, while those in groups 2 and 4 undergo induction of labour or caesarean section before the onset of labour.

In this study, group 1 was the second largest contributor to the caesarean section rate followed by group 3. Amongst the 44 patients in group 2, 27 patients had an induction of labour and the remaining 17 patients had a caesarean section before the onset of labour. In group 4, 24 patients underwent induction of labour while 18 patients had a caesarean delivery before the onset of spontaneous labour.

Fetal distress was the most common indication for caesarean sections in all 4 groups followed by dystocia. Failed induction of labour was diagnosed after the patient failed to initiate labour after 2 cycles of induction.

There were also 2 caesarean sections for poor obstetric history. Both patients had previous intrauterine fetal deaths at term. Due to the lack of facilities for continuous electronic fetal monitoring throughout induction of labour, elective caesarean section were performed. The category ñfetal reasonsò constitutes 2 caesarean sections that were conducted upon maternal request for anencephaly and hydrocephalus.

Group 5

Group 5 represents all patients with singleton, cephalic pregnancies at Ó37 weeks with at least one previous caesarean delivery.

Group 5 made the largest contribution to the caesarean section rate accounting for 23.7% of caesarean sections performed with 125 patients in this group. Seventy-three patients were in

spontaneous labour and 52 patients underwent caesarean section before labour. None of the patients in group 5 had an induction of labour as per hospital protocol.

Of the 125 patients in this group, 94 patients had one previous caesarean section, 27 patients had two previous caesarean sections and 4 patients had three previous caesarean sections. . Ten patients with two previous caesarean sections and 2 patients with three previous caesarean sections presented in spontaneous labour.

Table 11: Indications for caesarean section in patients with one previous caesarean section.

Indication	Absolute Number	Percentage
Patient request	33	35.1
Failed VBAC	24	25.5
Fetal distress	22	23.4
Other	15	16.0
Total	94	100

The commonest indication for caesarean section in patients with one previous caesarean delivery was patient request (35.1%). Eight of these patients presented in spontaneous labour and declined vaginal delivery. Twenty-four patients (25.5%) with a previous caesarean section attempted vaginal delivery but were unsuccessful. Fetal distress was the indication for caesarean section in 22 patients in group 5.

Fifteen caesarean sections were done for other reasons. One caesarean section was undertaken electively for a patient with spinal muscular atrophy. Another was performed for a patient with a previous classical uterine incision who presented in labour. Delivery was

necessary in 2 patients for postdates, 1 for prolonged pre-labour rupture of membranes, 2 for fetal reasons namely intrauterine fetal death and oligohydramnios and 7 patients required delivery due to hypertension and associated complications.

Groups 6, 7, 8 & 9

All these groups include women with previous caesarean section.

Groups 6 and 7 represent all nulliparous and multiparous patients with breech presentations, irrespective of gestation. Group 6 and 7 made up 1.7% and 3.4% of caesarean sections performed. There were 9 patients in group 6. Six of these patients presented in spontaneous labour and 2 patients underwent caesarean section prior to labour. There was one induction of labour in group 6. This was undertaken as the patient in question had HELLP syndrome and an intrauterine fetal death requiring urgent delivery at 27 weeks of gestation.

Group 7 consisted of 18 patients, 12 patients presented in labour and 6 underwent elective caesarean section before the onset of labour.

Group 8 consists of multiple pregnancies irrespective of gestational age or parity. There were 24 twin pregnancies and no higher order pregnancies in this study population. Of the 24 patients in group 8, 19 were in spontaneous labour. Seven patients had previous caesarean sections. Six patients underwent caesarean section due to breech presentation of first twin. There was one caesarean section for twin to twin transfusion syndrome.

Group 9 consists of patients with singleton pregnancies with an abnormal lie irrespective of gestational age. There were 9 patients in this group which contributed 1.7% to the caesarean section rate. Eight patients were in spontaneous labour and one patient had an elective caesarean section before labour. Three patients (33.3%) presented in preterm labour.

Group 10

Table 12: Indications for caesarean section in group 10:

Indication	Absolute number	Percentage
Fetal distress	39	47.0
Dystocia	3	3.6
Previous caesarean section x 1	10	12.0
Previous caesarean section x 2	4	4.8
Previous caesarean section x 3	1	1.2
Eclampsia	7	8.4
HELLP syndrome	5	6.0
Antepartum haemorrhage	8	9.6
Chorioamnionitis	3	3.6
Fetal reasons	3	3.6
Total	83	99.8

Group 10 consists of patients with singleton, cephalic pregnancies at Ò36 weeks gestation. This group includes nulliparous and multiparous patients as well as patients with previous caesarean sections. Forty-four patients had comorbid diseases in this category (53.0%).

Near-miss

Table 13: Near-miss

Near-miss	Frequency	Percentage
ICU admission	8	1.5
Blood Transfusion	5	1.0
Surgical Intervention	1	0.2
Intubated & Ventilated	8	1.5

There was one maternal death (0.2%) and twelve near-miss cases (2.3%) were identified. The near-miss ratio was 24.7 cases per 1000 deliveries.

The mean age of the patients with a near-miss was 26.8 years. The mean gestational age at the time of delivery was 32.1 weeks and 61.5% (8/13) of patients had a preterm delivery (Ò 36 weeks). Four patients (30.8%) had a previous caesarean delivery.

Eight patients were admitted to ICU. The remaining patients were admitted to HCA due to shortage of ICU beds. Eleven patients had pre-existing comorbid disease (84.6%). The most common comorbidity was hypertension and its related complications (81.8%).

Five patients had caesarean sections for eclampsia. These patients required intubation and ventilation for various reasons namely: metabolic acidosis, cardiac arrest due to magnesium sulphate toxicity and intractable seizures with associated aspiration pneumonia.

Five patients had primary postpartum haemorrhage requiring blood transfusion. Three of these patients underwent caesarean sections for abruptio placentae one of whom required intubation and ventilation. The fourth patient had 2 previous caesarean sections and

presented in spontaneous labour. She developed PPH due to uterine atony after an emergency caesarean section and required a total abdominal hysterectomy. The fifth patient developed PPH as a result of uterine rupture due to a previous classical caesarean section.

The remaining two patients required ventilation in ICU post caesarean section. One patient was known with rheumatic heart disease and developed a lower respiratory tract infection and the other patient suffered a cardiac arrest in theatre while undergoing caesarean section for fetal distress. The cardiac arrest was presumed to be anaesthetic related.

The maternal death occurred in a patient with spinal muscular atrophy III and one previous caesarean section who underwent an elective caesarean section and was admitted to ICU postoperatively for monitoring. She was extubated in theatre. However, she developed a pulmonary embolus on day 1 post caesarean section and demised in ICU.

6. Discussion

6.1 Caesarean section rate

The caesarean section rate is an important indicator of access to essential obstetric care. Similar to the global phenomenon of escalating caesarean delivery, there is concern that caesarean birth rates are increasing in the public health sector in South Africa.

In the current study the caesarean section rate was 39.4% at CHBAH. However, this is not the true caesarean delivery rate as it is not reflective of the population studied. CHBAH receives referrals from numerous MOUs and primary health care clinics in the area. Therefore the true caesarean section rate would need to take into account the number of live vaginal births occurring at these referral centres. However, the caesarean delivery rate of 39.4% is consistent with published data citing national rates of caesarean section of approximately 37% at tertiary centres in 2011/2012. The national average caesarean birth rates are in fact much lower as discussed.[76, 77]

The caesarean section rate, on its own, is an insufficient indicator of health care and is determined by maternal and fetal well-being. As CHBAH is a tertiary referral centre which manages high-risk pregnancies, the 15% suggested by the WHO may be less realistic in our setting.[7, 12, 55]

6.2 Indications for caesarean section

Caesarean sections have important long-term implications for women of reproductive age yet they remain a common surgical procedure. It is therefore important to determine the reasons for caesarean section at an institutional level which provides data about the management of labour and delivery in a particular facility.[74]

Demographic and history of index pregnancy

The average age of women undergoing caesarean section at CHBAH was 27.4 years. Similar to data from other countries, the majority of caesarean sections were performed in the 20-29 year age group which represents the most reproductively active group.[63] In addition most patients (34.7%) who had a caesarean delivery were nulliparous. Caesarean sections in these women may have future implications on health care by increasing the number of women with scarred uteri thereby potentially increasing future caesarean delivery rates.[32]

Indications for caesarean sections in the study

The 3 main clinical indications for caesarean section in this study were fetal distress (44.8%), previous caesarean section (23.3%) and dystocia (12.7%).

These results are not dissimilar to research undertaken in the public health sector in South Africa and across the world in which fetal distress, dystocia, previous caesarean section and breech presentation made up the majority of indications for caesarean section.[25, 26, 29, 74] However, the results are different to studies conducted at private institutions in South Africa where 74.5% of caesarean sections are for maternal request.[27, 28]

a. Fetal distress:

Although fetal distress is a frequent indication for caesarean section worldwide, the rates of fetal distress are significantly higher in South Africa. At CHBAH, fetal distress is the most common indication for caesarean section accounting for 44.8% of caesarean deliveries compared to 9.1% in the United Kingdom.[28] This stark difference can be attributed to the method of diagnosis of fetal distress. At CHBAH, electronic fetal monitoring is used to diagnose fetal distress. Randomised controlled trials have demonstrated that electronic fetal monitoring results in higher caesarean delivery rates without improving neonatal outcomes.

According to the World Health Organisation, the fetal heart rate should be monitored by intermittent auscultation during the first stage of labour and this should be done more frequently during the second stage. EFM should be used in carefully selected patients e.g. patients undergoing induction of labour.[6] The protocol at CHBAH is consistent with the WHO recommendations. However, due to the risk profile of the patients managed at this referral facility, the majority of patients have electronic fetal monitoring during labour.[82] Improving fetal monitoring during labour may potentially reduce the caesarean delivery rate.

b. Previous caesarean section:

The results of this study emphasise the self-perpetuating effect of caesarean sections. Previous caesarean section was responsible for 23.3% of caesarean sections performed in our study. The practice of elective repeat caesarean section has been difficult to dispel and has been cited as being a major factor in the increase in caesarean deliveries worldwide.[16] Previous caesarean deliveries and its role in the caesarean section rate will be addressed later.

c. Dystocia*:*

Dystocia was the indication for caesarean section in 12.7% of patients. Nulliparous patients have a greater risk of dystocia as evidenced in the above study where 61.2% of caesarean sections for dystocia were performed in nulliparous patients. Of concern is the fact that dystocia was the indication for caesarean delivery in 25% of multiparous women in spontaneous labour when it well known that dystocia is relatively uncommon in parous patients. The diagnosis and standard management of labour in these patients may require review as this is traditionally a low-risk group.[16, 55]Dystocia may also be targeted as an indication to reduce caesarean section rates. Skilled pelvic examination to exclude CPD, the use of the partogram to monitor and manage labour, judicious administration of oxytocin to augment labour, as well as the presence of a trained labour companion may reduce caesarean

sections for dystocia.[7-9, 28] As discussed previously, the presence of a supportive companion during labour not only shortens labour duration but also reduces the likelihood of emergency caesarean delivery. Current policy at Chris Hani Baragwanath Academic Hospital does not allow for the presence of a companion in labour and this may be a strategy to consider in reducing caesarean section rates, as well as improving patient satisfaction.

d. HIV:

The impact of HIV infection on caesarean sections at CHBAH should not be underestimated. Although, HIV infection, on its own, is not an indication for caesarean section in our setting, it may influence an individualôs decision with regard to repeat caesarean delivery. HIV infection may also have a substantial impact on caesarean sections for dystocia. Artificial rupture of membranes which is an effective technique in the induction and augmentation of labour is avoided in HIV-infected patients where imminent delivery cannot be guaranteed due to the higher risk of perinatal transmission. This may increase the number of caesarean sections performed for failure to progress or dystocia.[7, 8, 82]

e. Other*:*

Other common indications for caesarean section, in particular hypertensive complications and antepartum haemorrhage, further allude to the possibility that the caesarean section rate at CHBAH may be appropriate due to the high risk profile of the patients that are managed at this institution.

The analysis of the indications for caesarean section at CHBAH has suggested important areas of focus for research for example; it may prove useful to evaluate the efficacy of caesarean delivery for particular indications. The findings also suggest the need to put into

place clinical protocols for common indications for caesareans section to ensure caesarean sections are conducted when appropriate and to enhance clinical effectiveness.

6.3 The Robson Ten Group Classification System: Analysis

This study used the Robson Ten Group Classification System to highlight the particular subgroups of women who make the most significant contributions to the caesarean section rate within the study setting.

The high caesarean section rate in our institution is attributed to the women with previous caesarean deliveries at term (group 5) and nulliparous patients in spontaneous labour at Ó37 weeks (group 1). Groups 3 and 10 are also responsible for a significant amount caesarean sections performed in this population. Similar findings were reported in previous studies with the exception of group 3 which is usually associated with a low rate of caesarean birth.[31, 55, 60]

Data from Kalafong Hospital, also in the Gauteng Province in South Africa, demonstrated high caesarean section rates in groups 1, 3 and 5. The Baltimore Group on Caesarean Section suggested that the high rates of caesarean delivery in these groups could be attributed to poor pain relief in labour. It was also suggested that an improvement in the diagnosis and routine management of labour is required.[31]

The previous caesarean section group (group 5) and primigravid groups (groups 1 & 2) accounted for almost half (48.9%) of caesarean sections performed. This is in keeping with other institutions where these groups account for 50% of caesarean sections.[58, 62]

The contribution of the primary caesarean section rate to the overall caesarean rate by single, cephalic, term pregnancies namely groups 1, 2, 3 & 4 was 49.1% in this study which

correlates with other research from centres across the globe where the primary caesarean rate was approaching 50%.[58, 62]

6.3.1 Analysis of Each group

a. Groups 1 and 2 (nulliparous, singleton, cephalic pregnancy ≥ 37 weeks in spontaneous labour and on induction of labour or caesarean section before the onset of labour).

Nulliparous patients at term made up a quarter (25.2%) of caesarean sections (groups 1 and 2). In most studies conducted using the TGCS, groups 1 and 2 were the second and third largest contributors to the caesarean section rate.

Group 1 is the most important group in any obstetric population because it has the most variation in terms of management and outcomes. In both groups 1 and 2 fetal distress and dystocia were the commonest indications for caesarean section. Research shows that almost 99% of the variation in the caesarean delivery rate can be explained by the caesarean section rate in groups 1 and 2. Research also indicates that a reduction in induction of labour in nulliparous patients (group 2) is associated with a reduction in the caesarean rate. Non-medicalization, especially in the first pregnancy is therefore an important strategy in reducing the caesarean section rate.[55, 57-59]

b. Group 3: (multiparous patients without a previous caesarean section who enter labour spontaneously at term).

This group usually constitutes the largest proportion of the obstetric population as has been discussed in the literature review.[55, 64]

In the current study, group 3 was the third largest contributor to the caesarean rate accounting for 15.9% of cases performed. Fetal distress and dystocia were the indications for caesarean section in 96.4% of patients in this group. Therefore the large contribution to the caesarean

section rate made by this group could be because of the large number of patients in this group in the general obstetric population or because caesarean sections are being unnecessarily performed, for example over-diagnosis of fetal distress or mismanagement of the active stage of labour

c. Group 5 (previous caesarean section, singleton, cephalic pregnancy ≥ 37 weeks).

Group 5, on its own, is the largest contributor to the caesarean section rate accounting for almost a quarter (23.7%) of caesarean sections performed. This is consistent with institutions around the world.[55, 57-59]

As per protocol at Chris Hani Baragwanath Hospital, only patients with one previous lower segment caesarean section are eligible for VBAC. These patients are offered a choice of mode of delivery, if suitable for VBAC, after comprehensive antenatal counselling. Patients who opt for elective repeat caesarean section may present in labour and are booked for emergency caesarean section but may deliver vaginally while awaiting caesarean section.

In the current study there were 125 patients in group 5. Ninety-four (75.2%) of these patients had one previous caesarean section. Fetal distress and failed VBAC was responsible for the majority of caesarean sections in patients with one previous caesarean delivery (57.4%).

Group 5 contributes most significantly to the caesarean section rate, as discussed in the literature review. VBAC should be encouraged in patients with a single low transverse caesarean scar.[65, 71, 72] The large number of patients with failed VBAC in this study is of concern.

The Baltimore Group on Caesarean Sections suggests that the high rates of caesarean delivery in patients with a previous caesarean section in South Africa appear to be due to poor pain control in labour.[31] At Chris Hani Baragwanath Academic Hospital, opiates

(pethidine) are predominantly used for analgesia in labour. Epidural analgesia is limited by human resources. Appropriate analgesia should be prioritised in these patients and the presence of a doula (labour companion) should be advocated.

d. Groups 6-9 (deliveries complicated by breech presentation, abnormal lie and multiple pregnancies).

Although the caesarean rates in these groups may be high, the groups account for a small proportion of the obstetric population and therefore their contribution to the caesarean section rate is low. For instance, group 9 was only responsible for 1.7% of caesarean sections in the current study but a 100% caesarean delivery rate within the group is expected. Almost all studies internationally showed comparable results in these groups.[62, 64]

External cephalic version is an important clinical procedure to reduce the caesarean section rate in this population and is encouraged from 36 weeks gestation unless contraindications exist as per hospital protocol.[16, 22, 24, 82] HIV infection may again have an impact on caesarean sections in this category because in our setting, external cephalic version is contraindicated in HIV-infected patients who are not on anti-retroviral therapy.

Interventions to reduce caesarean delivery rates in groups 6-9 may result in only a modest impact on the overall caesarean birth rate due to the small size of these groups in the general population.[55]

e. Group 10 (patients with single, cephalic pregnancies at ≤ 36 weeks).

This group includes patients with previous caesarean section. Group 10 was the 4th largest contributor to the caesarean section rate at CHBAH (15.8%). Similar results were noted at a tertiary university hospital in Singapore.[61]. Of interest, in our study, 53.0% of patients in group 10 had comorbid disease. There were an additional 7 (8.4%) caesarean sections for

fetal complications such as abnormal liquor volumes and abnormal umbilical artery Doppler studies etc. Due to the vast range of maternal and fetal complications in group 10, it may be difficult to safely reduce the caesarean section rate in this group.[55, 60]

Application of the TGCS enabled a detailed analysis of the caesarean sections conducted at CHBAH. The TGCS with additional data regarding indications for caesarean delivery provided detailed information about the delivery unit. Stratification of caesarean deliveries using the TGCS also provided baseline data from which further analysis can be undertaken. It is anticipated that the results will aid in the development of initiatives to reduce the caesarean section rates in the largest groups.

6.4 Near-miss

The near-miss ratio was 24.7 cases per 1000 deliveries. This ratio falls within the wide range of near-miss ratios quoted in the literature of between 0.7 - 119.9 cases per 1000 deliveries.[41] It is important to bear in mind that the near-miss ratio is influenced by the definition of near-miss used.

The rate of comorbid disease amongst patients that experienced near-miss was 84.6% and most (61.5%) patients required a preterm delivery due to comorbid disease. Hypertension was the most commonly occurring comorbidity (69.2%). These results are supported by findings at a tertiary centre in Brazil where women with near-miss were found to have an earlier interruption of the pregnancy and a higher caesarean section rate when compared to other patients. In addition, 46% of women with near-miss had a significant comorbid disease most commonly pre-eclampsia.[41] The WHOGS in Africa, found that pre-eclampsia was a significant risk factor for maternal mortality as well as neonatal morbidity and mortality.[75]

An important finding in this study is the low complication rate associated with caesarean delivery at CHBAH. This is in contrast to the Saving Mothers Report in which 26.2% of maternal deaths were due to bleeding at or after caesarean delivery.[79] This low complication rate indicates the high level of skill that is available at CHBAH. In terms of near-miss, the caesarean section was rarely causative (n=3; 23.1%). In most cases, morbidity was due to the indication for caesarean delivery rather than to the operation itself. There were 3 cases in which the caesarean section could be considered contributory to the near-miss:

a) Primary PPH requiring peri-partum hysterectomy following a caesarean section performed in a patient with two previous caesarean sections.
b) Primary PPH due to emergency caesarean section for a ruptured uterus in a patient with a previous classical uterine incision.
c) Cardiac arrest in a patient requiring caesarean section due to fetal distress which was considered to be due to anaesthetic related complications.

Interestingly both patients, whose morbidity was directly related to caesarean section, had a previous caesarean delivery. This highlights the significant impact of repeat caesarean delivery on maternal morbidity.

The above results demonstrate that pre-eclampsia and postpartum haemorrhage are the most important initiating factors of near-miss occurring in 76.9% of patients. These findings are not dissimilar to other studies conducted in South Africa and around the world with regard to near-miss. A prospective multicentre 2 year audit of near-misses in 3 cities in South Africa revealed that the most common initiating conditions of near-miss were hypertension, haemorrhage, abortion and puerperal sepsis.[39] Similarly, PPH, abortion, pre-existing maternal disease and non-pregnancy related infections were responsible for most cases of near-miss in another study in South Africa.[42]

Evaluating near-miss in addition to maternal mortality significantly increased the amount of cases identified in this study. This provided valuable information about the disease profile of the population as well as major obstetric complications experienced.

We may conclude that caesarean delivery may be a marker for serious existing comorbid disease, which are associated with increased mortality and morbidity, rather than a risk itself. Often urgent delivery is required in these patients and vaginal delivery may prove difficult. High caesarean section rates may therefore be acceptable in these patients. Severe comorbid disease may therefore actually be a determinant for near-miss as well as a determinant of the caesarean section rate.

6.5 Future Research

Future research into alternative methods of fetal monitoring for high-risk patients and its effect on the caesarean section rate should be considered. Research should also evaluate near-miss on an intention to treat basis.

7. Limitations of the study

The high rate of caesarean delivery observed in this study cannot be directly extrapolated to the whole country or region because the study population is not representative of South Africa as a whole. Rather, it reflects the situation in tertiary institutions which typically cater to patients with a high-risk profile.

In terms of The Robson Ten Group Classification System, one of the major limitations of this study was failure to analyse spontaneous and operative vaginal deliveries. By including patients who delivered vaginally in this study, valuable information could have been gained regarding the size of each group in the population as well as the caesarean delivery rate within each group. Future studies at CHBAH should assess vaginal deliveries as well as calculate the proportion of patients undergoing caesarean section for each category.

With regard to the analysis of near-miss, a limitation of this study is that data was restricted to morbidity that occurred in hospital for a period of 48 hours after caesarean section. As a result some outcomes may have been underestimated and the Severe Acute Maternal Morbidity that occurs in the population cannot be inferred. A causal relationship between caesarean delivery and near-miss cannot be established due to the design of the current study. An ideal study design would compare near-miss in patients undergoing elective caesarean section with those undergoing planned vaginal delivery.

Coexisting HIV infection was not included in this study. HIV infection may have a substantial impact on caesarean delivery rates as well as Severe Acute Maternal Morbidity.

Confounding by indication was not avoidable in this study. Identifying complications caused by the procedure itself versus those caused by the conditions that required caesarean delivery

was challenging. The health status of the patients in this study may have been a determinant for caesarean delivery as well as a determinant of the health outcomes.

8. Strengths of the study

This study has several strengths. Data was collected prospectively and by a single researcher which meant consistency in collection and interpretation of data. Unlike other studies using the Robsonôs TGCS, our study analysed the ten groups in conjunction with the clinical indications for caesarean delivery which enabled a clearer understanding of the characteristics of patients undergoing caesarean birth as well as the reasons for surgery. Finally, the results of our study are in agreement with those observed both locally and internationally, which further elucidates the areas where improvement can be made in lowering the caesarean birth rate.

9. Conclusion

Defining an optimal caesarean delivery rate in our setting may not be realistic due to the wide range in the health status of patients. The World Health Organisations recommendations of 15% for caesarean delivery rates globally may need to be adapted to take into account the patient profile and morbidity in South Africa.

Improving access to quality medical services rather than focusing on the mode of delivery should be our primary concern. What matters most is that women who require caesarean section should receive one timeously and under optimal conditions. Those who do not require caesarean delivery, should receive appropriate care and support during labour. Not only will this improve patient satisfaction, but will also minimise maternal and perinatal morbidity and mortality

The caesarean section rate cannot be preordained as it is determined by the health status of patients as well as subjective clinical decisions. Ensuring equal access to good quality,

medically appropriate obstetric care should be our primary concern. We should not pursue a statistical ideal.

In the meanwhile we may conclude that to achieve optimal outcomes we should ñLet everyone practise the best obstetrics they know, and let the caesarean sections rate seek its own levelò.[83]

10. References

1. Cronjé HS, Cilliers JBF, Pretorius MS (Eds.). Clinical Obstetrics a South African perspective. 3rd ed. Pretoria: Van Schaik Publishers; 2011.
2. Sarris I, Bewley S, Agnihotri S (Eds.). Training in obstetrics and gynaecology the essential curriculum. New Work: Oxford University Press; 2009.
3. Zink, Christoph (Ed.). Dictionary of Obstetrics and Gynecology. Berlin, Boston: De Gruyter, 1988.
4. Lurie S. The changing motives of caesarean section: from ancient world to the twenty-first century. Arch Gynecol Obstet 2005; 271: 281-285.
5. Todman D. A history of caesarean section: from ancient world to the modern era. Aust N Z J Obstet Gynaecol 2007; 47: 357-361.
6. World Health Organisation. Appropriate technology for birth. Lancet 1985; 2(8452): 436-7.
7. Gibbons L, Belizán JM, Lauer JA, Betrán AP, Merialdi M, Althabe F. The global numbers and costs of additionally needed and unnecessary caesarean sections performed per year: overuse as a barrier to universal coverage. In World Health Report 2010 Background Paper, No 30. Edited by: World Health Organisation. Geneva.
8. Betrán AP, Merialdi M, Lauer JA, Bing-Shun W, Thomas J, Van Look P, et al. Rates of caesarean section: analysis of global, regional and national estimates. Paediatr Perinat Epidemiol 2007; 21(2): 98-113.
9. Villar J, Valladares E, Wojdyla D, Zavaleta N, Shah A, Campodónico L, et al. Caesarean delivery rates and pregnancy outcomes: the 2005 WHO global survey on maternal and perinatal health in Latin America. Lancet 2006; 367(9525): 1819-29.
10. Althabe F, Sosa C, Belizán JM, Gibbons L, Jacquerioz F, Bergel E. Caesarean section rates and maternal and neonatal mortality in low-, medium-, and high-income countries: An ecological study. Birth 2006; 33(4): 270-277.
11. Gibbons L, Belizan JM, Lauer JA, Betrán AP, Merialdi M, Althabe F. Inequalities in the use of caesarean section deliveries in the world. Am J Obstet Gynecol 2012; 206 (4): 331.
12. Pai M. Unnecessary medical interventions: caesarean sections as a case study. Economic and Political Weekly 2000; 35: 2755-61.
13. FC Notzon, PJ Placek, SM Taffel. Comparison of national caesarean section rates. N Engl J Med 1987; 316: 386-389.
14. Niino Y. The increasing cesarean rate globally and what we can do about it. Biosci Trends 2011; 5(4): 139-150.
15. Ronsmans C, Holtz S, Stanton C. Socioeconomic differentials in caesarean rates in developing countries: a retrospective analysis. Lancet 2006; 368: 1516-23.
16. Porreco RP, Thorp JA. The caesarean birth epidemic: trends, causes, solutions. Am J Obstet Gynecol 1996; 175: 369-74.
17. Parrish KM, Holt VL, Easterling TR, Connell FA, LoGerfo JP. Effect of changes in maternal age, parity, and birth weight distribution on primary caesarean delivery rates. JAMA 1994; 271: 443-47.
18. Thomas J, Callwood A, Brocklehurst P, Walker J. The national sentinel caesarean section audit. Br J Obstet Gynaecol 2000; 107(5): 579-80.
19. Kaimal AJ, Kuppermann M. Decision making for primary caesarean delivery: the role of patient and provider preferences. Seminars in Perinatology 2012; 36(5): 384-89.

20. Minkoff H, Chervenak FA. Elective primary caesarean delivery. N Engl J Med 2003; 348: 946-50.
21. Anderson GM. Making sense of rising caesarean section rates: time to change our goals. BMJ 2004; 329(7468): 696-97.
22. Placek PJ, Taffel SM. Trends in caesarean section rates for the United States, 1970-78. Public Health Reports 1974; 95(6): 540-48.
23. Department of Health. Changing Childbirth: The report of the expert maternity group. London: HSMO, 1993.
24. Haanah ME, Haanah WJ, Hewson SA, Hodnett ED, Saigal S, Willan AR. Planned caesarean section versus planned vaginal birth for breech presentation at term: A randomized multicentre trial. Lancet 2000; 356: 1375- 1382.
25. Leitch CR, Walker JJ. The rise in caesarean section rate: the same indications but a lower threshold. Br J Obstet Gynaecol 1998; 105(6): 621-6.
26. Häger R, Øian P, Nilsen ST, Holm HA, Berg AB. The breakthrough series on caesarean section. Tidsskr Nor Laegeforen 2006; 126(2): 173-5.
27. Tshibangu KC, de Jongh MA, de Villiers DJ, du Toit JJ, Shah SMH. Incidence and outcome of caesarean section in the private sector- 3-year experience at Pretoria Gynaecological Hospital. S Afr Med J 2002; 92(12): 956-9.
28. Naidoo N, Moodley J. Rising rates of caesarean sections: an audit of caesarean sections in a specialist private practice. SA Fam Pract 2009; 51(3): 254-8.
29. Moodliar M, Moodley J. Complications following caesarean delivery at King Edward VIII hospital, Durban, South Africa. Obstetrics & Gynaecology Forum 2004; 14(3): 21-26.
30. Dumont A, de Bernis L, Bouvier-olle MH, Bréart G. Caesarean section rate for maternal indication in sub-Saharan Africa: a systematic review. Lancet 2001; 358: 1328-334.
31. Stanton, C., Ronsmans, C. and the Baltimore Group on Cesarean. Recommendations for Routine Reporting on Indications for Cesarean Delivery in Developing Countries. Birth 2008; 35: 204ï 211.
32. Sultan AH, Stanton SL. Preserving the pelvic floor and perineum during childbirth-elective caesarean section? Br J Obstet Gynaecol 1996; 103(8): 731-34.
33. Amu O, Rajendran S, Bolaji II. Maternal choice alone should not determine method of delivery. BMJ 1998; 317(7156): 463-5.
34. Belizán JM, Althabe F, Cafferata ML. Health consequences of the increasing caesarean section rates. Epidemiology 2007; 18(4): 485-6.
35. Snyman L. Is the high caesarean section rate a cause for concern? Obstet Gynaecol Forum 2002; 12(2): 8-13.
36. Petitti DB. Maternal mortality and morbidity in caesarean section. Clin Obstet Gynecol 1985; 28(4): 763-69.
37. Lilford RJ, Van Coeverden De Groot HA, Moore PJ, Bingham P. The relative risks of caesarean section (intrapartum and elective) and vaginal delivery: a detailed analysis to exclude the effects of medical disorders and other acute pre-existing physiological disturbances. Br J Obstet Gynaecol 1990; 97: 883-92.
38. Say L, Souza JP, Pattinson RC. Maternal near miss- towards a standard tool for monitoring quality of maternal health care. Best Pract Res Clin Obstet Gynaecol 2009; 23: 287-296.
39. Mantel GD, Buchmann E, Rees H, Pattinson RC. Severe acute maternal morbidity: a pilot study of a definition for a near-miss. Br J Obstet Gynaecol 1998; 105: 985-990.

40. Souza JP, Gülmezoglu AM, Carroli G, Lumbiganon P, Qureshi Z. The World Health Organisation multicountry survey on maternal and newborn health: study protocol. BMC Health Serv Res 2011; 11: 286.
41. Souza JP, Cecatti JG, Parpinelli MA, Serruya SJ, Amaral E. Appropriate criteria for identification of near-miss maternal morbidity in tertiary care facilities: a cross sectional study. BMC Pregnancy and Childbirth 2007; 7: 20.
42. Cochet L, Pattinson RC, Macdonald AP. Severe acute maternal morbidity and maternal death audit -a rapid diagnostic tool for evaluating maternal care. SAMJ 2003; 93(9): 700.
43. Souza JP, Gülmezoglu AM, Vogel JV, Carroli G, Lumbiganon P, Qureshi Z et al. Moving beyond essential interventions for reduction of maternal mortality (the WHO Multicountry Survey on Maternal and Newborn Health): a cross-sectional study. Lancet 2013; 381: 1747-55.
44. Souza JP, Cecatti JG, Haddad SM, Parpinelli MA, Costa MA, Katz L et al. The WHO Maternal Near-Miss Approach and the Maternal Severity Index Model (MSI): Tools for Assessing the Management of Severe Maternal Morbidity. PLoS ONE 2012; 7(8): e44129.
45. van Roosmalen J, Zwart J. Severe acute maternal morbidity in high-income countries. Best practice & Research Clin Obstet Gynecol 2009; 23: 297-304.
46. Lumbiganon P, Laopaiboon M, Gülmezoglu AM, Souza JP, Taneepanichskul S, Ruyan P, et al. Method of delivery and pregnancy outcomes in Asia: the WHO global survey on maternal and perinatal health 2007-08. Lancet 2010; 375: 490-99.
47. Clark SL, Belfort MA, Dildy GA, Herbst MA, Meyers JA, Hankins GD. Maternal death in the 21st century: causes, prevention, and relationship to caesarean delivery. Am J Obstet Gynecol 2008; 199(1): 36.e1-36.e5.
48. Souza JP, Gülmezoglu AM, Lumbiganon P, Laopaiboon M, Carroli G, Fawole B, et al. Caesarean section without medical indications is associated with an increased risk of adverse short-term maternal outcomes: the 2004-2008 WHO Global Survey on Maternal and Perinatal Health. BMC Medicine 2010; 8: 71.
49. Villar J, Carroli G, Zavaleta N, Donner A, Wojdyla D, Faundes A, et al. Maternal and neonatal individual risks and benefits associated with caesarean delivery: multicentre prospective study. BMJ 2007; 335: 1025-29.
50. National Collaborating Centre for Womenôs and Childrenôs Health. Commissioned by the National Institute for Clinical Excellence. Caesarean Section Clinical Guideline. April 2004.
51. Pallasmaa N, Ekblad U, Gissler M. Severe maternal morbidity and the mode of delivery. Acta Obstet Gynecol Scand 2008; 87: 662-68.
52. Kolas T, Saugstad OD, Daltveit AK, Nilsen ST, Øian P. Planned caesarean versus planned vaginal delivery at term: Comparison of newborn infant outcomes. Am J Obstet Gynecol 2006; 195(6): 1538-43.
53. Shearer EL. Cesarean section: medical benefits and costs. Soc Sci Med 1993; 37: 1223-31.
54. Torloni MR, Betrán AP, Souza JP, Widmer M, Allen T, Gulmezoglu M, et al. Classifications for caesarean section: a systematic review. PLoS ONE 2011; 6(1): e14566.
55. Robson MS. Can we reduce the caesarean section rate? Best Practice and Research Clinical Obstetrics & Gynaecology 2001; 15(1): 179-194.
56. Farine D, Shepherd D. Classification of caesarean sections in Canada: the Modified Robson Criteria. J Obstet Gynaecol Can 2012; 34(10): 976-79.

57. Slavin V, Fenwick J. Use of a classification tool to determine groups of women that contribute to the caesarean section rate: establishing a baseline for clinical decision making and quality improvement. International Journal of Childbirth 2012; 2(2): 85-94.
58. Brennan DJ, Robson MS, Murphy M, O'Herlihy C. Comparative analysis of international caesarean delivery rates using 10-group classification identifies significant variation in spontaneous labour. Am J Obstet Gynecol 2009; 201: 308.e1-8.
59. Stavrou EP, Ford JB, Shand AW, Morris JM, Roberts CL. Epidemiology and trends for caesarean section births in New South Wales, Australia: A population-based study. BMC Pregnancy and Childbirth 2011; 11:8.
60. Chong C, Su LL, Biswas A. Changing trends of caesarean section births by the Robson Ten Group Classification in a tertiary teaching hospital. Acta Obstet Gynecol Scand 2012; 91: 1422-27.
61. Costa ML, Cecatti JG, Souza JP, Milanez HM, Gülmezoglu MA. Using a caesarean section classification system based on characteristics of the population as a way of monitoring obstetric practice. Reprod Health 2010; 7: 13.
62. Kazmi T, Sarva Saiseema V, Khan S. Analysis of caesarean section rate- according to Robson's 10-group classification. Oman Med J 2012; 27(5): 415-7.
63. Ebrashy AE, Kassab A, Nada A, Saleh WF, Soliman A. Caesarean section in a university and general tertiary hospitals in Cairo; Egypt: rates, indications and limits. KAJOG 2011; 2(1): 20-26.
64. Betrán AP, Gulmezoglu AM, Robson M, Merialdi M, Souza JP, Wojdyla D et al. WHO global survey on maternal and perinatal health in Latin America: classifying caesarean sections. Reprod Health 2009; 6: 18.
65. Walker R, Turnbull D, Wilkinson C. Strategies to address global caesarean section rates: A review of the evidence. Birth 2002; 29(1): 28-39.
66. Sachs BP, Kobelin C, Castro MA, Frigoletto F. The risks of lowering the caesarean delivery rate. N Engl J Med 1999; 340(1): 54-7.
67. Lowe NK. A review of factors associated with dystocia and caesarean section in nulliparous women. Journal of Midwifery & Women's Health 2007; 52: 216-28.
68. Pattinson RC, Howarth GR, Mdluli W, Macdonald AP, Makin JD, Funk M. Aggressive or expectant management of labour: a randomised clinical trial. BJOG 2003; 110: 457-61.
69. Brown H, Hofmeyr JG, Nikodem CV, Smith H, Garner P. Promoting childbirth companions in South Africa: a randomised pilot study. BMC Medicine 2007; 5: 7
70. Moran NF. Avoiding unnecessary caesarean sections: a key strategy for reducing obstetric haemorrhage deaths. O&G Forum 2013; 23: 21-6.
71. Rossi CA, D'Addario V. Maternal Morbidity following a trial of labor after caesarean section vs elective repeat caesarean delivery: a systematic review with metaanalysis. Am J Obstet Gynecol 2008; 199(3): 224-31.
72. McMahon MJ, Luther ER, Bowes WA, Olshan AF. Comparison of a trial of labour with an elective second caesarean section. N Engl J Med 1996; 335: 689-95.
73. Paul RH, Miller DA. Caesarean birth: How to reduce the rate. Am J Obstet Gynecol 1995; 172: 1903-11.
74. Anderson GM, Lomas J. Determinants of the increasing caesarean birth rate-Ontario Data 1979 to 1982. N Engl J Med 1984; 311: 887-92.
75. Shah A, Fawole B, M'Imunya JM, Amokrane F, Nafiou I, Wolomby JJ, et al. Cesarean delivery outcomes from the WHO global survey on maternal and perinatal health in Africa. Int J Gynaecol Obstet 2009; 107(3): 191-7.

76. Ataguba JE, McIntyre D. Paying for and receiving benefits from health services in South Africa: is the health system equitable? Health Policy and Planning 2012; 27: 135-145.
77. Hogan M, Foreman KJ, Naghavi M, Ahn SY, Wang M, Makela SM. Maternal Mortality for 181 countries, 1980-2008: a systematic analysis of progress towards Millennium Development Goal 5. Lancet 2010; 375 (9726): 1609-1623.
78. Childbirth in South Africa. Available at: http://www.birthways.co.za/inspired.php Accessed 8 February 2013.
79. National Committee for Confidential Enquiry into Maternal Deaths. Saving Mothers 2008-2010. Fifth Report on the Confidential Enquiries into Maternal Deaths in South Africa. Pretoria: National Department of Health; 2012.
80. Fawcus S, Moodley J. Haemorrhage associated with caesarean section in South Africa: be aware. S Afr Med J 2011; 101(5): 306-9.
81. Moran NF. Avoiding unnecessary caesarean sections: a key Strategy for reducing obstetric haemorrhage deaths. O&G Forum 2013; 23: 21-26.
82. Buchmann EJ (Ed.). Guidelines for the Department of Obstetrics and Gynaecology at Chris Hani Baragwanath Hospital. 3rd ed, Department of Obstetrics and Gynaecology, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand; 2007.
83. Cyr RM. Myth of the ideal caesarean section rate: Commentary and historic perspective. Am J Obstet Gynecol 2006; 194:932-6.

11. Appendix

Appendix 1: The WHO maternal near-miss criteria.

Organ Dysfunction	Identification Criteria
Cardiovascular Dysfunction	• Shock • Use of continuous vasoactive drugs • Cardiac arrest • Cardio-pulmonary resuscitation • Sever hypoperfusion (lactate > 5mmol/L) • Sever acidosis (pH < 7.1)
Respiratory Dysfunction	• Acute cyanosis • Gasping • Severe tachypnoea (respiratory rate > 40bpm) • Severe bradypnoea (respiratory rate< 6bpm) • Severe hypoxemia (PAO2/FIO2 , 200 or SaO2 < 90% for Ó60 min) • Intubation and ventilation not related to anaesthesia
Renal Dysfunction	• Oliguria non-responsive to fluids/ diuretics • Dialysis for acute renal failure • Sever acute azotaemia (creatinine Ó 300µmol/L)
Coagulation/ Haematologic Dysfunction	• Failure to form clots • Massive transfusion of blood or red cells (Ó5 units) • Severe acute thrombocytopenia (< 50 000 platelets/ml)
Hepatic Dysfunction	• Jaundice in the presence of pre-eclampsia. • Sever acute hyperbilirubinaemia (bilirubin >100µmol/L)
Neurologic Dysfunction	• Prolonged unconsciousness (lasting Ó12 hours)/ coma (including metabolic coma) • Stroke • Status epilepticus/ uncontrollable fits • Total paralysis
Uterine Dysfunction	• Haemorrhage or infection leading to hysterectomy

Appendix 2: The Four Key Obstetric Concepts which form the basis for the Robson TGCS

Table 1:

The Category of the Pregnancy
Single cephalic pregnancy
Single breech pregnancy
Single oblique or transverse lie
Multiple pregnancy

Table 2:

Previous Obstetric Record
Nulliparous
Multiparous (without a uterine scar)
Multiparous (with a uterine scar)

Table 3:

Current Course of Labour and Delivery
Spontaneous labour
Induced labour
Caesarean section before labour

Table 4:

Gestational Age
The gestational age in completed weeks at the time of delivery

Appendix 3: The Robson Ten Group Classification System

	The Robson Ten Group Classification System
1	**Nulliparous, single, cephalic, ≥ 37 weeks, in spontaneous labour.**
2	**Nulliparous, single, cephalic, ≥ 37 weeks, induced or caesarean section before labour.**
3	**Multiparous, single, cephalic, ≥ 37 weeks, in spontaneous labour.**
4	**Multiparous, single, cephalic, ≥ 37 weeks, induced or caesarean section before labour.**
5	**Previous caesarean section, single, cephalic, ≥ 37 weeks.**
6	**All nulliparous, single, breech presentation.**
7	**All multiparous, single, breech presentation, including previous caesarean section.**
8	**All multiple pregnancies, including previous caesarean section.**
9	**All abnormal lies, including previous caesarean section.**
10	**All single, cephalic, ≤ 36 weeks, including previous caesarean section.**

***Appendix 4*:** Data Sheet

Demographic Data:

- Study number: _____
- Age _____
- Parity: _____
- Gravidity: _____

Obstetric history:

- Gestational age:
  - Last Normal Menstrual Period (LNMP): _____
  - Early ultrasound (<20/40): _____
  - Late ultrasound (Ó20/40): _____
  - Palpation: _____
- Number of foetuses: _____
- Presentation: Cephalic/Breech/Transverse
- Previous caesarean sections: Y N
- Number of previous caesarean sections: _____
- Comorbid Disease _____

Labour and delivery data:

  - Spontaneous labour
  - Elective caesarean section
  - Induced labour:

SAMM:

- ICU admission (includes intubation and ventilation in HCA):
- Blood transfusion (> 3 units):
  - Number of units: _____
- Surgical intervention:
  - Re-look laparotomy:
    - Indication for re-look laparotomy: _____
  - Hysterectomy:
    - Indication for hysterectomy: _____
- Prolonged intubation (> 12 hours) Y N
- Mortality Y N

Cause of Death _____

Appendix 5: Ethics Approval

M130521

R14/49 Dr Rizwana Ayob

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M130521

NAME: (Principal Investigator)	Dr Rizwana Ayob
DEPARTMENT:	Department of Obstetrics & Gynaecology CH Baragwanath Academic Hospital
PROJECT TITLE:	An Observation of the Caesarean Section Rate at a Teaching Hospital in Johannesburg
DATE CONSIDERED:	31/05/2013
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr KA Frank
APPROVED BY:	Professor PE Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 25/07/2013

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

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.

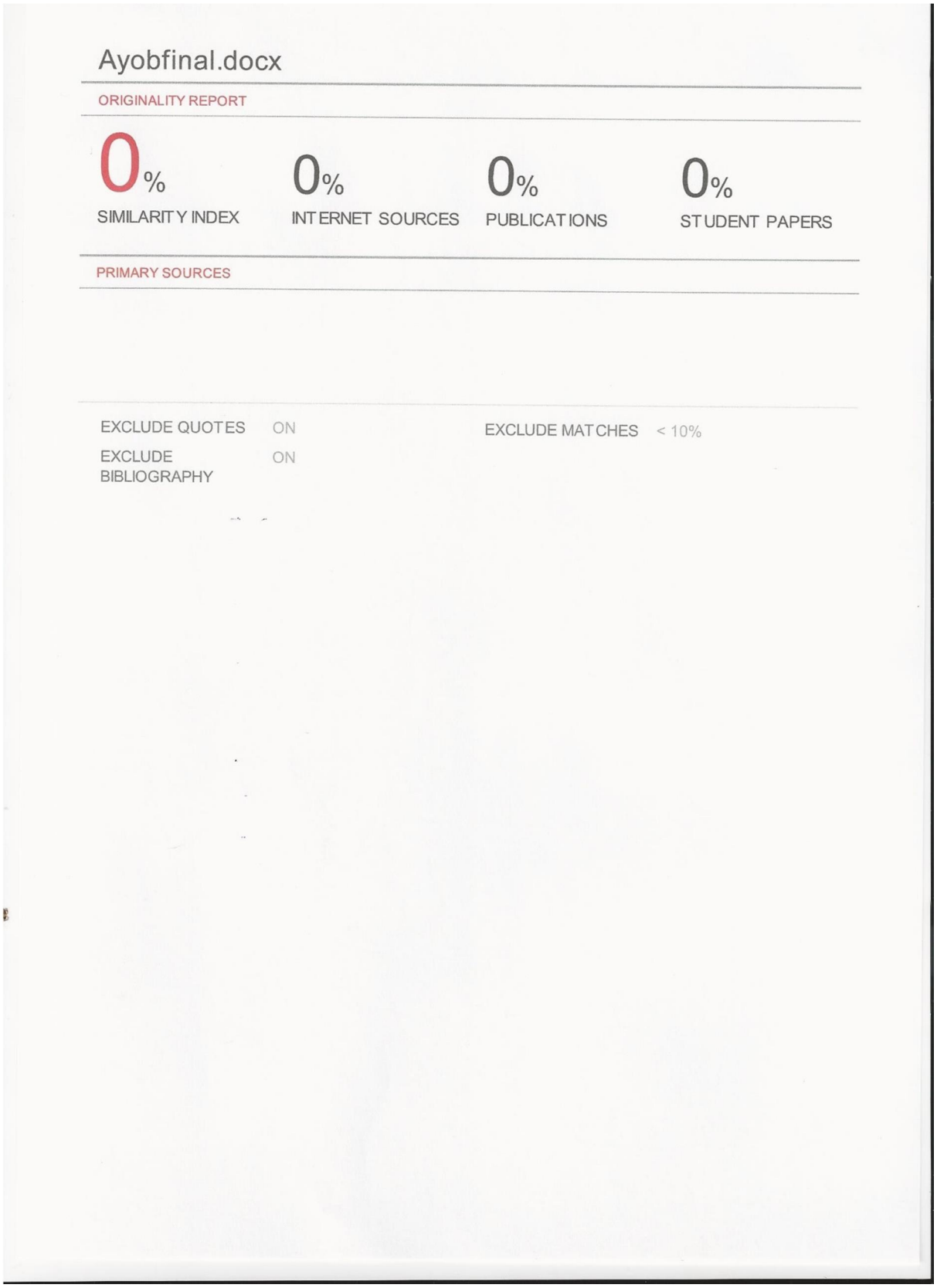
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature

Date 30/07/2013

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

***Appendix 6*:** Turnitin Report



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