The profile of caesarean section deliveries at an academic hospital: A retrospective study

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Declaration

I, Nazeera Cassim, declare that this research report is my own, unaided work. It is being submitted for the degree of Master of Medicine in the branch of Anaesthesiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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Signed on 29th day of May 2019 in Johannesburg

Abstract

Background

A caesarean section is a well-established and increasing method of obstetric delivery. The provision of safe anaesthesia for caesarean section is of paramount importance. It is not known what the profile of caesarean sections including the anaesthesia management thereof are, at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

Methods

A retrospective study using consecutive convenience sampling was done reviewing the records of caesarean section patients at CMJAH from 1 August to 31 October 2016.

Results

Caesarean section deliveries comprised 1110 (49.2%) of 2257 deliveries. Emergency caesarean sections accounted for 78.1%. Weekdays recorded 78.3% of caesarean sections performed, with a relatively equal day (51%) and night (49%) distribution. The most common indication was foetal distress (40.6%). Spinal anaesthesia was performed in 91% of patients, all receiving intrathecal hyperbaric bupivacaine [mean (SD) dose 9.1 mg (0.4mg)]. Fentanyl [mean (SD) dose 11 mcg (3 mcg)] was co-administered intrathecally with hyperbaric bupivacaine in 99.9%. Supplemental oxygen was administered to 18.8% of patients receiving spinal anaesthesia. The incidence of failed spinal anaesthesia was 10.5%. Of these, 3.5% were converted to general anaesthesia, while 7% received supplemental analgesia intravenously.

Conclusions

The study described the profile of caesarean section deliveries at CMJAH with a focus on anaesthesia management. Key findings included a caesarean section rate higher than the national average; spinal anaesthesia being the predominant anaesthetic technique performed; and a failed spinal anaesthesia incidence of 10.5%.

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ASA	American Society of Anaesthesiologists
CMJAH	Charlotte Maxeke Johannesburg Academic Hospital
ESMOE	Essential Steps in the Management of Obstetric Emergencies
SAJAA	South African Journal of Anaesthesia and Analgesia
WHO	World Health Organisation

Section 1: Literature review

1.1. Introduction

In this section, the literature regarding the use of caesarean section for obstetric delivery will be reviewed. This will include data on the international and national incidence of caesarean sections performed for obstetric delivery. Features related to the performance of a caesarean section are reviewed with regard to the proposed benefits, complications, elective versus emergency performance, the associated indications as well as the frequency of performance in relation to time of day. The next aspect of review will explore the anaesthetic techniques employed for caesarean section delivery with consideration of the benefits and risks of the various anaesthetic techniques. Specific focus is placed on spinal anaesthesia for caesarean section performance and the medication being administered intrathecally. Lastly, the incidence of failed spinal anaesthesia in the obstetric patient and the subsequent management thereof is reviewed.

1.2. History of caesarean section

A caesarean section, is an operation performed to remove the foetus from a pregnant uterus via an incision made into the abdomen of the mother (1). Its true origin remains unknown. In Greek mythology, Asclepius was removed from his mother's womb by his father Apollo (2). Caesarean sections were practiced in ancient cultures with references found in Chinese, Egyptian, Greek and Roman folklore. The term "caesarean" is commonly thought to be derived from the Roman emperor, Julius Caesar, who was believed to have been delivered surgically (2). Other possibilities are that the term was derived from Latin, as the words "caedere" means to cut, or "caesone" describing a child born in this manner. These procedures were performed on mothers deemed very ill, close to death, or dead, in an attempt (usually in vain) to save the unborn child, or to allow for burial of the child separate from the mother. The goal then, was never focused on saving the life of the mother. It was not until the nineteenth century, with advances in medicine, that the focus of saving both mother and child became a recurring possibility (3).

The first successful caesarean section to be performed in the United States of America took place in 1794, performed by Dr J Bennett on his wife (4). Sometime between 1815 and 1821, James Miranda Stuart Barry performed the first recorded successful caesarean section in the British Empire (3). In Uganda, in 1879, a British traveller, Robert William Felkin, witnessed a caesarean section being performed. To alleviate pain, banana wine was given to the mother and used to cleanse the surgeon's hands, as well as the mother's abdomen before the surgery. A midline incision was used and rudimentary cautery applied to minimise bleeding. The patient recovered, and this technique was used there for a long time (5). In Rwanda, caesarean sections were also being performed with herbal preparations being used to anaesthetise the patient (3).

In the latter half of the nineteenth century, with urbanisation, more hospitals were available with special focus on women's health. Surgeons could operate on patients at these hospitals and develop new obstetrical surgical skills. Problems remained however, as maternal mortality secondary to blood loss and infection was still a confounding factor (6).

In 1928 Alexander Fleming discovered penicillin, which later in 1940, became available for use as a drug. Antibiotic administration dramatically reduced maternal mortality for both normal and caesarean section deliveries (3).

The advent of improved anaesthetic techniques revolutionised surgical practices regarding caesarean sections. Prior to this, surgeons, even those with good anatomical knowledge, were limited by patients feeling overwhelming pain. Anaesthesia provided the platform to perfect suturing and refine surgical methods. Administration of anaesthesia was not without risk however. In 1946, Mendelson described peptic aspiration pneumonia in obstetric patients who had a history of vomiting after use of inhalational anaesthesia either during the operation or in the early post-operative period. The clinical course was one of rapid deterioration of respiratory symptoms and death usually resulted from cardiac failure (7).

The twentieth century also saw an increase in medically managed obstetric deliveries and better ante-natal care. By 1938, in the United States of America, about 50% of deliveries were taking place in hospitals, and by 1955 this had risen to over 90% (8). In a monitored hospital setup, labour complications could be detected early and, if needed, the decision for operative delivery could be made (9).

1.3. Incidence of obstetric delivery by caesarean section – international and national trends

Normal vaginal delivery, the natural physiological process of obstetric delivery has been around since the very beginning and continues to be the preferred method of delivery. On average, a normal vaginal delivery is associated with a shorter hospital stay, earlier discharge and return to normal activity, and also avoids any exposure to the potential problems associated with having a caesarean section (10).

The United Nations summit in September 2000, resulted in the drafting of eight Millennium Development Goals, one being to reduce child mortality, and another, to improve maternal health (11). The aim was to reduce the maternal mortality ratio by three-quarters between 1990 – 2015 (12). One of the ways this could be achieved was the implementation of Emergency Obstetric Care. The World Health Organisation (WHO) has described Emergency Obstetric Care, as consisting of basic and comprehensive elements, critical to reducing maternal and neonatal mortality. Included amongst the comprehensive elements is the performing of a caesarean section. The provision of a caesarean section, when medically indicated, is effective in improving maternal and neonatal outcomes (12).

Socio-economic upliftment, improved infrastructure, increased access to medical care and the availability of antibiotics, have resulted in caesarean sections becoming one of the most commonly performed operations (12, 13). The caesarean section rate is expressed as a percentage, calculated by dividing the total number of caesarean sections performed, by the total number of deliveries within a specified period (14). In 1985, at a meeting organised by the WHO, international reproductive health experts agreed that there was no justification for any region to have a caesarean section rate above 10 – 15%. It has been shown that rates above 10% are not associated with a reduction in maternal and neonatal mortality. In 2015, the WHO has advocated that a caesarean section be offered to any woman in need rather than to achieve a specific rate (14).

According to data from the Saving Mothers 2014 – 2016: Seventh Triennial Report on Confidential Enquiries into Maternal Deaths in South Africa (15), hereafter referred to as the Saving Mothers Report, a national caesarean section rate of 25.7% in the public sector over the triennium was demonstrated (15). Of these caesarean sections performed, 39% were at district level hospitals, 37% were at regional hospitals, 12% were at tertiary hospitals, and 12% at central hospitals. In the Gauteng province, an increasing caesarean section rate was noted, from 23.7% in 2011, 24.6% in 2012, 25.5% in 2013 (16), to 27.1% for the period from 2014 – 2016 (15).

A 2017 study found a caesarean section rate of 43.9% across 13 hospitals in the public sector in Gauteng (17). The 2011 – 2013 Saving Mothers Report included data on the private sector in South Africa, which showed that 63% of all deliveries performed in the private sector were by caesarean section (16). This is in keeping with data obtained from a previous study, conducted at five private hospitals in Kwa Zulu Natal, over a period of one year in 2004, where a caesarean section rate of 60.4% was found (18).

Internationally, the caesarean section rate has also tended to be above the recommended 10 – 15%. In a study conducted from January to December of 2005 in four South East Asian countries, an average caesarean section rate of 27% was found (19). In Pakistan, a study conducted from January to December of 2011 found a caesarean section rate as high as 44.8% (20). In a Mozambique study, however, caesarean section rates were found to be low, with a rate of 2.5% in 1997, increasing to 4.7% in 2011 (21). An Iraqi study demonstrated an increase in the overall (both public and private sector) caesarean section rate from 18% in 2008 to 24.4% in 2012, with a rate of 77.9% in private hospitals in 2012 (22). A 2017 study at a tertiary hospital in India reported a caesarean section rate of 31.4% (23). In the United States of America, a 2016 study found a similar rate of 33.1% (24).

A study published in 2016, on data from 150 countries, both developing and developed, over a 24-year period, from 1990 – 2014, found an average caesarean section rate of 18.6%. The average caesarean section rate ranged from 6% in the least developed to 27.2% in the most developed regions. Latin America and the Caribbean region had the highest caesarean section rates (40.5%), followed by Northern America (32.3%), Oceania (31.1%), Europe (25%), Asia (19.2%) and Africa (7.3%). Analysing the trend between 1990 and 2014, the average global caesarean section rate increased by 12.4% from 6.7% – 19.1%. This increasing trend in the caesarean section rate is noted despite differences in countries having either higher or lower resource settings (25).

Multiple factors have played a part in the rising rate of caesarean sections being performed. Apart from the medically indicated reasons to perform a caesarean section, other factors thought to play a role in the increasing caesarean section rate include, social and cultural considerations (26), maternal request (27), the increase in malpractice claims and fear of litigation (28).

1.4. Obstetric delivery by caesarean section

1.4.1 Benefits of caesarean section

Caesarean section offers the advantages of avoiding birth complications in instances of maternal pelvic abnormalities; foetal mal-presentation; or maternal medical conditions complicating a normal delivery. These medical conditions can affect various organ systems such as: the cardiovascular system (complicated hypertension, cardiac valvular abnormalities or heart failure), the endocrine system (diabetes which can result in foetal macrosomia), and infectious diseases (29). With the increased incidence of Human Immunodeficiency Virus, transmission of the virus from mother to child remains a concern, with planned delivery via caesarean section decreasing the risk (30).

Other benefits of caesarean section centre around the avoidance of perineal injuries and decreasing the risk of pelvic floor disorders (urinary stress incontinence, and faecal incontinence) arising from unassisted normal delivery or assisted normal delivery with the use of forceps or vacuum (27, 31).

1.4.2 Complications of caesarean section

One of the disadvantages of delivery by caesarean section involves the increased cost of the service (32). More importantly, are the complications arising from the procedure itself: injury to surrounding organs (bladder or bowel) (29) and haemorrhagic blood loss – on average, a caesarean section delivery is associated with more blood loss compared to normal vaginal delivery (27, 33, 34).

Additional complications in the post-operative period include infection, sepsis, and venous thromboembolism (29). There are further risks associated with the delivery of the next pregnancy in patients who have had a prior caesarean section. Not only does the likelihood of a second operative delivery become more likely, but, there is an increased risk of uterine rupture or abnormal placental implantation, conditions which increase the risk of severe haemorrhage (35). In some cases, a hysterectomy may even need to be performed as a lifesaving procedure if haemostasis is not achievable (33).

Obstetric delivery by caesarean section makes anaesthesia necessary, which has direct implications on patient management and outcome. Even though general anaesthesia safety has increased over recent decades, its performance in the obstetric population, represents a higher risk (36). The main area of concern being difficulty or inability to manage the airway after induction of general anaesthesia, with resultant complications (37). Difficulty in intubation is 10 times more frequently encountered in the obstetric population compared to the non-obstetric population (38). The risk of aspiration in the obstetric patient under general anaesthesia with the development of a chemical pneumonitis remains significant. Respiratory complications have accounted for most of the anaesthetic related deaths in obstetric patients (39, 40). A caesarean section can also impact on the unborn child. Unless a caesarean section is performed at term, problems relating to neonatal prematurity is another area of concern (41).

In South Africa, during the triennium 2014 – 2016, there were 1184 caesarean section related maternal deaths, with bleeding during or after caesarean section accounting for 217 of those (15). There were 87 anaesthesia related complications recorded during the triennium with a national maternal mortality ratio for anaesthesia related deaths of 3.16 (15).

1.4.3 Indications for caesarean section

The indication for a caesarean section could be either absolute or relative (26), which is ultimately determined by the attending obstetrician.

There are numerous indications (26, 42) for a caesarean section including:

- maternal medical conditions including hypertension or diabetes,
- maternal infections (Human Immunodeficiency Virus or Herpes Simplex Virus),
- multiple pregnancy including twins or more,
- breech presentation or abnormal lie,
- cord prolapse,

- labour related (preterm labour, prolonged labour, or poor progress of labour),
- foetal distress,
- previous caesarean section,
- abnormal placental implantation,
- ante-partum haemorrhage,
- birth canal outlet obstruction secondary to tumours or warts,
- pregnancy secondary to in vitro fertilisation, and
- maternal request.

An Australian study found foetal distress to be the most common indication for caesarean sections performed during the five year study period (43). In a United States of America study, non-reassuring foetal status accounted for 32%, arrest of labour 18%, and multiple gestation 16% among the top three indications for caesarean section (44).

A South African study conducted in the private sector in Kwa Zulu Natal, found that previous caesarean section was the most common indication for caesarean section, followed by foetal distress and cephalopelvic disproportion (18). A 2018 study at Chris Hani Baragwanath Academic Hospital found foetal distress to be the most common indication at 49% (45). Foetal distress was also the most common indication in a 2017 Zambian study (46).

A study conducted in four South East Asian countries, demonstrated an average caesarean section rate of 27% with a previous caesarean section being the most common indication (7% of overall births), followed by cephalopelvic disproportion (6.3%), mal-presentation (4.7%) and then foetal distress (3.3%) (19). A study conducted at an academic centre in Taiwan from 1997 – 2012, found 26% of all caesarean sections performed were for a previous caesarean section, followed by foetal distress at 18.1% and mal-presentation at 16.9% (47).

In a study conducted in Pakistan, the most common indication was a caesarean section for a previous caesarean section at 30.9%, followed by foetal distress at 15.2%, poor progress of labour at 13.9%, and mal-presentation at 6.57% (20). Similarly in an Indian study, previous caesarean section was also the most common indication at 36.5% (23).

1.4.4 Incidence of elective versus emergency caesarean section

Caesarean sections can be performed either electively, or as an emergency procedure. Caesarean sections may be classified into four categories of urgency (48). Category 1 – where there is maternal or foetal compromise with immediate threat to life of the mother or foetus. Category 2 – where there is maternal or foetal compromise with no immediate threat to life of the mother or foetus. Category 3 – where delivery is required early but with no evidence of maternal or foetal compromise. Category 4 – where there is no evidence of maternal or foetal compromise and delivery is planned, a suitable date chosen, as decided and agreed upon by the obstetrician and patient (48).

It has been demonstrated that emergency caesarean sections may be associated with higher maternal mortality compared to electively performed caesarean sections (27). A South African study conducted in the private sector in Kwa Zulu Natal, found that 52.2% of all caesarean sections were performed as elective procedures, 8.6% as urgent and 39.2% as an emergency procedure (18). A 2017 study carried out in the Eastern Cape found that emergency caesarean sections constituted 78.1% of their study demographic (49).

An Australian study, showed that emergency caesarean sections made up 69% of all caesarean sections performed during the study period (43). In a 2013 Iranian study, 44% of the caesarean sections were performed as an elective procedure with the majority performed as an emergency procedure (50). Similarly, a Pakistani study demonstrated that 58.5% of caesarean sections performed were as emergency procedures (20). A 2016 study in Ireland found that emergency caesarean sections made up 54.4% of all performed (51). In a 2017 study in India similar results were obtained with emergency caesarean sections constituting 62% (23). A 2017 Zambian study, however, found that 69.8% of caesarean sections were performed electively (46).

1.4.5 Caesarean section performance in relation to time of day

Obstetric services are offered 24 hours a day, as part of essential care in South Africa (52). A 2014 study conducted at three academic hospitals in Gauteng, South Africa, found that 71.3% of caesarean sections were performed during the week, with the remainder over the weekend (53). The study also revealed that 57.7% of the caesarean sections were performed at night, and 42.3% were completed during the day (53).

A United Kingdom study from 2012 – 2013, considered caesarean sections performed in-hours (when a consultant obstetrician was available), and out of hours (when no consultant obstetrician was available) and found that caesarean section deliveries were evenly distributed throughout the 24 hours. Elective caesarean sections however, tended to occur more frequently between the hours of 9:00 and 19:00 (54). A more recent 2018 study, similarly found that elective caesarean sections were mostly carried out on weekdays between 09:00 and 12:00, with emergency caesarean sections being more frequent after hours (55).

An Australian study found that the majority of caesarean sections were performed between 07:00 and 17:00 (45.5%), followed by 31% between 17:00 and 00:00, and, 23.4% between 00:00 and 07:00 (43).

1.5. Anaesthesia for caesarean section

There are two described modalities concerning anaesthesia for caesarean section. The first is neuraxial anaesthesia which may be subdivided into either a spinal anaesthetic, an epidural anaesthetic or a combined spinal epidural anaesthetic. The second is a general anaesthetic. The decision regarding which anaesthetic technique to perform, will depend on the indication and urgency of the caesarean section, the patients' preference, skill of the anaesthetist, any contraindications, as well as maternal medical conditions (56).

In South Africa, the Essential Steps in the Management of Obstetric Emergencies, also known locally as ESMOE (57), have published protocols with regards to the anaesthetic management of patients undergoing a caesarean section. These detail the method of carrying out a safe spinal anaesthetic (58) or, if required, a safe general anaesthetic (59).

1.5.1 Neuraxial anaesthesia

Neuraxial anaesthesia involves the injection of local anaesthetic into the cerebrospinal fluid which surrounds the spinal cord (called a spinal anaesthetic), or into the tissue surrounding the nerves in the epidural space (called an epidural anaesthetic) (60).

In the United Kingdom, a 2000 study found that 78% of caesarean sections were performed under neuraxial anaesthesia (61). A Czech Republic study, demonstrated that the rate of neuraxial use in caesarean sections had increased from 6.7% in 1993 to 55.6% in 2011 (62).

A 2014 Turkish study found that neuraxial anaesthesia was performed in 55% of the caesarean sections performed (63). In India, a 2018 study conducted over a 4-year period revealed that 82% of emergency and 90% of elective caesarean sections were performed under neuraxial anaesthesia (64). A 2017 study demonstrated that neuraxial anaesthesia is used in over 94% of caesarean section deliveries in the United States of America (65).

Neuraxial techniques are preferred for caesarean section delivery as it results in the avoidance of the risks associated with the performance of a general anaesthetic, prevention of the passage of anaesthetic drugs used in a general anaesthetic, from mother to foetus, and, it allows the remembrance of the birth experience by the mother (60).

1.5.1.1 Spinal anaesthesia

Spinal anaesthesia has a rapid onset of action and is a commonly employed neuraxial anaesthetic technique for caesarean section surgery (60). Spinal anaesthesia is usually performed as a single shot technique, meaning that local anaesthetic is administered once only. As a result, the duration of the block cannot be increased if surgical time is prolonged (60).

A 2005 study found that spinal anaesthesia was performed in 80% of elective caesarean sections and 59% of emergency caesarean sections in the United States of America (66). A German study found that spinal anaesthesia was used in 90.8% of caesarean sections performed (67). A Nigerian study found similar results with 85.9% being done under spinal anaesthesia (68).

The main disadvantage of spinal anaesthesia is hypotension, which may be profound. The hypotension is correctable with the administration of a vasoconstrictor and adequate volume loading (60). Another disadvantage is the risk of post dural puncture headache. A study conducted by Shaikh et al (69) found an incidence of post dural puncture headache ranging from 2 to 8.3%, following spinal anaesthesia in obstetric patients, depending on the size and type of spinal needle used. Post dural puncture headache is usually managed with bed rest, adequate hydration, caffeine, nonsteroidal anti-inflammatory drugs, and in some instances, by use of an epidural blood patch (69). There are other potential complications associated with spinal anaesthesia, including most notably a high neural block, haematoma formation, backache, infection from non-aseptic technique, neurological injury and transient neurological symptoms amongst others (70).

1.5.1.1.1 Spinal medication for caesarean section

Bupivacaine is the most common local anaesthetic used in spinal preparations for caesarean sections (60, 71). A South African review found that low dose spinal anaesthesia was advocated due to the potential for improved cardiovascular stability (72). To obtain adequate local anaesthetic spread, the hyperbaric variety of bupivacaine is used. It is available in concentrations of 0.5% or 0.75% with doses of 10 – 15 mg being administered, if used as the sole agent (60). Doses lower than 10 mg may be used, but anaesthesia of poor quality may result. Lower doses of bupivacaine are therefore usually combined with opioids to enhance the quality and duration of neuraxial block (56, 71). Fentanyl (73, 74), sufentanil (75), and morphine (76) have been described.

The addition of small doses of intrathecal fentanyl (15 mcg) may be used to prolong the duration of spinal anaesthesia for caesarean section (73). A study conducted in Germany, found that the addition of intrathecal sufentanil (5 mcg) resulted in good toleration of pain for up to twelve hours (75). At the KK Women's and Children's Hospital in Singapore a spinal anaesthetic dose consisting of 2 ml of 0.5% hyperbaric bupivacaine and morphine 100 mcg is used for elective caesarean sections (76).

In South Africa, the Caesarean Section Monograph (74) suggests for spinal anaesthesia the use of hyperbaric bupivacaine (dose of 1.8 ml of 5 mcg/ml solution), together with fentanyl (dose of 0.2 ml of 50 mcg/ml solution), for caesarean section (74).

1.5.1.1.2 Failed spinal anaesthesia

Spinal anaesthesia is regarded as the more reliable of the neuraxial blocks (77). For a successful block to occur, certain criteria need to be met. First, the spinal needle needs to puncture the dura mater and lie within the subarachnoid space. Second, the local anaesthetic agent needs to be deposited within the cerebrospinal fluid. Third, the appropriate drug(s) and dose needs to be administered. A failed spinal anaesthetic, implies that a spinal anaesthetic was attempted, but either an inadequate block, or no block resulted. In the case of complete failure of the spinal anaesthetic, a conversion to general anaesthetic may be required depending on the urgency of the caesarean section, or the spinal anaesthetic reattempted. If a partial failure of the spinal anaesthetic occurred, a conversion to general anaesthetic may need to be performed, or, supplementation with intravenous analgesics, and or sedatives would be required (77).

The Royal College of Anaesthetists suggests a conversion rate from neuraxial anaesthesia to general anaesthesia to be less than 1% for elective caesarean sections, and less than 3% for emergency caesarean sections (78).

A study conducted in the Eastern Cape where 197 patients received spinal anaesthesia for caesarean section, found a failed spinal anaesthesia rate of 11.7%. Patients received either 1.8 or 2 ml of 0.5% hyperbaric bupivacaine with a similar incidence in failed spinal anaesthesia with either dose (49). Another South African study which surveyed 12 different management options in a failed spinal anaesthesia scenario, found conversion to general anaesthesia (31.7%), repeating the spinal anaesthetic (16.3%) and administering intravenous ketamine (11.5%) as the top three choices (79).

A study in the United States of America found a failed spinal anaesthesia rate of 2.7% of which 1.2% required conversion to general anaesthesia (80). In a United Kingdom study conducted over a 5-year period, 3224 caesarean section patients underwent spinal anaesthesia with a 6% reported failure to achieve pain free operation (81).

A study was conducted at a teaching hospital in Nigeria, where a failed spinal anaesthesia rate of 6% was noted of the 414 patients who had received a single shot spinal anaesthetic for the caesarean section surgery. They found that the experience of the anaesthetist was a significant contributing factor (82).

In a Singapore study, 800 patients undergoing elective caesarean section received a single shot spinal anaesthetic. The incidence of total spinal anaesthesia failure requiring conversion to general anaesthesia was 0.5%. Intraoperative analgesic supplementation was required in 4.1% of the patients. The study found that the added performance of a sterilisation with the caesarean section, was an independent risk factor for partial failure requiring intravenous analgesic supplementation (76).

In Kathmandu, a 2015 study had 660 caesarean section patients who received spinal anaesthesia with 2.2 ml 0.5% hyperbaric bupivacaine. The incidence of failed spinal anaesthesia was 1.6%. Of these 0.7% were converted to general anaesthesia, and 0.9% received supplemental analgesia (83). A 2016 study at a tertiary hospital in Nepal, had 6641 caesarean section patients who received spinal anaesthesia with 2.2 ml 0.5% hyperbaric bupivacaine and demonstrated a failed spinal incidence of 9.9%. Of these 6.1% then received supplemental agents intravenously and 3.8% were converted to general anaesthesia (84).

1.5.1.2 Epidural anaesthesia

Epidural anaesthesia is used for caesarean section in a situation where, an epidural catheter had previously been placed for labour analgesia, or, when there is an indication to establish the neuraxial block slowly. An epidural anaesthetic takes longer to perform than a spinal, with a slower onset of action. The slower onset may be preferred in patients where a precipitous decrease in blood pressure is deleterious (60). In the case of a caesarean section needing to be performed urgently, the epidural may be topped up with fast onset local anaesthetic or be removed and converted to either a spinal or general anaesthetic. The incidence of post dural puncture headache after inadvertent dural puncture from epidural insertion can be as high as 70% (85).

In the United Kingdom, epidural anaesthesia was used in 26% of caesarean section patients during the 5-year study period (81). In a 2014 Turkish study, 3% of caesarean section patients had epidural anaesthesia (63). A South African study demonstrated that 1.3% of caesarean section patients received epidural anaesthesia (45).

1.5.1.3 Combined spinal epidural

Combined spinal epidural is a technique that combines the fast onset of a spinal anaesthetic with the ability to re-administer local anaesthetic through the epidural catheter. A combined spinal epidural also takes longer to perform than a spinal anaesthetic alone, and, is not typically used in situations where caesarean section delivery is urgent.

In the United Kingdom, combined spinal epidural anaesthesia was used in 5% of caesarean section patients during the 5-year study period (81). A 2014 Turkish study showed that 7%

of caesarean section patients received a combined spinal epidural (63). In a 2018 South African study, no patients received combined spinal epidural anaesthesia (45).

1.5.2 General anaesthesia

A general anaesthetic may be performed from the outset, or, following a neuraxial technique. The aim is to maintain respiratory and haemodynamic homeostasis, and to minimise the time between induction and delivery. Induction involves adequate preoxygenation, a rapid sequence induction with cricoid pressure, and endotracheal intubation. The advantage of a general anaesthetic is the faster induction it affords in an emergency (37).

The main risks associated with a general anaesthetic include an increased incidence of pulmonary aspiration of gastric content, and inability to intubate or ventilate the patient (56). These have been the major causes of morbidity and mortality related to general anaesthesia (56). Use of the halogenated volatile anaesthetics have been shown to dose dependently increase blood loss during a caesarean section. General anaesthesia is associated with an additional 100 – 200 ml average blood loss, compared with regional anaesthesia (38).

A study conducted in Taiwan, from 2000 – 2008, found an increasing trend in spinal anaesthetics performed, and the general anaesthetics conducted had decreased from 5.5% in 2000 to 3.9% in 2008. Over the study period, 4.2% of caesarean sections were done under general anaesthesia, 31.9% under epidural anaesthesia, and, 63.8% under spinal anaesthesia (86).

Over a six year study period in the United States of America, general anaesthesia for caesarean section ranged from 0.4 – 1% (87). In a United Kingdom study, general anaesthesia was used in 5% of caesarean section patients (81).

In a 2018 South African study conducted at Chris Hani Baragwanath Academic Hospital, 14.2% of caesarean section patients received general anaesthesia (45).

A study conducted in Australia which only considered emergency caesarean sections, however, found that 54.6% were done under general anaesthesia (43). Similarly a 2014

Turkish study also demonstrated that 45% of the caesarean section patients received general anaesthesia (63).

1.6. Summary

The literature presented demonstrates the establishment of obstetric delivery by caesarean section and its role in the management of the pregnant patient. Monitoring of the caesarean section rate is important, as it has implications on socio-economic and health care resources. Emphasis, is however placed on ensuring safety to mother and foetus during pregnancy and delivery, rather than targeting a specific caesarean section rate. An individual assessment of the risk and benefit of performing a caesarean section including anaesthetic technique employed, is essential. Various anaesthetic techniques are available for caesarean section surgery. Lastly, with regards to spinal anaesthesia for caesarean section, the intrathecal drugs administered as well as the incidence of failed spinal anaesthesia and its subsequent management, were reviewed.

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The formatting of this Research Report complies with the University of the Witwatersrand's Style Guide for Theses, Dissertations and Research Reports. The formatting of the draft article may differ from the rest of the Research Report in order to comply with the author guidelines for the journal to which it is intended to be submitted.

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Acknowledgements

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The following are sample references:

1. Jun BC, Song SW, Park CS, Lee DH, Cho KJ, Cho JH. The analysis of maxillary sinus aeration according to aging process: volume assessment by 3-dimensional reconstruction by high-resolutional CT scanning. Otolaryngol Head Neck Surg. 2005 Mar;132(3):429-34.
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Section 3: Draft article

The profile of caesarean section deliveries at an academic hospital: A retrospective study

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Caesarean section, spinal anaesthesia, general anaesthesia, failed spinal anaesthesia, supplemental analgesia

Abstract

Background

A caesarean section is a well-established and increasing method of obstetric delivery. The provision of safe anaesthesia for caesarean section is of paramount importance. It is not known what the profile of caesarean sections including the anaesthesia management thereof are, at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

Methods

A retrospective study using consecutive convenience sampling was done reviewing the records of caesarean section patients at CMJAH from 1 August to 31 October 2016.

Results

Caesarean section deliveries comprised 1110 (49.2%) of 2257 deliveries. Emergency caesarean sections accounted for 78.1%. Weekdays recorded 78.3% of caesarean sections performed, with a relatively equal day (51%) and night (49%) distribution. The most common indication was foetal distress (40.6%). Spinal anaesthesia was performed in 91% of patients, all receiving intrathecal hyperbaric bupivacaine [mean (SD) dose 9.1 mg (0.4mg)]. Fentanyl [mean (SD) dose 11 mcg (3 mcg)] was co-administered intrathecally with hyperbaric bupivacaine in 99.9%. Supplemental oxygen was administered to 18.8% of patients receiving spinal anaesthesia. The incidence of failed spinal anaesthesia was 10.5%. Of these, 3.5% were converted to general anaesthesia, while 7% received supplemental analgesia intravenously.

Conclusions

The study described the profile of caesarean section deliveries at CMJAH with a focus on anaesthesia management. Key findings included a caesarean section rate higher than the national average; spinal anaesthesia being the predominant anaesthetic technique performed; and a failed spinal anaesthesia incidence of 10.5%.

Conflict of interest

We declare that we have no financial or personal relationships, which may have inappropriately influenced the writing of this paper.

Introduction

The practice of obstetric delivery by caesarean section has become well established. Medical advances, social and cultural perceptions, and legal factors have led to changes in the attitude toward caesarean sections being performed.[1] In a 2013 report on data collected in the United States of America, caesarean section surgery was the most common major operating room procedure.[2] Globally, the caesarean section rate has been increasing. A 2016 study found that caesarean section rates had increased worldwide from 6.7% in 1990 to 19.1% in 2014.[3]

These trends have evoked concern, because of the associated health, social, and financial implications of a rising caesarean section rate.[3] The World Health Organisation (WHO) has recommended a caesarean section rate of 10 – 15%, but has also suggested that a caesarean section be offered to any women in need rather than aiming to achieve a specific rate.[4] In developing countries, caesarean section rates are an important indicator of access to essential obstetric care.[5]

Several factors have been attributable to the rise in the caesarean section rate such as an increase in medically justified caesarean sections and maternal risk profile.[1] The rise in medical malpractice claims have played a part in decreasing the threshold to perform a caesarean section.[6] Maternal request is also an indication to have a caesarean section, and reasons may include social, cultural or psychological factors.[7]

Internationally, common indications for a caesarean section have included a previous caesarean section, foetal distress or poor progress of labour.[8-11] In South Africa, a study conducted in the private sector, also found the most common indications for a caesarean section were a previous caesarean section and cephalopelvic disproportion.[12]

Caesarean sections may be performed electively, or as an emergency procedure. It has been demonstrated that emergency caesarean sections have been associated with higher maternal mortality compared to electively performed caesarean sections.[7]

In South Africa, facilities to provide a caesarean section are functions of district, regional and central hospitals.[13] Higher risk profile patients should be managed at regional and central hospitals where specialist services and intensive care unit facilities are available.[13] Included, is the provision for caesarean section and anaesthesia services.[13]

The increased use of caesarean sections for obstetric delivery, has direct implications on the anaesthetic management and outcomes of these patients.[14] The anaesthesia options available include neuraxial techniques such as spinal or epidural anaesthesia, as well as general anaesthesia. Even though general anaesthesia safety has increased over recent decades, its performance in the obstetric population, represents a significantly higher risk.[15] The main area of concern being difficulty or inability to manage the airway after induction of general anaesthesia, with resultant complications.[16] Difficulty in intubation is ten times more frequently encountered in the obstetric population compared to the non-obstetric population.[17] The risk of aspiration under general anaesthesia and the development of a chemical pneumonitis are of concern. General anaesthesia is associated with an additional 100 – 200 ml average blood loss, compared with regional anaesthesia.[17] A declining trend in the use of general anaesthesia for caesarean section has been noted.[18]

Spinal anaesthesia has become the most commonly employed anaesthetic technique for caesarean section delivery. In addition to avoiding the above-mentioned complications associated with general anaesthesia, spinal anaesthesia is relatively straightforward to perform, with rapid onset of action providing good neuraxial block. In the United Kingdom, a study found that 78% of caesarean sections were performed under neuraxial anaesthesia.[19] A 2005 study found that spinal anaesthesia was performed in 80% of elective caesarean sections and 59% of emergency caesarean sections in the United States of America.[20] Spinal anaesthesia was the most common mode of anaesthesia for caesarean sections in Taiwan in the past decade.[21] A Czech Republic study, demonstrated that the rate of neuraxial use in caesarean sections had increased from 6.7% in 1993 to 55.6% in 2011.[22]

In South Africa, the essential steps in the management of obstetric emergencies also known locally as ESMOE,[23] have published protocols with regards to the anaesthetic management of patients undergoing a caesarean section. These detail the method of carrying out a safe spinal anaesthetic[24] or if required, a safe general anaesthetic.[25]

Occasionally, the attempted spinal anaesthetic may result in an inadequate block or no discernible block. This is referred to as a failed spinal anaesthetic which may then require either supplemental analgesia or conversion to a general anaesthetic.[26] The Royal College of Anaesthetists[27] suggests a conversion rate from neuraxial anaesthesia to general anaesthesia to be less than 1% for elective caesarean sections, and less than 3% for emergency caesarean sections. International studies have found spinal anaesthesia failure rates in obstetric caesarean section patients, ranging from 0.5% – 6%.[28, 29]

Bupivacaine is the most common local anaesthetic used for caesarean section spinal anaesthesia.[30] The addition of certain additives confers advantageous properties, in the case of spinal anaesthesia for caesarean section, an opioid is usually added. The addition of an opioid will tend to prolong the duration and improve the quality of the block.[30]

A caesarean section is a well-established method of obstetric delivery when appropriately indicated.[31] It is not without problems however, and has been associated with increased maternal and foetal complications.[32, 33] These complications may be related to the surgery itself, the anaesthesia, or pre-existing patient risk factors. In South Africa, during the triennium 2014 – 2016, there were 1201 caesarean section related maternal deaths, with bleeding during or after caesarean section accounting for 217 of those.[14] There were 87 anaesthesia related complications recorded during the triennium with a national maternal mortality ratio for anaesthesia related deaths of 3.16.[14]

In a setting with a high case volume load, and increased burden of disease, the requirement for increasingly safe anaesthesia is of paramount importance. The ESMOE programme provides guidelines for carrying out an anaesthetic for the obstetric patient, including a compilation of drugs required for anaesthesia for caesarean section.[34]

It is not known what the current practice is, in the anaesthetic management of patients presenting for caesarean section at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH). The aim of this study is to retrospectively describe the profile of caesarean section deliveries with a focus on the anaesthesia management at CMJAH over a 3-month period.

Methods

The research design used in this study is one of a retrospective, contextual, descriptive nature. Approval to conduct this study was obtained from the University of the Witwatersrand Human Research Ethics Committee (Medical) and other relevant authorities.

CMJAH is central academic hospital in Gauteng, and the anaesthesia providers would comprise of interns, medical officers, registrars and consultants. As a central hospital it offers specialised services and would receive referrals from other centres.

The study population was the theatre register and records of the patients who had a caesarean section at CMJAH. The sample size was determined by the number of patients who had a caesarean section at CMJAH during the period 1 August to 31 October 2016. This study used a consecutive, convenience sampling method. Illegible records were excluded from this study.

Data was collected in two parts from CMJAH once the study had been approved.

Part one: general information

The CMJAH labour ward admissions record and obstetric theatre register was used to determine the number of patients that had a normal vaginal delivery, and caesarean section respectively, and recorded on a Microsoft Excel spreadsheet.

Part two: data collection information

The CMJAH anaesthetic charts for caesarean sections done during the study period, was used to obtain details regarding the caesarean sections performed and recorded on a Microsoft Excel spreadsheet. The data collected included the following:

- ASA classification
- elective versus emergency caesarean section
- indication for caesarean section
- timing of caesarean section
- anaesthetic technique performed
- drugs and dose used for spinal anaesthesia including use of supplemental oxygen
- any failed spinal, and the subsequent management thereof including type of supplemental analgesia if used.

Each entry was recorded with the patient's name, hospital number and allocated study number on a separate Microsoft Excel spreadsheet, allowing for the identification of specific records if required. Only the study number was used during data analysis.

Data capturing was done in the Department of Obstetrics and Gynaecology and the Department of Anaesthesiology at CMJAH by a single researcher. Records were not removed from the hospital premises.

A Microsoft Excel spreadsheet was used to capture and analyse all the data obtained. Descriptive statistics were used to analyse numerical data. Categorical data is presented using frequencies and percentages. Normally distributed continuous variables are presented using means and standard deviations. Continuous data that is not normally distributed is presented using medians and interquartile ranges.

Results

The total number of deliveries recorded over the 3-month study period was 2257. Of this total, caesarean section deliveries comprised 1110 (49.2%). The caesarean section deliveries performed during the study period were distributed monthly as follows: August 369 (33.2%), September 349 (31.4%) and October 392 (35.3%). Elective caesarean section accounted for 243 (21.9%) and emergency caesarean section 867 (78.1%) of the deliveries.

Table I lists the ASA classification of the patients, Table II indicates the timing of the caesarean sections performed, and Figure 1 lists the caesarean section indications.

Table I: ASA Classification

	ASA 1 n (%)	**ASA 2 n (%)**	**ASA 3 n (%)**	**ASA 4 n (%)**	**TOTAL n (%)**
Elective	0 (0)	236 (21.2)	7 (0.7)	0 (0)	243 (21.9)
Emergency	0 (0)	801 (72.2)	56 (5)	10 (0.9)	867 (78.1)
TOTAL	0 (0)	1037 (93.4)	63 (5.7)	10 (0.9)	1110 (100)

Table II: Timing of caesarean sections performed

	Elective n (%)	**Emergency n (%)**	**TOTAL n (%)**
Weekday			869 (78.3%)
Day (07:00 – 16:00)	170 (15.3)	306 (27.6)	476 (42.9)
Night (16:00 – 07:00)	51 (4.6)	342 (30.8)	393 (35.4)
Weekend			241 (21.7%)
Day (07:00 – 16:00)	7 (0.7)	83 (7.4)	90 (8.1)
Night (16:00 – 07:00)	15 (1.3)	136 (12.3)	151 (13.6)
TOTAL	243 (21.9%)	867 (78.1%)	1110 (100%)

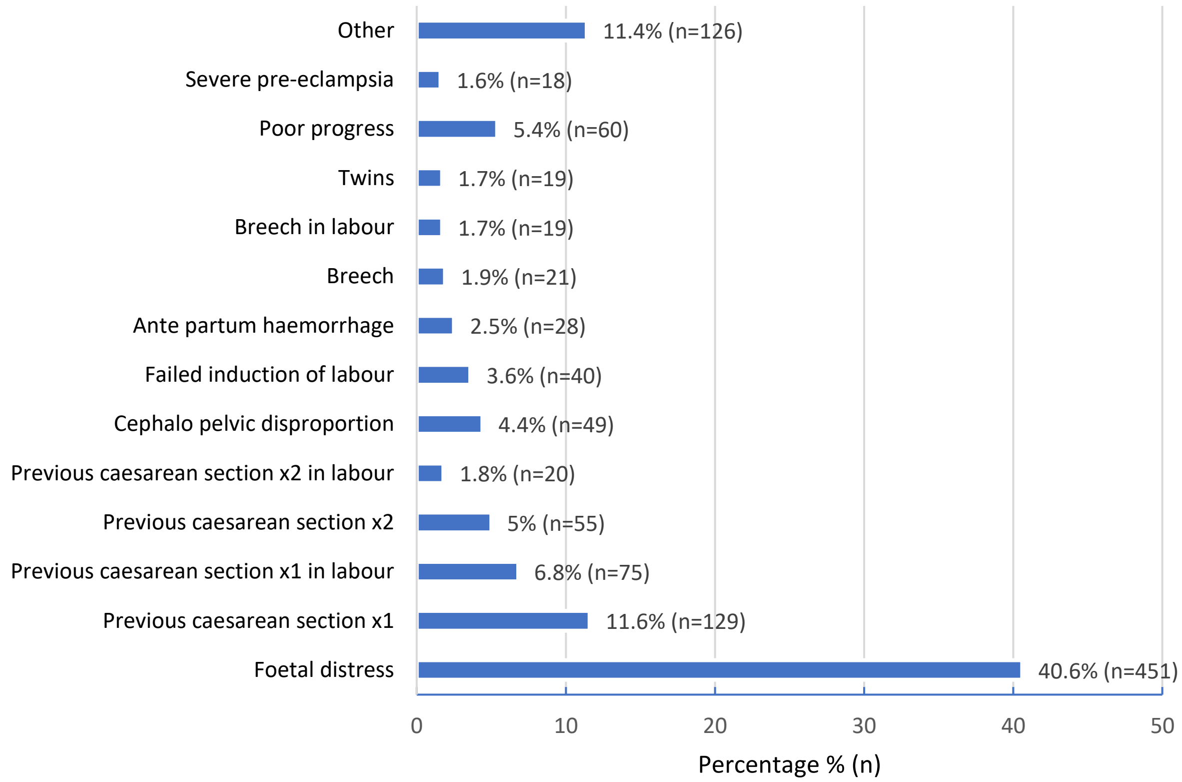

Figure 1: Indications of caesarean sections by frequency

The various anaesthetic techniques performed are shown in Table III. The number of general anaesthesia cases are those carried out from the start and do not include conversions to general anaesthesia.

Table III: Anaesthetic technique performed

Technique	n (%)
Spinal anaesthesia	1010 (91)
Spinal anaesthesia adequate	904 (89.5)
Failed spinal anaesthesia	106 (10.5)
General anaesthesia	98 (8.8)
Epidural anaesthesia	2 (0.2)
TOTAL	1110 (100)

Hyperbaric bupivacaine was administered to all 1010 patients under spinal anaesthesia. Fentanyl was administered concurrently with bupivacaine in 1009 (99.9%) patients. The remaining 1 (0.1%) patient received bupivacaine only. No other drugs were administered. The mean (SD) dosage for hyperbaric bupivacaine was 9.1

mg (0.4 mg), minimum dosage 7 mg, and maximum dosage 12 mg. The mean (SD) dosage for fentanyl was 11 mcg (3 mcg), minimum dosage 10 mcg, and maximum dosage 20 mcg.

Of the 1010 patients that received a spinal anaesthetic, 190 (18.8%) received supplemental oxygen. Oxygen was administered via a face mask in 180 (17.8%), and 10 (1%) were via nasal cannula, while the remainder 820 (81.2%) had no record of supplemental oxygen being administered.

In the event of a failed spinal anaesthetic, the patient was either converted to general anaesthesia or was given intravenous supplemental analgesia. The management of failed spinal anaesthesia is shown in Figure 2.

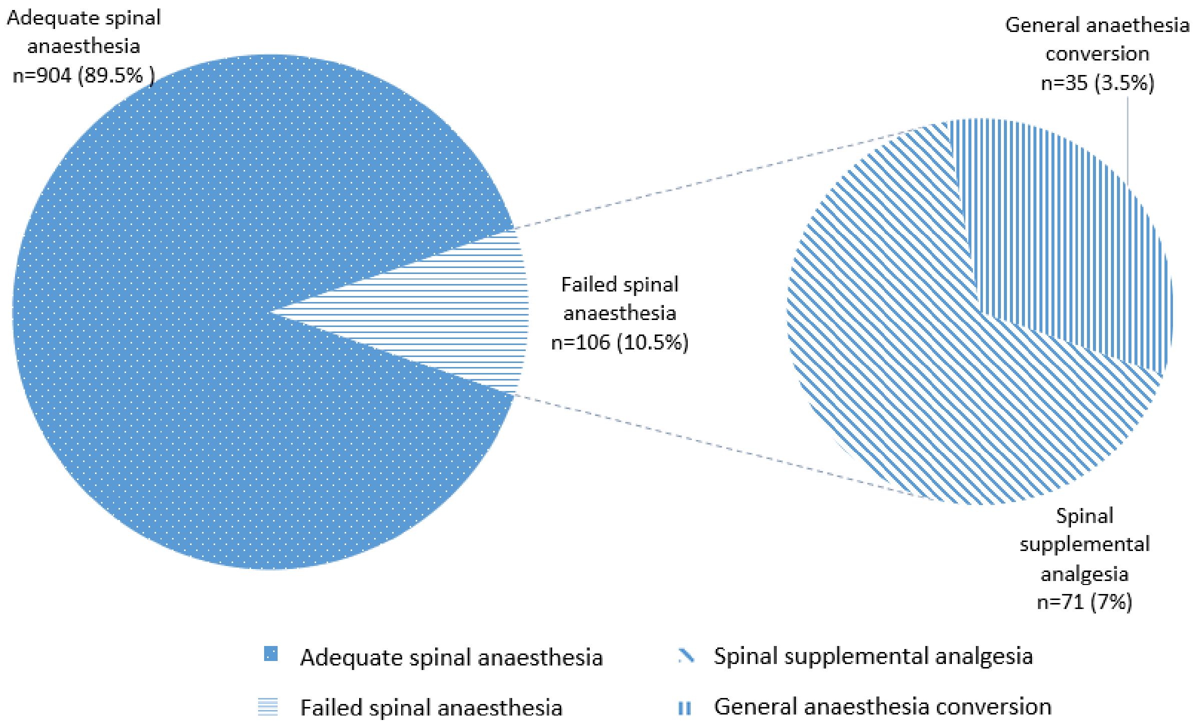

Figure 2: Management of failed spinal anaesthesia

There were 71 (7%) patients under spinal anaesthesia who required supplemental analgesia intravenously. The supplemental analgesics administered are listed in Table IV. Some patients received a combination of drugs.

Table IV: Supplemental analgesics administered

Supplemental analgesic	Patient n	Dosage			
		Minimum	Maximum	Mean	Median
Fentanyl	38	50 mcg	100 mcg	78.4 mcg	100 mcg
Morphine	7	2 mg	6 mg	3.3 mg	3 mg
Midazolam	35	0.5 mg	5 mg	1.3 mg	1 mg
Ketamine	22	5 mg	75 mg	25.9 mg	20 mg
Paracetamol	20	1 g	1 g	1 g	1 g

Discussion

This study has described the profile of caesarean section deliveries performed at an academic hospital in South Africa. A caesarean section rate of 49.2% was found at CMJAH. This is well above the World Health Organisation's recommended caesarean section rate of 10 – 15%.[4] The 2014 – 2016 Saving Mothers Report, revealed a national caesarean section rate of 25.7%,[14] almost half of that recorded at CMJAH. It is also higher than the 43.9% recorded in a 2017 study conducted across 13 public hospitals in Gauteng.[35] This high rate at CMJAH may be explained by the hospital serving as an academic training centre, and being a central hospital, it would also receive patients referred from other centres. The rate at CMJAH is however lower than the 60.4% obtained from a 2009 study in the private sector in South Africa.[12]

Internationally, four developing countries in South East Asia, and at a tertiary hospital in Pakistan had caesarean section rates of 27% [8] and 44.8% [9] respectively, which are lower than the rate at CMJAH. Developed countries in Europe [3] and in the United States of America [36] similarly have demonstrated lower caesarean section rates of 25% and 33.1% respectively. Incorrect or over cautious decision making in terms of which patients require a caesarean section may be accountable. Fear of litigation and an increase in malpractice claims may also be contributory.[6]

Of the caesarean sections performed, 78.1% were performed as emergency procedures. This mirrors the 78.1% of emergency caesarean section performed in a 2017 Eastern Cape study.[37] International studies in both developing and developed countries also had a high percentage of emergency caesarean sections performed at 56% in Iran [38] and 62% in India,[39] with 69% in Australia [11] and 54.4% in Ireland.[40] This may be explained by the patients for elective caesarean section going into labour and therefore shifting into the emergency caesarean section category. Another reason may be the use of cardiotocography foetal monitoring during labour and delivery, increasing the detection of foetal distress and warranting an emergency caesarean section as a result. Delays in patients being referred to the hospital including those who received poor ante natal care or being managed by inexperienced staff may contribute to the increased emergency caesarean section rate observed.

Of the emergency caesarean sections performed, 72.2% of the patients were classified as ASA 2, whereas only 5% and 0.9% were classified as ASA 3 and ASA 4 respectively. This is an unusually high percentage for CMJAH, a central hospital [41] offering specialised services, where one would have expected a higher number of ASA 3 and ASA 4 physical status classification of patients. This may reflect an inappropriate referral or acceptance of relatively healthy ASA 2 patients to a central hospital who could have been managed at either a regional or district level hospital in South Africa. These patients might also have arrived at CMJAH late in labour having received poor ante-natal care.

The majority (78.33%) of the caesarean sections were performed on weekdays. There was a relatively equal distribution of caesarean sections performed during the day (51%) and at night (49%). These results are similar to a 2014 South African study [42] where 71.3% of caesarean sections were performed during the week, except that they found a higher performance of caesarean sections at night (57.7%). These results at CMJAH reflect the provision of caesarean section services 24 hours a day, as stated in the guidelines for maternity care in South Africa.[13]

Foetal distress was the most common indication for caesarean sections performed at 40.6%, with previous caesarean section at 25.1% ranking second. Foetal distress was the most common indication in a national,[43] international developing,[44] and developed [11, 45] country studies. Previous caesarean section was the most common indication in a South African private sector study [12] as well as at a tertiary hospital in Pakistan,[9] and a 2017 Indian study.[39] These two indications remain a driving force behind an increasing caesarean section rate.

Neuraxial anaesthesia was performed in 91.2% of the patients having a caesarean section with general anaesthesia performed in the remainder. This is in keeping with data from a 2018 study in India [46] and a 2017 study in the United States of America,[47] where neuraxial anaesthesia was performed in 86% and 94% of caesarean section patients respectively. These results confirm the preference for neuraxial anaesthesia as the anaesthetic technique of choice in the obstetric patient presenting for caesarean section.[48]

Of the neuraxial anaesthetic techniques performed, spinal anaesthesia was used in 91%, and epidural anaesthesia in only 0.2% of patients. Combined spinal epidural anaesthesia was not utilised. Similar results were obtained in a 2018 South African study where epidural anaesthesia was used in 1.3% of patients with combined spinal epidural anaesthesia not used at all.[43] In the United Kingdom however, 26% and 5% of caesarean section patients received an epidural and combined spinal epidural anaesthetic technique respectively.[49] This is perhaps a reflection on lack of familiarity and experience with epidural and combined spinal epidural anaesthetic techniques or may be related to time constraints especially in a setting where emergency caesarean sections were performed in 78.1% of the patients.

In those patients who received spinal anaesthesia, the medication administered intrathecally constituted hyperbaric bupivacaine with a mean (SD) dose of 9.1 mg (0.4 mg) in combination with the opioid, fentanyl mean (SD) dose of 11 mcg (3mcg) in all except one patient who received solely bupivacaine. This is in keeping with the national ESMOE protocol [23, 24] which has suggested a dose of 9 mg of hyperbaric bupivacaine and 10 mcg of fentanyl.

Supplemental oxygen was administered to 18.8% of patients under spinal anaesthesia. The national ESMOE protocol for caesarean section under spinal anaesthesia recommends the use of supplemental oxygen.[23, 24] The supplementation of oxygen during spinal anaesthesia despite normal oxygen saturation recordings is debatable but may be of benefit in certain conditions.[50]

The incidence of failed spinal anaesthesia was 10.5%. Of these, 7% required supplemental analgesia and 3.5% required conversion to general anaesthesia. This is higher than the general anaesthesia conversion rate as suggested by the Royal College of Anaesthetists to be less than 1% in elective caesarean sections, and less than 3% in emergency caesarean sections.[27] Data on acceptable standards for failed spinal anaesthesia could not be identified in South Africa.

The failed spinal anaesthesia incidence is lower than that of an Eastern Cape study which found a failed spinal anaesthesia rate of 11.7% and a general anaesthesia conversion rate of 4.6%.[37] Internationally, it remains higher compared to findings from a Singapore study of 4.6%, with a general anaesthesia conversion rate of 0.5%,[28] and those from a tertiary hospital in Nepal of 9.9%.[51] In the United States of America the incidence of failed spinal anaesthesia was lower at 2.7%, with a general anaesthesia conversion rate of 1.2%.[52] The reason for the high incidence of failed spinal anaesthesia is likely multifactorial. Skill level of the anaesthetist may play a role, as well as longer duration of the caesarean section surgery. Technical difficulties encountered as a result of patient factors such as obesity, may increase the risk of failed spinal anaesthesia.[37]

Supplemental analgesia was provided in the form of fentanyl, morphine, midazolam, ketamine and paracetamol in varying doses either solely or in combination. Studies in the Eastern Cape, Singapore, and Nepal similarly utilised ketamine,[37] fentanyl and Entonox,[28] and ketamine and midazolam [51] respectively, as supplemental analgesics.

Conclusion

This retrospective study described the profile of caesarean section deliveries with a focus on anaesthesia management at CMJAH, a central hospital. Key findings included a caesarean section rate higher than the national average; spinal anaesthesia being the predominant anaesthetic technique performed; and a failed spinal anaesthesia incidence of 10.5%.

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Section 4: Appendices

4.1 Postgraduate committee approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

02 April 2017
Person No: 0402502R
PAG

Dr N Cassim
P O Box 9034
Azaadville
1750
South Africa

Dear Dr Cassim

Master of Medicine: Approval of Title

We have pleasure in advising that your proposal entitled *The profile of caesarean section deliveries at an academic hospital: a retrospective study* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

4.2 Ethics clearance certificate

R14/49 Dr Nazeera Cassim

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M170109

NAME: **(Principal Investigator)**	Dr Nazeera Cassim
DEPARTMENT:	Anaesthesiology Charlotte Maxeke Johannesburg Academic Hospital
PROJECT TITLE:	The Profile of Caesarean Section Deliveries at an Academic Hospital: A Retrospective Study
DATE CONSIDERED:	27/01/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Juan Scribante
APPROVED BY:	Professor P. Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	29/03/2017

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 Research Office Secretary in Room 10004,10th floor, Senate House/2nd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/We fully understand the the conditions under which I am/we are authorised 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 to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review in January and will therefore be due in the month of January each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature   Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

4.3 Approval letter from Chief Executive Officer of CMJAH

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Enquiries:
Mr. J. Maepa
Office of the Clinical Director
Tell: (011): 488-3365
Email:Johannes.maepa@gauteng.gov.za
08 March 2017

Dear Dr. Nazeera Cassim

STUDY TITLE: The profile of caesarean section deliveries at an academic hospital: a retrospective study.

Permission is granted for you to conduct the above recruitment activities as described in your request provided:

1. Charlotte Maxeke Johannesburg Academic Hospital will not anyway incur or inherit costs as result of the said study.
2. Your study shall not disrupt services at the study sites.
3. Strict confidentiality shall be observed at all times.
4. Informed consent shall be solicited from patients participating in your study.

Please liaise with the HOD and Unit Manager or sister in charge to agree on the dates and time that would suit all parties.

Kindly forward this office with the results of your study on completion of the research.

Supported / ~~not supported~~

Dr. M.I. Mofokeng
Clinical Director
DATE: 9/3/2017

Approved/not approved

Ms G. Bogoshi
Chief Executive Officer
Date: 10.03.2017

4.4 Approval letter from the Head of Department of Obstetrics and Gynaecology at CMJAH

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

UNIVERSITY OF THE WITWATERSRAND
JOHANNESBURG

Department of Obstetrics and Gynaecology

Charlotte Maxeke Johannesburg Academic Hospital

University of the Witwatersrand

011 488 3179

24 November 2016

Re: The profile of caesarean section deliveries at an academic hospital: a retrospective study

Dear Dr N Cassim

Permission granted to access records of patients in the Department of Obstetrics and Gynaecology, at Charlotte Maxeke Johannesburg Academic Hospital, for the period 1 August 2016 to 31 October 2016, for the purposes of your M Med research study.

Yours sincerely,

Dr H Rhemtula

Acting Head: Department of Obstetrics and Gynaecology

CMJAH

4.5 Approval letter from the Head of Department of Anaesthesia at CMJAH

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

DEPARTMENT OF ANAESTHESIA
Area 361
Charlotte Maxeke Johannesburg Academic Hospital
University of the Witwatersrand
Tel: 011 488 4344
Fax: 086 765 3477

22 November 2016

Ms GM Bogoshi
Chief Executive Officer
CMJAH

Dear Ms Bogoshi

MMed RESEARCH DATA COLLECTION: DR NAZEERA CASSIM

Dr Nazeera Cassim is a registrar in Anaesthesia requesting permission to collect data at Charlotte Maxeke Johannesburg Academic Hospital for her MMed research study, titled: "The profile of caesarean section deliveries at an academic hospital: a retrospective study." The proposed study entails an audit of anaesthesia records in the Department of Anaesthesia for the period 1 August 2016 to 31 October 2016.

The study will not have any cost implications to the hospital and has to be approved by the relevant ethics authority before data collection can start.

I fully support Dr Cassim in this research endeavor. The findings from her study may contribute towards improved service delivery to our maternity patients.

Yours sincerely,

Prof EE Oosthuizen
Clinical head: Department of Anaesthesia
CMJAH

Section 5: Proposal

The profile of caesarean section deliveries at an academic hospital: A retrospective study

Nazeera Cassim

0402502R

Supervisor:	Helen Perrie Department of Anaesthesiology
Co-supervisor:	Juan Scribante Department of Anaesthesiology
Co-supervisor:	Gladness Dakalo Nethathe Division of Critical Care, University of the Witwatersrand

1. Introduction

The practice of obstetric delivery by caesarean section has become well established. Medical advances, social and cultural perceptions, and legal factors have led to changes in the attitude toward caesarean sections being performed (1). In a 2013 report on data collected in the United States of America, caesarean section surgery was the most common major operating room procedure (2). In the United States of America, the caesarean section rate had increased by 41% between 1997 and 2010 (2) with a caesarean section rate of 33.1% reported in 2016 (3). Globally, the caesarean section rate has been increasing. A 2016 study found that caesarean section rates had increased worldwide from 6.7% in 1990 to 19.1% in 2014 (4).

These trends have evoked concern, because of the associated health, social, and financial implications of a rising caesarean section rate (4). There is a lack of consensus on what an appropriate caesarean section rate should be. The World Health Organisation (WHO) has recommended a caesarean section rate of 10 – 15%, but has also suggested that a caesarean section be offered to any women in need rather than aiming to achieve a specific rate (5). In developing countries, caesarean section rates are an important indicator of access to essential obstetric care (6).

Several factors have been attributable to the rise in the caesarean section rate such as an increase in medically justified caesarean sections and maternal risk profile (1). Having had a previous caesarean section will increase the likelihood of having a repeat caesarean section. The rise in medical malpractice claims have played a part in decreasing the threshold to perform a caesarean section (7). Maternal request is also an indication to have a caesarean section, and reasons may include social, cultural or psychological factors (8).

Internationally, common indications for a caesarean section have included a previous caesarean section, foetal distress or poor progress of labour (9-12). In South Africa, a study conducted in the private sector, also found the most common indications for a caesarean section were a previous caesarean section and cephalopelvic disproportion (13).

Caesarean sections may be performed electively, or as an emergency procedure. It has been demonstrated that emergency caesarean sections have been associated with higher maternal mortality compared to electively performed caesarean sections (8). In an Iranian study in 2013, 44% of the caesarean sections performed during the study period were performed electively and 56% as an emergency (14). These findings are similar to a study in Pakistan where 58.5% were emergency caesarean sections (10). The South African study conducted in the private sector had an almost equal elective and emergency caesarean section distribution with 52% and 48% respectively (13).

In South Africa, labour and delivery services are functions offered twenty-four hours a day at all hospital levels. Included, is the provision for caesarean section and anaesthesia services (15). An Australian study found that most emergency caesarean sections were performed between 07:00 and 17:00 (45%), followed by 31% during 17:00 and 00:00, and 23.4% between 00:00 and 07:00 (12). A study in the United Kingdom found that elective caesarean sections occurred more frequently between the hours of 09:00 and 19:00 (16).

The increased use of caesarean sections for obstetric delivery, has direct implications on the anaesthetic management and outcomes of these patients. The anaesthesia options available include neuraxial techniques such as spinal or epidural anaesthesia, as well as general anaesthesia. Even though general anaesthesia safety has increased over recent decades, its performance in the obstetric population, represents a significantly higher risk (17). The main area of concern being difficulty or inability to manage the airway after induction of general anaesthesia, with resultant complications (18). Difficulty in intubation is ten times more frequently encountered in the obstetric population compared to the non-obstetric population (19). The risk of aspiration under general anaesthesia and the development of a chemical pneumonitis are of concern. General anaesthesia is associated with an additional 100 – 200 ml average blood loss, compared with regional anaesthesia (19). A declining trend in the use of general anaesthesia for caesarean section has been noted (20).

Spinal anaesthesia is a commonly employed anaesthetic technique for caesarean section delivery. In addition to avoiding the above-mentioned complications associated with general anaesthesia, spinal anaesthesia is relatively straightforward to perform, with rapid onset of action providing good neuraxial block (21). In the United Kingdom, a study found that 78% of caesarean sections were performed under neuraxial anaesthesia (22). A 2005 study found that spinal anaesthesia was performed in 80% of elective caesarean sections and 59% of emergency caesarean sections in the United States of America (23). Spinal anaesthesia was the most common mode of anaesthesia for caesarean sections in Taiwan in the past decade

(24). A Czech Republic study, demonstrated that the rate of neuraxial use in caesarean sections had increased from 6.7% in 1993 to 55.6% in 2011 (25).

In South Africa, the essential steps in the management of obstetric emergencies also known locally as ESMOE (26), have published protocols with regards to the anaesthetic management of patients undergoing a caesarean section. These detail the method of carrying out a safe spinal anaesthetic (27) or if required, a safe general anaesthetic (28).

Occasionally, the attempted spinal anaesthetic may result in an inadequate block or no discernible block. This is referred to as a failed spinal anaesthetic which may then require either supplemental analgesia or conversion to a general anaesthetic (29).

The Royal College of Anaesthetists (30) suggests a conversion rate from neuraxial anaesthesia to general anaesthesia to be less than 1% for elective caesarean sections, and less than 3% for emergency caesarean sections. International studies have found spinal anaesthesia failure rates in obstetric caesarean section patients, ranging from 0.5% – 6% (31, 32).

Bupivacaine is the most common local anaesthetic used for caesarean section spinal anaesthesia (33). A South African study found that low dose spinal anaesthesia was advocated due to the potential for improved cardiovascular stability (34). To obtain adequate local anaesthetic spread, the hyperbaric variety of bupivacaine is used. It is available in concentrations of 0.5% or 0.75% with doses of 10 – 15 mg being administered, if used as the sole agent. A dose of 7.5 mg may be used, but anaesthesia of poor quality may result. Lower doses of bupivacaine are therefore usually combined with opioids (33). In some centres, local anaesthetics such as levobupivacaine or ropivacaine may also be used. The addition of certain additives confers advantageous properties, in the case of spinal anaesthesia for caesarean section, an opioid is usually added. The addition of an opioid will tend to prolong the duration and improve the quality of the block (33). Some institutions use morphine (31), some sufentanil (35), and others, fentanyl (36, 37).

The provision of caesarean section and anaesthesia services as part of emergency obstetric care, play an important role in reducing maternal and neonatal mortality (38, 39). In South Africa, facilities to provide a caesarean section are functions of district, regional and central hospitals (15). Higher risk profile patients should be managed at regional and central hospitals where specialist services and intensive care unit facilities are available (15). It is relevant to obtain information relating to the profile of caesarean sections within a specific setting, and particularly the anaesthetic management thereof.

2. Problem statement

A caesarean section is a well-established method of obstetric delivery when appropriately indicated (40). It is not without problems however, and has been associated with increased maternal and foetal complications (41, 42). These complications may be related to the surgery itself, the anaesthesia, or pre-existing patient risk factors. In South Africa, during the triennium 2014 – 2016, there were 1201 caesarean section related maternal deaths, with bleeding during or after caesarean section accounting for 217 of those (43).

There were 87 anaesthesia related complications recorded during the triennium with a national maternal mortality ratio for anaesthesia related deaths of 3.16 (43).

In a setting with a high case volume load, and increased burden of disease, the requirement for increasingly safe anaesthesia is of paramount importance. The ESMOE programme provides guidelines for carrying out an anaesthetic for the obstetric patient, including a compilation of drugs required for anaesthesia for caesarean section (44).

It is not known what the current practice is, in the anaesthetic management of patients presenting for caesarean section, at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

3. Aims

The aim of this study is to retrospectively describe the profile of caesarean section deliveries with a focus on the anaesthesia management at CMJAH over a 3-month period.

4. Objectives

The primary objectives of this study are to:

- classify the anaesthetic technique used,
- determine the incidence of failed spinal anaesthesia and the subsequent management thereof,

- describe the drugs used and quantify the dose of spinal medication being administered.

The secondary objectives of this study are to:

- determine the proportion of caesarean section deliveries,
- quantify the number of elective versus emergency caesarean sections performed,
- describe the indications for the caesarean sections performed,
- describe the timing of the caesarean sections performed (day/night and weekday/weekend).

5. Research assumptions

The following definitions will be used in the study.

Elective caesarean section	A caesarean section performed when there is no evidence of maternal or foetal compromise and a suitable delivery date is chosen and agreed upon by both patient and obstetrician (category 4) (45). In this study any patient booked as an elective caesarean section shall be classified as such.
Emergency caesarean section	A caesarean section performed when: there is maternal or foetal compromise with immediate threat to life (category 1) or, there is maternal or foetal compromise which is not immediately life threatening (category 2) or, early delivery is required but with no evidence of maternal or foetal compromise (category 3) (45). In this study any patient booked as an emergency caesarean section shall be classified as such.
Failed spinal anaesthesia	An attempted spinal anaesthetic which resulted in an inadequate neuraxial block or no evidence of a neuraxial block, necessitating the use of supplemental analgesia or conversion to general anaesthesia (29).

Day	From 07:00 – 16:00.
Night	From 16:00 – 07:00.
Weekday	From Monday 07:00 to Friday 16:00.
Weekend	From Friday 16:00 to Monday 07:00.

6. Demarcation of the study field

The study will be conducted in the Department of Anaesthesiology and the Department of Obstetrics and Gynaecology at CMJAH. CMJAH is a central category hospital located in Gauteng. It is affiliated to the Faculty of Health Sciences of the University of the Witwatersrand. There are approximately 320 caesarean sections done per month, as per the CMJAH Obstetrics and Gynaecology departmental statistics.

7. Ethical considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (Medical) and the Graduate Studies Committee of the University of the Witwatersrand.

Once this is obtained, permission to conduct the study will be requested from the Chief Executive Officer of CMJAH (Appendix A). Approval to access stored records will be obtained from the Head of Department of Obstetrics and Gynaecology (Appendix B) and the Head of Department of Anaesthesia at CMJAH (Appendix C).

This is a retrospective study and no identifying information will be recorded on the data collection sheet. Each patient record will be allocated a study number. Patient names, hospital numbers and study numbers will be recorded and filed separately to ensure anonymity. Confidentiality will be maintained as only the researcher and supervisors will have access to the raw data.

All data will be stored securely in a password protected database for six years after completion of the study.

This study will be conducted according to the principles of the Declaration of Helsinki (46) and the South African Guidelines for Good Clinical Practice (47).

8. Data collection

8.1 Research design

The research design used in this study is one of a retrospective, contextual, descriptive nature.

A retrospective study measures variables that have occurred in the past (48). This study will obtain information from previously completed records.

A contextual study will focus on a specific group, defined by De Vos et al (49) as a "small-scale world". This study will be contextual as it will be undertaken at CMJAH.

A descriptive study, will describe variables with no manipulation (48). This study will describe the profile of caesarean sections at CMJAH.

8.2 Study population

The study population will be the theatre register and records of the patients who had a caesarean section at CMJAH.

8.3 Study sample

Sample size

The sample size will be determined by the number of patients who had a caesarean section at CMJAH for the period 1 August 2016 to 31 October 2016.

Sampling method

This study will use a consecutive, convenience sampling method. Consecutive sampling will attempt to include all subjects meeting the inclusion criteria into the study. Convenience sampling includes all conveniently available subjects in a non-probable manner (50).

A consecutive convenience sampling method will be used, as all the records, as they have been entered will be used to collect data.

Inclusion and exclusion criteria

Included in this study, will be the records (including incomplete) of every patient who had a caesarean section at CMJAH from 1 August 2016 to 31 October 2016. Illegible records will be excluded from this study.

8.4 Data collection

Data will be collected in two parts from CMJAH once the study has been approved.

Part one: general information (Appendix D)

The following data will be recorded on a Microsoft Excel spreadsheet

- total normal vaginal deliveries.
- total caesarean section deliveries.

The CMJAH labour ward admissions record and obstetric theatre register will be used to determine the number of patients that had a normal vaginal delivery, and caesarean section respectively.

Part two: data collection information

The CMJAH anaesthetic charts for caesarean sections done during the study period, will be used to obtain details regarding the caesarean sections performed and recorded on a Microsoft Excel spreadsheet. The data collected (Appendix E) will include the following information:

- ASA classification
- elective vs emergency caesarean section
- indication for caesarean section
- timing of caesarean section
- anaesthetic technique performed
- drugs and dose used for spinal anaesthesia including use of supplemental oxygen
- any failed spinal, and the subsequent management thereof including type of supplemental analgesia if used.

Each entry in the CMJAH obstetric theatre register will be recorded with the patient's name, hospital number and allocated study number on a separate Microsoft Excel spreadsheet, allowing for the identification of specific records if required. Only the study number will be used during data analysis.

Data capturing will be done in the Department of Obstetrics and Gynaecology and the Department of Anaesthesiology at CMJAH by a single researcher. Records will not be removed from the hospital premises.

8.5 Data analysis

A Microsoft Excel spreadsheet will be used to capture and analyse all the data obtained. Descriptive statistics will be used to analyse the numerical data. Categorical data will be presented using frequencies and percentages. Normally distributed continuous variables will be presented using means and standard deviations. Continuous data that is not normally distributed will be presented using medians and interquartile ranges.

9. Significance of the study

Information on the current anaesthetic management of patients presenting for caesarean section would provide useful information on our current practices and to monitor the standard of care. The profile of caesarean section delivery at CMJAH, a central care facility, where a high burden of disease is expected, is important to understand the background and patient population profile in which anaesthesia services are currently being rendered. This study would provide useful information to all involved in the management of expectant mothers.

The current practice can help identify any gaps or deficiencies and can allow for the implementation of new strategies, skills development and training, as well as best practice methods to improve service delivery and quality of health care.

The continual monitoring of caesarean section services and rates, is important to gauge and improve health care services. A caesarean section rate above the recommended 15% in the setting of CMJAH, could be attributable to several factors. High caesarean section rates translate into a higher requirement for safe and optimal anaesthesia.

10. Validity and reliability of the study

The validity of a study seeks to determine how well the study reflects the concepts being investigated. Reliability is concerned with determining the consistency of the technique used to obtain the measurements (51).

To ensure validity and reliability, the research design used for this study will be appropriate. Every tenth entry into Microsoft Excel will be checked for accuracy. A single researcher will be collecting data as per a standardised data collection sheet.

11. Potential limitations of the study

Study limitations are defined as methodological restrictions which may decrease the generalisability of the findings (51).

Due to the contextual nature of the study, the findings may not be representative of what may be occurring in other hospitals, within South Africa, or even internationally. A retrospective study is limited to only the information that has been recorded.

Other study limitations pertain to the quality of the records used to obtain the data. Records may be incomplete, inaccurate or illegible.

There is no distinction made between the various categories (1 – 3) of urgency of emergency caesarean sections in this study.

12. Project outline

	Nov 2016	Dec 2016	Feb 2017	Mar 2017	April 2017	May 2017	July 2017	Aug 2017	Sept 2017	Oct 2017	Nov 2017
Proposal and literature review											
Proposal submission											
Ethics approval											
Postgraduate approval											
Data collection											
Data analysis											
Draft article											
Submission											

13. Financial plan

The Department of Anaesthesiology at the University of the Witwatersrand will bear the costs of printing and paper for the study.

	Price per page	Number of pages	Copies	Total
Proposal	R1	20	10	R200
Ethics form	R1	10	25	R250
Post graduate form	R1	2	6	R12
Completed report	R1	80	4	R320
			Grand total	R782

14. References

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Appendix A: Request to CEO of Charlotte Maxeke Johannesburg Academic Hospital

Dr Nazeera Cassim

Department of Anaesthesiology

University of the Witwatersrand

Attention: The CEO of Charlotte Maxeke Johannesburg Academic Hospital

Re: The profile of caesarean section deliveries at an academic hospital: a retrospective study

Dear Doctor

I am a registrar in the Department of Anaesthesiology. For the research component of my MMed I propose to conduct a retrospective audit of the profile of caesarean sections being performed at Charlotte Maxeke Johannesburg Academic Hospital. The study has been approved by the Human Research Ethics Committee (Medical) (M170109) and Graduate Studies Committee.

This audit will involve reviewing the caesarean section and anaesthetic records for the period 1 August to 31 October 2016. The records will be the focus of the study and no identifying patient or medical staff information will be recorded. Records will be reviewed where they are stored and will not be removed from the premises.

There will be no financial implications for Charlotte Maxeke Johannesburg Academic Hospital or the Gauteng Department of Health. A copy of the final report will be made available to you if requested.

Yours sincerely

Dr Nazeera Cassim

0721253094

nazca45@gmail.com

Appendix B: Request to HOD of Obstetrics and Gynaecology at Charlotte Maxeke Johannesburg Academic Hospital

Dr Nazeera Cassim

Department of Anaesthesiology

University of the Witwatersrand

Attention: The HOD of Obstetrics and Gynaecology at Charlotte Maxeke Johannesburg Academic Hospital

Re: The profile of caesarean section deliveries at an academic hospital: a retrospective study

Dear Dr L Chauke

I am a registrar in the Department of Anaesthesiology. For the research component of my MMed I propose to conduct a retrospective audit of the profile of caesarean sections being performed at Charlotte Maxeke Johannesburg Academic Hospital.

This audit will involve reviewing the records of patients who had a caesarean section for the period 1 August to 31 October 2016. I request permission to access these records for my study. No identifying patient or medical staff information will be recorded. Records will be reviewed where they are stored and will not be removed from the premises.

A copy of the final report will be made available to you if requested.

Yours sincerely

Dr Nazeera Cassim

0721253094

nazca45@gmail.com

Appendix C: Request to HOD of Anaesthesiology at Charlotte Maxeke Johannesburg Academic Hospital

Dr Nazeera Cassim

Department of Anaesthesiology

University of the Witwatersrand

Attention: The HOD of Anaesthesiology at Charlotte Maxeke Johannesburg Academic Hospital

Re: The profile of caesarean section deliveries at an academic hospital: a retrospective study

Dear Prof E Oosthuizen

I am a registrar in the Department of Anaesthesiology. For the research component of my MMed I propose to conduct a retrospective audit of the profile of caesarean sections being performed at Charlotte Maxeke Johannesburg Academic Hospital.

This audit will involve reviewing the anaesthetic chart records of patients who had a caesarean section for the period 1 August to 31 October 2016. I request permission to access these records for my study. No identifying patient or medical staff information will be recorded. Records will be reviewed where they are stored and will not be removed from the premises.

A copy of the final report will be made available to you if requested.

Yours sincerely

Dr Nazeera Cassim

0721253094

nazca45@gmail.com

Appendix D: general information

Total normal vaginal deliveries during study period	
Total caesarean section deliveries during study period	

Appendix E: data collection information – caesarean section profile

Study number	
ASA classification	
Elective or emergency caesarean section	
Indication for caesarean section	
Timing of caesarean section	Day/ Night Weekday/ Weekend
Anaesthetic technique	Spinal General Epidural Other
Spinal anaesthesia drugs and dose	**Local anaesthetic and dose (mg)** Hyperbaric bupivacaine 5 mg/ml Other **Opioid and dose (mcg)** Fentanyl 50 mcg/ml Sufentanil 5 mcg/ml Other **Supplemental oxygen:** None Face mask including FiO2 Nasal cannula including FiO2
Failed spinal anaesthesia	Supplemental analgesia used: Opioids Ketamine Other Conversion to GA