OBSTETRIC ANAESTHESIA IN LEVEL 1 AND 2 HOSPITALS IN THE FREE STATE. A STUDY AND AUDIT AND REMEDIAL INTERVENTIONS

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FACULTY OF HEALTH SCIENCES
UNIVERSITY OF THE FREE STATE
BLOEMFONTEIN

March 24th 2010

PROMOTER: Prof. BJS Diedericks

DECLARATION

I hereby declare that this study which is submitted here is the result of my own independent investigation. Where assistance was given, this has been acknowledged.

I declare that this study is submitted for the first time at this university and faculty, towards a Ph.D in Anaesthesiology and that it has never been submitted to any other university or faculty for the purpose of obtaining a degree.

I declare that I have no conflicts of interest regarding this study.

Permission for this study was obtained from the Free State Department of Health.
Ethics Committee approval was granted by the University of the Free State
(ETOVS NR 251/02).

…… ……..

G. LAMACRAFT **DATE**

I hereby cede copyright of this product in favour of the University of the Free State

…… …….

G. LAMACRAFT **DATE**

DEDICATION

This study is dedicated to all the children in the Free State, whose mothers died as a result of obstetric anaesthesia.

A motherless soft lambkin
    Along upon a hill;
No mother’s fleece to shelter him
    And wrap him from the cold:
I’ll run to him and comfort him,
    I’ll fetch him, that I will;
I’ll care for him and feed him
    Until he’s strong and bold.
Christina Rossetti (1830-94)

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- Prof G. Joubert and the Department of Biostatistics of the University of the Free State, for their assistance in design of the study and data analysis.

Role of the Co-Investigators:

The co-investigators were Dr S. Hollingworth, Dr M.J. Schmidt, Dr P. Kenny and Dr .J Dowie.

Data collection was performed by me, with the assistance of the co-investigators:
In Phase 1 of the study I visited 50% of the hospitals myself, accompanied by one co-investigator. I was unable to travel to all the hospitals myself at that time, as I was seven months pregnant. The remaining, more distant hospitals were visited by the senior co-investigator (Dr J Dowie), with another of the co-investigators. In Phase 2 of the study, I visited all the hospitals myself, accompanied by one co-investigator.

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ABBREVIATIONS

AUT NIBP	Automated non-invasive blood pressure monitor
CAPNOG	Capnograph
CEMACH	Confidential Enquiries into Maternal and Child Health
CEMD	Confidential Enquiries into Maternal Deaths
CEO	Chief Executive Officer
CIMDRG	Confidential Inquiry into Maternal Deaths Research Group
COHSASA	Council for Health Services Accreditation of Southern Africa
Comm Serv Dr	Community Service Doctor
Crico set	Cricothyroidotomy set
CS	Caesarean Section
ECG	Electrocardiograph
ET	Endotracheal
FiO2	Inspired Oxygen analyser
FS Dept Health	Free State Department of Health
GA	General Anaesthesia
GP	General Practitioner
GTN	Glyceryl trinitrate
HPCSA	Health Professions Council of South Africa
iCAM	Interactive Learning Communication and Management
INDMR	Intermediate acting non-depolarising muscle relaxant
IV	Intravenous
LMA	Laryngeal mask
MO	Medical Officer
MMM	Mofumahadi Manapo Mopeli Hospital
NCCEMD	National Committee on Confidential Enquiries into Maternal Deaths
NICE	National Institute for Clinical Excellence
NPSA	National Patient Safety Agency
OA	Obstetric Anaesthesia
PNS	Peripheral nerve stimulator
Prop	Propofol
RA	Regional Anaesthesia
SA	South African

SASA	Southern African Society of Anaesthesiologists
Thio	Thiopentone
UFS	University of the Free State
UK	United Kingdom

DEFINITIONS

Maternal death: The International Classification of Diseases, Injuries and Causes of Death (10th Revision), defines a maternal death as the "death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes" [1].

Direct maternal death: a maternal death due to obstetric complications of pregnancy, childbirth or the puerperium[1].

Indirect maternal death: a maternal death due to previous existing disease or condition that developed during pregnancy and which was not due to direct obstetric causes, but was aggravated by the physiological causes of pregnancy[1].

Pregnancy related death: a maternal death due to unrelated causes which happened to occur in pregnancy or the puerperium[1].

Maternal mortality rate: (Maternal deaths (direct and indirect) ÷ live births) X *k* (where *k* may be 1000, 10,000 or 100,000 as preferred and indicated by country)[1].

Level one hospital: a district hospital**.** The Free State Department of Health definition of a district hospital is given as one of the following 24 hospitals: Diamant (Diamond), Stoffel Coetzee, Embekweni, National, Botshabelo, Mantsopa, Dr JS Moroka, Nala, Mohau, Thusanong, Winburg, Katleho, Parys, Metsimaholo, Mafube, Tokollo, Elizabeth Ross, Thebe, Phumelela, Phekolong, Nketoana, John Daniel Newberry, Phutholoha, Itemoheng[2].

Level two hospital: a regional hospital. The Free State Department of Health defines this as one of the 5 following hospitals: Boitumelo, Bongani, Dihlabeng, Mofumahadi Manapo Mopeli (MMM), Pelonomi[2].

Level three hospital: a tertiary hospital. The Free State Department of Health defines this as Universitas Academic Hospital[2].

Community Service Doctor: a newly qualified doctor who, after completion of Internship, must complete a year of Community Service in South Africa before obtaining full registration with the Health Professions Council of South Africa.

Confidential enquiries into maternal deaths (CEMD): a systematic multidisciplinary anonymous investigation of all or a representative sample of maternal deaths occurring at an area, region (state) or national level which identifies the numbers, causes and avoidable or remediable factors associated with them. Through the lessons learnt from each woman's death, and through aggregating the data, confidential enquiries provide evidence of where the main problems in overcoming maternal mortality lie and an analysis of what can be done in practical terms, and highlight the key areas requiring recommendations for health sector and community action as well as guidelines for improving clinical outcomes[3].

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SUMMARY

Key terms: anaesthetic drugs, anaesthetic equipment, anaesthesia experience, general anaesthesia, manpower, maternal mortality, monitors, obstetric anaesthesia, protocols, referral system, regional anaesthesia, resuscitation, spinal anaesthesia, supervision, training.

Reports from the maternal death notification system showed a high number of maternal deaths from anaesthesia in the Free State. I initiated this study in order to investigate and rectify factors identified as being associated with this problem.

The study method used was an audit cycle. I selected from the literature on maternal deaths the five main factors most likely to be relevant ie manpower, use of regional anaesthesia, anaesthetic drugs and equipment, resuscitation protocols and the referral system.

In the first part of the study (Phase 1), every level one and two hospital in the Free State in which Caesarean sections (CS's) were being performed was inspected to determine whether the required standards for these factors were being met. The intention was to then implement remedial interventions to correct any problems identified in Phase 1 and then in Phase 2 to repeat the hospitals visits to assess the effect of the interventions.

Phase 1 showed deficiencies in essential anaesthetic drugs and equipment in most hospitals. Hospital staff and managers were clearly informed regarding these problems but there was only a slight overall improvement in standards when the audit was repeated in Phase 2 and even a decline in certain aspects.

Anaesthetic manpower was studied using self-completed questionnaires. Only a third of these questionnaires were returned and they showed that doctors were largely inadequately trained and supervised whilst administering obstetric anaesthesia. These results were presented to Free State Department of Health Top Management. Concern over possible bias regarding the doctors who returned the forms was raised and it was requested this study should be repeated using a different method to improve the response rate. This was done in Phase 2, a 69% response rate was achieved and the results confirmed the Phase 1 findings.

Management was presented with these findings and interventions to resolve these problems was suggested to them.

Use of regional anaesthesia was studied via inspection of theatre record books. In Phase 1 it was found that 71% of CS's were performed using regional anaesthesia (RA), close to the proposed goal of 75%. However, in some hospitals no or few CS's were performed using RA. There followed remedial interventions in which RA was promoted and in Phase 2 it was found that 84% of CS's had been performed using RA. Unfortunately there is now concern that RA is being over utilised and general anaesthesia is not being administered when appropriate.

In Phase 1, there were virtually no hospitals in which up-to-date resuscitation protocols were displayed. Protocols were distributed to all and in Phase 2 more, but not all, hospitals had the required protocols on display.

The referral system was studied in Phase 1 using data collection sheets which were to be completed by the doctors when a patient had a CS. There was such poor compliance with this part of the study that it was decided that to resolve this would require a completely separate study utilizing greater research resources. Further investigation was therefore abandoned.

Performing this audit had the desired result of improving the awareness of problems relating to obstetric anaesthesia in the Free State, at a Provincial and National level amongst both health care professionals and management. Although the remedial interventions did not "cure" some of the problems identified, progress was made and where progress was not made there is now greater knowledge as to where the problems lie. It remains for those who have the resources to tackle these issues, which are largely concerned with manpower, to take cognisance of the results of this study and implement the suggested corrective measures.

(SUMMARY IN AFRIKAANS)

Verslae van die moederlike sterfte aanmeldingsstelsel in die Vrystaat het op `n hoë aantal moederlike sterftes geassosieer met narkose gedui. Ek het die studie onderneem om die probleem te ondersoek en `te verbeter.

Die studie metode gebruik is `n oudit siklus. Ek het vyf hooffaktore in die literatuur aangaande moedelike sterftes geïdentifiseer wat as hoofsaaklike redes kan wees: mannekrag, gebruik van regional narkose tegnieke, narkose middels en toerusting, resussitasie protokolle en die verwysingstelsel.

In die eerste gedeelte van die studie word al die vlak een en twee hospitale in die Vrystaat waar keisersnitte (k/s `e) uitgevoer word ondersoek om vas te stel of aan verwagte standaarde vir hierdie faktore voldoen word. Die doel was dan om `korrigerende intervensies te implementer om probleme in fase 1 geïdentifiseer te verbeter en in fase 2 die hospitale weer te besoek en die effek van intervensies te evalueer.

Fase 1 het op tekorte in essensiële narkose middels en toerusting in meeste hospitale gedui. Hospitaalstaf en –bestuurders was goed ingelig t.o.v hiervan, maar daar was klein verbeteringe en selfs agteruitgang van standaarde met die oudit herhaal in Fase 2.

Narkose mannekrag is geëvalueer deur ingevulde vraelyste.. Slegs `n derde van vraelyste is terug ontvang. Die vraelyste dui dat dokters meestal sonder voldoende opleiding en supervisie obstetriese narkose toedien. Die resultate is voorgelê aan die topbestuur van Vrystaat Departement van Gesondheid. Kommer rondom moontlike sydigheid in vorms deur dokters teruggestuur, is gelig. Daar is versoek om die studie te herhaal deur gebruik te maak van `n ander metode om die terugvoersyfer te verbeter. Dis uitgevoer in Fase 2, 69% terugvoer is ontvang en die resultate het Fase 1 se bevindings bevestig Hierdie bevindings en intervensies is voorgelê aan die bestuur.

Die gebruik van regionale narkose is ondersoek via inspeksie van teater rekords. In Fase 1 is bevind dat 71% van k/s`e onder regionale narkose uitgevoer is, naby aan die voorgestelde doelwit van 75%.In sommige hospitale is gevind dat geen of minimale k/s`e onder regionale tegnieke gedoen word. Korrigerende intervensies om regionale tegnieke te bevorder het

gevolg en in Fase 2 is gevind dat 84% van keisersnitte onder regionale narkose plaasgevind het. Daar is egter nou kommer dat algemene narkose nie toegedien word in toepaslike gevalle nie.

In Fase 1 was daar omtrent geen hospitale met op datum resussitasie protokolle nie. Protokolle is aan almal voorsien en in Fase 2 het meer, maar tog nie almal,die toepaslike protokolle gehad.

Die verwysingstelsel is in Fase 1 bestudeer met die gebruik van versamelingsdata vorms ingevul deur dokters met die uitvoer van `n k/s. Samewerking was egter swak. Om die faktor aan te spreek sal `n geheel ander studie gebruik moet word met meer navorsing hulpbronne. Verdere ondersoek is dus gestaak.

Met die uitvoer van hierdie oudit is die verwagte resultaat verkry rondom die bewuswording van probleme geassosieer met obstetriese narkose in die Vrystaat op Provinsiale en Nasionale vlak tussen gesondheidwerkers en bestuur. Al het die korrigerende intervensies nie al die probleme geïdentifiseer “opgelos” nie, is vordering gemaak. Waar nie verbeter is nie, is problematiese areas geïdentifiseer. Die verantwoordelikheid lê nou by diegene met die nodige hulpbronne om die faktore (hoofsaaklik mannekrag) aan te spreek met in agneming van resultate en voorstelle in hierdie studie gemaak.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

1.1.1 The problem of maternal deaths due to anaesthesia

A maternal death is a tragedy. Instead of the anticipated joy of birth and a new life, the family now suffers grief for the loss of a woman who was a cherished wife or partner, a beloved daughter or sister, or an adored mother of now motherless children.

In many cases the baby dies with the mother. In others the baby is born with serious morbidity as a consequence of experiencing cerebral hypoxia due to a traumatic delivery. A common cause of developmental disability in children in South Africa is perinatal hypoxia[4]. Rarely the baby is born well, but then has to be nurtured without the protective effect from childhood illnesses of maternal breastfeeding. There is a higher mortality rate for infants who have been made motherless, particularly in rural areas[5,6]. Whereas traditionally, in the African culture, motherless children are cared for by the extended family, the AIDS epidemic is stressing this traditional support system as well as social services[7]. Youth-headed households are consequently becoming more prevalent. The health of children living in such households is not good; the young heads of these households experience social isolation and depression, and the youngest children in these homes experience emotional distress[8].

The growing child has to develop without the emotional support of a mother. It may have to endure the stigma of being known in the family as the child whose birth resulted in the death of the mother. Rejection and psychological difficulties can result. In some families, the mother has to rear the children alone, as the father has absconded soon after conception. For these families, the loss of the mother at birth effectively renders not that baby, and its older siblings as parentless orphans.

These problems can persist into adulthood. Where children are not taught by parents to control their emotions and energy, they can develop dangerous behavior[9]; this could result in a higher crime rate amongst parentless children as teenagers and adults. Institutional rearing

of orphaned children can result in gross psychological trauma and seriously diminished functioning in late adulthood[10]. Psychosomatic disorders such as headache are more prevalent where there has been childhood family adversity[11].

In developed countries, where medico-legal claims can result in lawsuits of hundreds of millions of rands, an obstetric accident resulting in the death of a mother and the birth of a brain damaged child is associated with payouts of the highest order. There will be a claim for the death of the woman both as a spouse and as a caregiver to her previous children; in addition there will be a substantial claim for the lifelong care of a severely handicapped baby. There are web sites particularly designed for making legal claims after obstetric complications[12]. In the USA there is a "tense medico-legal climate in obstetrics and obstetric anaesthesia"; 20.2% of obstetric anaesthesiologists intend to cease practicing in this sub-speciality in the next 2 years because of medico-legal concerns and is the most common subspeciality to be sued[13].

In developing countries such as South Africa, medico-legal claims currently occur infrequently. This is largely because of poverty and ignorance. Often the family is not informed of the details of the mother's death and assumes it is a consequence of natural causes. Even if the family is aware, or suspects, that negligence occurred, many are too poor to independently pursue a legal claim, or live in communities without easy access to free legal advice or aid.

This situation is now changing. Action Groups are empowering the disadvantaged and there is a slow but growing awareness that even the poorest of the poor in this country have a right to know the full details of a family member's death, and are entitled to compensation where justified. It is a sad but true fact that it often takes expensive legal claims *after* tragedies have occurred, before a government takes action to *prevent* tragedies occurring.

They are now legal firms which specialise in medico-legal claims which can also be accessed using the internet[14]. These legal claims are just around the corner. Some may be dated back several years as a Supreme Court of Appeal judgment in 2006 allows a claim to be made for up to three years after the plaintiff has managed to secure a medical opinion regarding it, not just three years from when the incident occurred[15] Unless action is taken to prevent anaesthesia-related maternal deaths, the Department of Health will soon be faced

with substantial legal claims for maternal deaths due to anaesthesia. Most of these deaths have been shown to be avoidable; the Saving Mothers Reports of South Africa, which each contain a chapter dedicated to anaesthesia-related deaths (see below), have all shown legally indefensible problems such as operator incompetence to be main factors related to anaesthesia-related deaths. Little has been done to correct these problems[16], and there still remains a potential for substantial late claims.

1.1.2 Monitoring maternal deaths due to anaesthesia

Monitoring the maternal deaths that occur in a country is essential for their prevention. The numbers must be recorded and the causes analysed. Appropriate action to correct the problems identified can then be implemented and the outcome measured by the effect on the subsequent number of maternal deaths.

The World Health Organisation (WHO) describes three ways in which the causes and characteristics of maternal deaths can be studied using audit systems[17]. These are the use of a confidential enquiry into maternal deaths (CEMD), facility-based death reviews and community-based reviews

The South African maternal death notification system was modeled on that of the United Kingdom and uses a CEMD approach. Information from this system is published by the South African Department of Health as the Saving Mothers Reports.

The United Kingdom developed the system known as the Confidential Enquiries into Maternal Deaths (CEMD) in 1952, shortly after the inception of the National Health System, which occurred in 1947. A further description of the UK Confidential Enquiries into Maternal deaths is given below (1.1.2). It is likely that to have a similar, effective notification system as that of the UK, a country needs to have a substantial number of health care professionals working in a National Health Care environment. One of the problems faced by South African public health care doctors, who are involved in compiling the Saving Mothers Reports, is being able to complete one’s clinical duties and then spend time analysing maternal death notification forms and files. With the current shortage of doctors in SA and their relatively low pay compared to private practice, they will continue to leave the

overburdened public system either for private practice or overseas and this situation is unlikely to change in the near future.

Some private practitioners have a genuine desire to help the public health care system but find it particularly difficult to leave their private practice to attend Health Department meetings as these are often in other cities. They have no paid “academic” time and must use what little leisure time they have to analyse maternal deaths. There is no remuneration for the time spent in this activity, time potentially lost from their private practice and thus lost income.

1.1.2.1 The South African maternal death notification system

An understanding of the maternal death notification system of South Africa is essential for the understanding of this thesis, so there now follows a description of this system which results in the Saving Mothers Reports (1.1.1). The Confidential Enquiries into Maternal Deaths of the United Kingdom, is then described (1.1.2), as this is the system on which the South African one has been modeled.

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On the first of October 1997, maternal deaths in South Africa became legally notifiable in terms of the National Policy Health Act, number 116 of 1990. This occurred three years after the end of apartheid and at a time when the new government was changing the Health Care system in order to benefit previously disadvantaged citizens. Several models for improving health care were introduced at this time, from changes in education at medical schools to health care delivery. These were frequently based on models used from the United Kingdom, probably because this is the only English-speaking country in the world with a predominantly public health care system of a high standard. The system used in the United Kingdom to monitor and prevent maternal deaths, The Confidential Enquiries into Maternal Deaths, was one such model introduced, and the South African maternal death notification system was based on this model. The system is run by the National Department of Health via the National Committee for the Confidential Enquiries into Maternal Deaths in South Africa (NCCEMD) (see below: 1.1.2.1.6).

1.1.2.1.1. Reporting a maternal death to the Provincial Co-coordinator

When a maternal death occurs in an institution, the most senior health care professional involved (this can be a doctor or a nurse) must complete the maternal death notification form within 24 hours. Each Provincial Maternal Health Department has a coordinator for maternal deaths, and that person must be informed telephonically of the death. The coordinator gives the contact person the unique number by which the patient will subsequently be identified. Photocopies of all of the patient's records are sent with the maternal death notification form. The original records must be kept by the hospital or clinic where the death occurred for their own adverse event inquiry system use or medico-legal purposes.

1.1.2.1.2 Problems of reporting

Several problems have been experienced even at this initial stage of the maternal death notification system.

a Being unable to telephonically contact the co-coordinator -the Free State co-coordinator has a voice-mail telephone facility so she can respond to calls made outside of normal working hours.

b Some institutions are without photocopiers. In some they are malfunctioning and repairs are delayed.

c Institutions located in remote rural areas are often unable to readily access transport, so there are delays, or failures, of transporting the documents to the Provincial Maternal Health Departments. This transport can also be inefficient, and files may be lost in the transport process.

d Lack of awareness that the maternal death must be reported. Even though it is a legal requirement to notify a maternal death, there are remain practitioners who appear unaware of this law or who seem not to understand the definition of a maternal death. It may be that some of these doctors are from overseas and the maternal death notification system has not been clearly explained to them. Rural hospitals, particularly in regions of poverty, are frequently staffed by such doctors as they cannot attract South African doctors. These are the hospitals where anaesthesia-related deaths occur with the highest frequency and it is incumbent on each Provincial Maternal Health Department to ensure that all the doctors in these hospitals are fully aware of the correct procedure to follow after a maternal death.

e Fear of recrimination from reporting a maternal death. Some health care professionals (again, possibly those from overseas) do not wish to report a maternal death as they are under the misconception that they will be penalised for the actions they took which led to the maternal death. It is emphasised that this system is strictly confidential and there are no repercussions from reporting a maternal death.

f Failure to enforce the law. Laws need enforcing to be effective, and to date, no health care professional in South Africa has been prosecuted for failing to report a maternal death. Furthermore, although it is a legal requirement that all deaths that occur whilst the patient is under the influence of anaesthesia should be referred for a *forensic post-mortem*, this rarely occurs. Practitioners are often reluctant to approach the patient's family to inform them of this, and if the family expresses a wish for a post-mortem not to be performed, the practitioner does not contact the police so that the law may be enforced. On occasions the police are themselves also reluctant to enforce this law, for their own personal reasons. Because of this failure to obtain forensic post-mortems, it is has occasionally been difficult to establish the true cause of a patient's death and false conclusions may have been made.

1.1.2.1.3 Confidentiality

The information from the maternal death notification forms, and photocopied patient's records, is treated confidentially throughout the maternal death notification system. The patient must only be referred to in the assessment forms by their unique number and no personal details of the health care professionals involved may be given, in order to protect their identity. The precise hospital(s) at which the event(s) occurred are also not published, only the level of hospital(s) is referred to in the final reports. This maintenance of confidentiality is deemed central to the success of the system. Without it health care professionals will be fearful of the consequences of reporting such events and not do so, even those who are aware it is a legal requirement to report a maternal death.

As a final act of ensuring confidentiality, to prevent the documents being subpoenaed in the event of a medico-legal claim, the maternal death notification forms and photocopies form files, are destroyed once analysis has been completed at National Office. This protects the health care professional who completed the maternal death notification form from being subpoenaed, based on what was written on the maternal death notification form.

1.1.2.1.4 Problems resulting from a confidential system

Whilst this confidentiality protects both the health care professionals involved, and the family of the deceased (from being subjected to reading in a public report the explicit details of the woman's death), there are drawbacks. The health care professional assessing the maternal death is unable to directly communicate with those involved to ask further details pertaining to the death and thus may be unable to obtain clarity as to the sequence of events leading to the maternal death. In some instances the person completing the form has poor writing or simply writes too little, and the assessor finds it difficult from this poor or limited information to establish the precise cause leading to the maternal death and has to give a "best guess".

A frequent problem when analysing a maternal death due to anaesthesia, has been that the anaesthetic form is either incomplete or simply not sent with the other documents relating to that patient. Sometimes the doctor who performed the anaesthetic keeps the anaesthetic form for their own personal record of events, although this is not legal as all patient records must be kept in the patient's file. In order to correct this problem, a National Obstetric Anaesthesia Form has been formulated, with involvement from all the Provincial Assessors in South Africa. This form will be a non-removable part of the patient's maternity records and will prompt doctors to complete the relevant information required. It is hoped that this will be introduced in 2009.

1.1.2.1.5 Role of the Provincial Maternal Health Department Coordinator

Each Provincial Maternal Health Department has a coordinator for maternal deaths. It is their responsibility to ensure that they receive the maternal death files (ie notification forms and copies of patient records) from the reporting institution of maternal deaths. Often they receive the telephonic notification of the death, but it is months before the forms and records are received by the coordinator. This person often has to make repeated contact with the institutions involved before the files are sent to him/her. Where there are transport problems or problems with photocopiers, it is their duty to resolve such problems. This is usually done by liaison with the management of the institution involved.

The Coordinator must then ensure that the maternal death files are received by the assessors. Each death has to be analysed by two Provincial Assessors, an Obstetric Doctor and a

Midwife. These health care professionals are appointed to perform these duties by their Provincial Department of Health. They are trained to fulfill this duty and their institute of employment is required to give them leave from clinical duties when they are required to perform these assessments. They are supposed to be together when assessing a report, so they can discuss the case and jointly agree on the cause of the death. This can logistically be a problem, but in the Free State this has largely been overcome by having "assessment days", whereby all the healthcare professionals involved in maternal death assessments meet at the same place, on the same day, and all the maternal death files are then analysed and the assessment forms completed. The assessment forms are uniform for South Africa and are produced by the NCCEMD.

1.1.2.1.6 Role of the Provincial Assessor for Anaesthesia

If the above assessors consider the death due to anaesthesia, they send the maternal death file to the Provincial Assessor for Anaesthesia for confirmation that anaesthesia was indeed the cause of the death and not coincidental.

This process has problems, again particularly with transport and files being lost or delayed. To solve this problem it was decided in the Free State that the anaesthetic assessor should attend the previously mentioned assessment days. The anaesthetic assessments were then completed at the same time as the other assessments were performed and relevant discussion regarding cases with the non-anaesthesia assessors could take place.

Another problem has been the misdiagnosis of deaths due to anaesthesia. Some deaths due to anaesthesia have not been recognized as such by non-anaesthetic assessors. They have on occasions failed to recognise that an incorrect anaesthesia technique has been used for a patient's clinical condition, and she died as a result of the faulty technique and not from "natural causes". There have been other instances in which the anaesthetist has significantly contributed to a death, but did not primarily cause it, eg allowing a severely haemorrhaging woman, post Caesarean section, to be discharged from the recovery area to the ward, instead of remaining in the recovery area where remedial action could have been taken. This relevant information was not being recorded and reported. Consequently, since 2005 the anaesthesia assessor examines the files of *every* woman who received any anaesthetic at all

during the course of her admission, to determine whether substandard anaesthesia care did indeed occur and whether this contributed to her death.

1.1.2.1.7 The NCCEMD

The results of these provincial assessments are then sent with the maternal death files to the National Committee for the Confidential Enquiry into Maternal Deaths (NCCEMD), at the National Department of Health in Pretoria. The committee is appointed by the Minister of Health and its task is *"to make recommendations, based on the confidential study of maternal deaths to the Minister of Health such that the implementation of the recommendations will result in a decrease in the maternal mortality"*[3]. Its terms of reference are:

- To make recommendations based on analysis of the maternal deaths that were reported such that the implementation of the recommendations would result in a reduction in the maternal mortality.
- Recommendations must be phrased in such a manner that their implementation can be measured.

The NCCEMD includes experts in the fields of obstetrics, anaesthesia, midwifery, HIV/AIDS, Health Research and Management. Since 1998, three "Saving Mothers Reports" have been published by the NCCEMD. The First Report was an annual one, covering data collected from 1998. Subsequent reports have used the triennial system of the UK CEMD. This is in order to improve the quality of the statistics, as the patient numbers involved are not sufficiently large for meaningful analysis of trends if only annual reports are given. Consequently, the Second Report covered 1999-2001 and the Third Report covered 2002-2004. The Fourth Report, for 2005-2007 has been written and is currently awaiting approval by the Minister of Health before being printed. Each Report contains chapters related to the various causes of maternal deaths and includes statistical information and recommendations for the prevention of these deaths. There are, in addition, annual interim reports in which the statistical information for the previous year are presented to the NCCEMD and the assessors, in order to see if there are significant problems developing which should be acted upon before the end of the triennium.

The common theme regarding anaesthesia deaths in these Saving Mothers Reports has been that most were avoidable and due to incompetence or inexperience of the practitioner who administered the obstetric anaesthesia resulting in the maternal death. This is discussed more fully in chapter 5 (Manpower).

1.1.2.2 The United Kingdom confidential enquiries into maternal deaths.

The Confidential Enquiries into Maternal Deaths (CEMD) of the United Kingdom (UK) is internationally recognized as an effective tool by which maternal deaths can be reduced and as a gold standard of professional audit. The methods it uses have been included in the WHO publication "Beyond the Numbers"[18], which is part of the *Making Pregnancy Safer* initiative. South Africa is one of over 15 countries from Africa and Asia which have approached the CEMD of the UK in order to adapt their methodology to help plan health services[19], although there is no other country in Africa in which it has yet been implemented.

The collection of national statistics for births and deaths for England and Wales commenced in 1837. However, it was only in the 1920's when a governmental body was formed specifically for maternal deaths, ie the Departmental Committee on Maternal Death. They recorded 8505 maternal deaths between 1828 and 1932. In 1935 they concluded that this high maternal death rate could, and should, be halved. The maternal mortality rate at that time was 5/1000 births and was similar to that of the mid nineteenth century. The 1930's marked the advent of antibiotics effective in the treatment of puerperal sepsis, one of the most common causes at that time of maternal deaths. There followed a dramatic decline in the number of maternal deaths from the 1930's such that by the 1950's the mortality rate had declined to <1/1000. From that time, it was noted that the deaths that did occur needed more details in order for their cause to be established and in 1952 the CEMD for England and Wales was commenced and the first *Report on Confidential Enquiries into Maternal Deaths* for the years 1952-1954 was published in 1957[20].

The original assessors were obstetricians, but they were later joined by other specialities and health care professions and now include anaesthetists, pathologists, physicians, midwives, psychiatrists and intensive care specialists.

The United Kingdom consists of four countries: England, Wales, Scotland and Northern Ireland. In 1956, Northern Ireland commenced its own CEMD, as did Scotland in 1965. In the 1980's they amalgamated, and the first CEMD covering all 4 UK countries was produced for 1985-1987. Since the 1950's, the maternal death rate continued to reduce until the 1970's, at which time it plateaued to about 1/10 000.

From 2000, the CEMD was incorporated with the Confidential Enquiries for Stillbirths and Deaths in Infancy (CESDI) for England and Wales and published as part of the report of the Confidential Enquiry into Maternal and Child Health (CEMACH). Whereas previously the Department of Health was responsible for the CEMD reports, CEMACH became the responsibility of the National Institute for Clinical Excellence (NICE). One of their changes was to reduce the use of clinical vignettes in the reports, in the interest of confidentiality[21]. The first CEMACH report was published in November 2004 and covered the triennium 2000-2002. More recently the responsible body for CEMACH has been transferred from NICE to the National Patient Safety Agency (NPSA).

Another change has been a change of the title of the CEMD report, from "Why Mothers Die" to "Saving Mothers Lives". This change has been criticised as an attempt to conceal the reality of the situation, in that "saving these women's lives is precisely what the maternity system has abjectly failed to achieve"[22]. One wonders whether such a thought would also be relevant when considering the name of the South African report being so similar ie. "Saving Mothers".

The most recent CEMACH report to be published was in 2008, and covered the triennium 2003-2005[23]. It is the 18th CEMD report. Findings include an increased incidence of heart disease as a cause for maternal mortality. The incidence of maternal death from heart disease for that triennium was 2.27/100 000, double that of the 1990's. Closer inspection of these deaths from heart disease has found that these were linked to increased maternal age, smoking, lack of exercise and poor diet, leading to obesity, diabetes and hypertension. Over 2/3 of women who died from heart disease were overweight or obese. In the remaining 1/3, most were related to rheumatic heart disease and occurred in women who had immigrated to the UK from other countries in which there is a higher prevalence of rheumatic heart disease[24].

The central assessors for the 2003-05 report reviewed 150 maternal deaths, in which the woman had also had an anaesthetic. This constituted about half of all the maternal deaths for that triennium. Six of these women died directly from problems associated with anaesthesia and in 31 cases substandard anaesthesia care probably contributed to the death. The anaesthesia mortality rate was similar to the previous triennium and the number of deaths was the same (Table 1.1.2)

Triennium	Number	% of all *direct* maternal deaths	Rate per 100 000 maternities
1985-87	6	4.3	0.26
1988-90	4	2.8	0.17
1991-93	8	6.3	0.35
1994-96	1	6.3	0.05
1997-99	3	0.7	0.14
2000-02	6	2.8	0.3
2003-05	6	5.7	0.28

Table 1.1.2 Direct deaths due to anaesthesia in the United Kingdom: 1985-2005.

Of the six women with anaesthesia-related deaths, four were obese and two morbidly obese. Two of the deaths of obese women occurred after surgery in early pregnancy, and were related to inexperienced anaesthesia trainees failing to appreciate the dangers of anaesthetising such women[25].

The problem regarding the rising number of obese women in the population, who then suffer complications from anaesthesia owing to their obesity, is also a South African problem. This was highlighted in the 2002-2004 Saving Mothers report, where for 23% of anaesthesia-related deaths in level 1 hospitals, morbid obesity was a co-morbidity factor[3].

Although the number and rate of maternal deaths from anaesthesia are substantially less in the United Kingdom than South Africa, the problems causing these deaths can be quite

strikingly similar. Inexperienced trainees and obesity are just two examples. Other similar problems include administering anaesthesia in isolated sites where assistance of any sort, including experienced, is not readily accessible; there are delays in obtaining blood for massive haemorrhage; and transfer to another unit with intensive care incurs problems in patient care. In addition, in both countries, rapid and early team management with experienced staff for cases of severe haemorrhage and severe hypertensive disease of pregnancy needs to be improved[21].

In both South Africa and the UK, there has been such a growing trend in performing most procedures under regional anaesthesia, that concern has been raised over the loss of general anaesthesia skills for obstetric patients. In all six of the women who died in the 2003-2005 triennium in the UK, general anaesthesia was administered. The problems that arose included:

- Failure to recognize an oesophageal intubation
- Lack of a capnograph
- Failure to check the anaesthetic machine
- Failure to follow a failed intubation drill
- Anaphylaxis
- Inhalation of gastric contents
- Delay in treating cardiac arrest

These are all problems that are encountered in everyday anaesthetic practice, not just obstetrics, and usually related to inexperience.

In addition, general problems of language and failure to call for help contributed to the deaths from anaesthesia. Social disadvantage, poverty and being a black African woman were also risk factors for maternal deaths in the UK[26], again similar to South Africa.

Hence one can conclude that in South Africa we can and must continue to learn from the CEMD of the UK. Its disciplined approach generates reports of the highest quality written by leaders in their particular field of medicine. Progress is monitored and the effectiveness of recommendations is evaluated, thus closing the audit loop. As a consequence of recommendations from these reports, anaesthetists in the UK have changed their practice and

training and supervision have been markedly improved to the extent that anaesthesia for CS is now thirty times safer than in the 1960's. "There is no better example of a major effect that the report has had on changing practice and improving patient care"[27]. We need to recognize that in South Africa our problems are often similar in nature to those in the UK, although our numbers differ, and we can improve our practice based on recommendations from their reports as well as our own.

1.1.2.3 Monitoring maternal deaths in other countries.

Reducing maternal mortality from all causes is a major goal in public health in many other countries, both developed and developing. It is considered a basic health indicator and marker of adequacy of a country's health care system[28]. In the last twenty years there has been an increased global awareness of the need to reduce maternal mortality rates, particularly in developing nations. In 2000, the United Nations issued eight Millenium Development Goals, the fifth of which pertains to maternal mortality and the goal here is to reduce the rate by 75% by 2015[29]. Currently the highest maternal mortality rates are in Africa, where the lifetime risk is 1 in 16, and the lowest is in developed countries where the lifetime risk is 1 in 2800[30]

Globally, the main causes of maternal death are haemorrhage (31%), sepsis (11%) hypertensive disorders (10%), anaemia (8%), obstructed labour (7%), unsafe abortion (5%), other direct causes (eg ectopic pregnancy, embolism and anaesthesia complications) (5%) and indirect causes (eg anaemia, malaria and heart disease) (14%). HIV accounted for 3% of maternal deaths and 6% were unclassified[31].

When devising strategies to reduce maternal mortality, international organisations tend to use evidence-based interventions which target these main causes of maternal deaths. However, evaluating the success of these interventions has been a challenge as two-thirds of nations do not have the infrastructure to collect data, and data often varies in quality between countries[32]. Registers of death have been used, but the accuracy of this data is not guaranteed. There is a lack of agreement as to which interventions should be implemented and there is frequently a lack of commitment from the ministries of health of the countries involved[33]. Despite this, some countries do appear to have made progress towards reducing

maternal deaths and achieving the fifth Millenium Development Goal and these include less affluent countries such as Bolivia, Brazil, China, Egypt, Morocco and Peru[34].

Despite this important need to examine a country's own rates and causes of maternal deaths, few countries in the world have attempted to implement the confidential reporting system well known to be successful in the UK, and currently only in the UK and South Africa is there a legal requirement to notify a maternal death. The Director of the UK Confidential Enquiry has assisted other countries to set up similar enquiries, these included South Africa as well as India and Israel[35], but only from South Africa does there appear to be triennial reports published on the basis of these enquires.

Examples of countries which are using other methods of collecting maternal mortality statistics but have found that they are inadequate and are considering using a similar system to that of the UK (and South Africa) include the USA, France and Japan. Details of the methods used to collect data regarding to maternal deaths in these countries is described further. This is followed by information regarding maternal deaths in six other African countries: Botswana, Malawi, Ghana, Nigeria, Egypt and Zimbabwe. There is a paucity of literature regarding maternal deaths from other African countries.

1.1.2.3.1 The USA

The Centers for Disease Control and Prevention (CDC) in the USA produces annual maternal mortality rates for the USA. But, there is considerable under-reporting (estimated at 30%) as the data is only supplied to the CDC by each state on a voluntary, not statutory, basis. The CDC has little or no access to the medical records of the women who died. Useful analysis of the reasons why the women died and what could have been prevented are rarely obtainable. There is always the problem of medico-legal claims in this country and health care practitioners are generally reluctant to disclose any information regarding a case.

A confidential system similar to that of the UK as been advocated for the USA, particularly as there has been little improvement in the maternal mortality rate in recent years and reasons for this failure are required. This has yet to occur[36]. A recent report has found that the maternal mortality ratio in the USA doubled from 6.6/100 000 live births in 1987 to 13.3/100 000 live births in 2006. Whilst this can partially be attributed to better reporting it

is still causing a national outcry. The USA spends more on health care than any other country in the world and yet the maternal death rate is five times higher than in Greece, four times higher than in Germany and three times higher than in Spain. Of concern it is mostly the poor and minorities in the USA who are more likely to succumb from pregnancy related-complications with African-American women being more likely to die than white women[37].

There is some evidence that anaesthesia-related maternal deaths are a small but significant cause of maternal deaths in the USA. In one state, 5.2% of deaths during hospital admission for delivery were attributed to anaesthesia-related complications. This figure was slightly higher, 6.6% in African-American women, but again the reason for this is not known[38].

1.1.2.3.2 France

In France there is a National Committee for Maternal Mortality which reports on maternal deaths (Le Comité national sur la mortalité maternelle). This system only produces death rates and does not enable detailed analysis of deaths to occur or recommendations for their prevention to be published.

A recent comparison of causes of maternal deaths in France and England showed some interesting results. The causes of maternal deaths between these two countries were strikingly dissimilar. There were many more deaths in the UK associated with obesity, smoking, diabetes and older maternal age than in France. The commonest indirect cause of maternal death in the UK was cardiac disease, which was extremely rare in France. Maternal deaths from haemorrhage had declined in the UK but in France were still a cause for concern, being associated with approximately a third of direct maternal deaths.

The authors of this paper recommended that a similar system to that of the UK be introduced so that systematic auditing, with set standards to be achieved, could be introduced to improve patient safety in France[39].

1.1.2.3.3 Japan

Compared to other developed countries, Japan has a relatively high maternal mortality rate. In 1990 this was found to be 8.6 per 100,000 live births, compared to 8.2, 7.6 and 2.4 for the USA, UK and Canada, respectively. This was despite Japan having perinatal and infant

mortality rates which were the lowest at that time in the world[40]. A problem regarding maternal mortality was therefore recognised and in 1995, The Confidential Inquiry into Maternal Deaths Research Group (CIMDRG) was created to address this problem of maternal mortality.

One of the main recommendations from the CIMDRG was to staff every hospital in which deliveries are performed with an obstetrician *and* an anaesthesiologist. It is rather surprising to find that in a relatively advanced such as Japan, there were many hospitals in which the obstetrician also administered the anaesthesia and this was associated with a high number of preventable deaths (6.4.3.3).

The reason why these Japanese doctors have to work as both obstetrician and anaesthetist is similar to the reasons why they occasionally do so in South Africa ie lack of anaesthesiologists. To correct this problem, along with recruiting more anaesthesiologists, the recommendation from the CIMDG of Japan was similar to that which has been advocated in South Africa ie. have a smaller number of better staffed regional obstetric medical facilities instead of doctors scattered over a large number of small hospitals where they work in isolation[41].

1.1.2.3.4 Botswana

Geographically, Botswana is a neighbour of South Africa, forming part of its northern border. Its population of 1.9 million is much smaller than that of South Africa, whose population was estimated at almost 49 million in 2008[42].

Statistics on maternal mortality prior to 2000 have been considered unreliable with maternal mortality figures in the 1990's ranging from 200-250/100 000[43,44] to 481/100 00. In 1990 the government of Botswana launched a national Safe Motherhood Initiative with the objective of reducing its maternal mortality by 50% ie to 150, by 2000[45]. Furthermore, following the Millenium Development Goals, it aims to reduce this 1990 maternal mortality rate to 75% by 2015[46]. In order to measure the impact of the Safe Motherhood Initiative programmes a national maternal morbidity and mortality monitoring system was introduced in 1998.

This system has two levels, internal (institutional) and external (non-institutional). If a morbidity/death occurs at an institution, both staff and management are required to meet and

compile a report of the case, which is then sent to the Ministry of Health Safe Motherhood Programme. The external system is based at national level and consists of a committee which includes senior midwives, obstetricians and representatives from WHO and UNFPA. This committee is known as the National Maternal Mortality Audit Committee and meets on a quarterly basis. Its role is to assess all maternal deaths reported at a national level and advise the ministries accordingly[47].

The data is collected anonymously from the institutions with the respect to the name of the health care practitioners involved not being name. However, geographical details and the name of the deceased are included in the case reports. Problems with the maternal death notification forms being too lengthy, resulting in forms not being completed, were expressed with the result that the form was reduced from four to eight pages in 2006 and the revised forms were distributed in 2007[48].

A further problem with the data collected from this system is that it only captures hospital based-data. In an effort to expand the data-base collection, especially with regard to deaths that occurred at home or in clinics, in 2006 maternal deaths were made legally notifiable.

From analysis of data collected on maternal deaths, the causes appear similar to those found in South Africa. In 2004 and 2005 there were 116 maternal deaths reported. For 2005, the commonest direct cause of death was post-partum haemorrhage (34% of direct maternal deaths). Obstructed labour and ruptured uterus were given as the second and third commonest causes of direct maternal death at 25% and 20% respectively, although these are not final causes of death according to the South African maternal death reporting system eg. for a ruptured uterus, haemorrhage might be the final cause of death. Anaesthesia is mentioned as direct cause of maternal death but its incidence is not clear[47].

Lack of skilled health care professionals was suggested as a factor in maternal deaths and in 2006, the Sexual and Reproductive Unit of the Ministry of Health performed a study to investigate emergency obstetric care services[49]. This study found that just over 50% of doctors and 67% of midwives were trained in “life saving skills”. Further skills training has since been implemented, trained doctors and midwives have been recruited from Cuba and China and in June 2007 the first medical school in the country was set up at the University of Botswana in Gabarone.

In addition the 2006 study found that not all hospitals had essential drugs and equipment eg magnesium sulphate and oxytoxics were often in short supply. Lists of drugs and equipment norms have subsequently been made.

1.1.2.3.5 Malawi

Malawi is a sub-Saharan country with a maternal mortality ratio of 1,100/100,000 live births, one of the highest in the world (WHO 2007). Maternal deaths are monitored in Malawi using a combination of community-based and facility-based reviews whose aim is to reduce maternal mortality and improve professional practice[50,51]. In addition the Ministry of Health conducts regular confidential enquiries as part of the Safe Motherhood Project, established in Malawi in 1995.

A report from this confidential system, covering deaths that occurred in 2001 in the Southern region of Malawi, found that puerperal sepsis was the commonest cause of maternal death, direct or indirect (20%) and half of these occurred after CS. A high proportion of the other direct deaths were from the complications of obstructed labour, ruptured uterus and from obstetric haemorrhage whilst AIDS and anaemia were leading causes of indirect deaths. Approximately 1.5% of deaths were due to “anaesthesia accidents.. Overall, deficiencies in hospital care were identified as the chief avoidable factor[52].

Facility and community maternal death reviews are held in each district each month and are attended by representatives of each health facility in the district. As the number of maternal deaths that occur each month in a district is too great for all to be reviewed at these meetings, there is an emphasis on each health-care facility to review individual cases in their own facility. In practice this does not happen frequently[53]. Other problems identified were that maternal death reviews were not conducted in a “blame-free” manner and recommendations from reviews were not being implemented[54]. To improve on this, facility-based maternal death review was introduced in nine hospitals in 2006. A analysis of the strengths, weaknesses, opportunities and threats (SWOT analysis) encountered during the process of maternal review using this system identified several opportunities and challenges[53]. Recommendations to remedy the problems identified included a greater emphasis on confidential reporting, increasing staffing levels so reviews can be conducted, improving

staff motivation, formulating essential resources requirements and standards of care, and greater support from management.

A recent review of the causes of maternal deaths for 2007, in the Central Region of Malawi, as established using the facility-based death review system, found that of the 43 deaths reviewed, 65.1% were from direct causes and 34.9% from indirect obstetric causes. The commonest direct causes were postpartum haemorrhage (25.6%), postpartum sepsis (16.3%), ruptured uterus (7%), complications of abortion (7%), antepartum haemorrhage (4.7%) and eclampsia (4.7%). Indirect causes were dominated by HIV/AIDS (16.3%) and anaemia(7.0%). Lack of blood for transfusion was the commonest administrative factor (20.9%). No deaths were attributed to lack of essential supplies or transport between facilities, but inadequate obstetric life-saving skills (60.5%) and resuscitation skills (69.6%) of health-care workers, delays in seeking medical attention by the patient or family (32.6%), use of traditional medicines or practices (23.3%) and lack of transport from home to the health care-facility were identified as major problems. Recommendations to remedy these problems have since been implemented[55].

1.1.2.3.6 Ghana

This West African country, with a population estimated at 23,887 812 in 2010[56], has a high maternal mortality rate of about 540/100 000 live births[57] and a low CS rate of only 4%[58], which is below the global “standard” of 5-15%[59].

Whilst Ghana does not have a national confidential reporting system for maternal deaths, a modification of confidential enquiry into maternal deaths has been used to investigate maternal deaths in this country, with respect to before and after a universal exemption from payment of fees for delivery was instituted[60]. Here the study population was cases of delivery-related hospital maternal deaths in two regions of Ghana, the Central and Volta regions, which have districts that have similar population and healthcare profiles. The study took place between January and July 2006 and the sample included deaths that had occurred before and after exemption from fees was introduced in the two regions.

The maternal death assessment form used was based on the South African version and the information captured was reviewed, with the patient’s clinical case records by an eight-

member panel including specialists from obstetrics, anaesthesiology, internal medicine, midwifery, pathology and public health. Ten cases were obtained from each region, half before and half after fee exemption was introduced.

The key finding of this study was that levels of care were sub-standard but did not worsen as a result of the increased client numbers resulting from fee exemption. The panel judged that doctors often made bad decisions and had an "unacceptable attitude" whilst midwifery care was often "superior to that of doctors." Of concern was that of the 20 deaths, in only 5 cases had the doctor attended the patient, despite being informed of her condition, in the time leading up to her death. The conditions that these doctors were expected to work in probably contributed to their poor performance. In most district hospitals only one medical officer would be on duty to deal with all types of emergencies, including obstetrics, and some of the emergencies had severe complications for which a higher level of expertise, which was not available, was required. The authors concluded that whilst fee exemption led to more women accessing health care earlier, the benefit was offset by the poor care they subsequently received in hospital.

1.1.2.3.7 Nigeria

Nigeria is the most populated country in Africa and the tenth most populated of the world's 193 nations. In 2010 the population was estimated at being 154,729 000[61] There is no national database regarding the causes of maternal mortality in Nigeria, hence estimates can only be made and these are likely to be imprecise. Data from the rural areas where most of the women deliver are virtually non-existent. Most of the research has been based at academic units in Nigeria and these studies give information limited to the deaths that occurred at their units.

A review of over 12,000 deliveries that took place over 10 years, between January 1991 and December 2000, at the University of Benin Teaching Hospital, a tertiary level hospital in Benin City, found the CS rate to be 18.7% and the maternal morality rate to be 678/100 000 deliveries (there were a total of 84 maternal mortalities)[62]. The leading causes of death were given as: infection, haemorrhage, hypertensive disease and anaesthesia. Anaesthesia was given as the sole cause of death in six cases, five of which were for CS and the other for cervical cerclage. In all of these cases death was a result of airway problems occurring when

general anaesthesia was administered. GA was given for 87% of all CS's at that hospital during the study period, and 81.8% of all cervical cerclages, with regional (epidural or spinal) or local (cervical cerclages only) anaesthesia being used for the remainder.
The authors noted that the anaesthesia deaths occurred in women who were otherwise healthy and might have been avoided if they had received spinal anaesthesia. The use of appropriate monitors such as pulse oximetry and capnography, which are generally considered as essential monitors in obstetric anaesthesia, might also have prevented some of these deaths. Lack of knowledge, experience and supervision of the trainee anaesthesiologists was given as a further factor which led to these anaesthesia deaths.

A similar study has been published from a University teaching hospital in Enugu[63]. This retrospectively reviewed deaths that had occurred at this institution over an eight year period from 1998 to 2006. There were 7085 births, a CS rate of 23% and a death rate due to anaesthesia given for CS of 37/10 000 CS's. They found this to be higher than that of the study previously performed in Benin, for which they calculated death due to anaesthesia given for CS to be 26/10 000 CS's.

There were six deaths directly attributed to anaesthesia and three in which anaesthesia indirectly attributed to the deaths. In all cases GA was administered and in all of the cases where death was directly attributed to anaesthesia, airway problems were responsible. All the deaths occurred during the first five years of the study period, 1998-2003. From 2003 to 2006 there were no maternal deaths due to anaesthesia and the authors note this coincided with increased supervision of trainees, better working conditions and renumeration for anaesthesiologists, increased use of pulse oximetry and an increase in spinal anaesthesia rate from 18% in 2003 to 71% in 2006. They conclude that the policy of better working conditions for health care workers who administer obstetric anaesthesia (both doctors and nurses administer anaesthesia in Nigeria) and the encouragement to use spinal anaesthesia more frequently should be extended to primary and secondary level hospitals, "where the poorer patients usually present."

1.1.2.3.8 Egypt

In contrast to many other African countries, Egypt has managed in recent years to reduce its maternal mortality rate significantly. Two national maternal mortality surveys were performed in 1992-93 and 2000. Results from these surveys showed a 52% reduction in the

maternal mortality ratio from 174/100 000 in 1992-93 to 84/100 000 live births in 2000. There is further evidence that this rate has continued to decline such that Egypt may achieve its Millenium Development target of an MMR of 50/100 000 live births by 2015[64].

In 1989 the MMR was 220/100 000 live births and a nationwide effort was implemented by the Egyptian Ministry of Health with assistance from the USA to reduce this figure. These efforts were re-evaluated and improved upon as a result of the 1992-3 survey and led to the further reduction in the MMR seen in 2000[65].

The surveys were performed using the death registration system. Health bureaus register these deaths and a random sample of a third in each of 18 governorates were selected and all the bureaus in the remaining nine, as they were of special interest. Field workers identified maternal deaths and then conducted in-depth home interviews with relatives of the deceased and the health care providers who had been involved. For 1992-3, 54/772 interviews could not be conducted and in 2000, 5/585 interviews could not be conducted, because the homes of the deceased could not be located. The interviews were all conducted strictly confidentially.

In both surveys, haemorrhage was the major cause of death (30%) and whilst postpartum haemorrhage changed little, there was a marked reduction in deaths from antepartum haemorrhage (7% to 3%). Whilst maternal deaths also dropped from other causes such as hypertensive disease, sepsis and abortion, deaths related to anaesthesia rose from 13 (2%) to 30 cases (5%). In some of these anaesthesia-related deaths, the problem was more one of lack of anaesthesia services rather than anything due to the administration of anaesthesia, with 24 (4%) of maternal deaths in 2000 attributed to lack of anaesthetist or anaesthesia facilities (not assessed in 1992-93 survey).

However, there is evidence from later surveys that there are problems with the administration of obstetric anaethesia. In July 1st, 2001, a Maternal Mortality Surveillance System was introduced in Egypt, which provides on-going information regarding maternal mortality and is used to evaluate and guide programmes designed to reduce maternal mortality[66]. Data from these surveys show that in one region of Egypt, Damietta, in 2004 anaesthesia was the 3rd commonest direct cause of maternal death, being responsible for 4/19 direct maternal deaths (17%). In 2005, anaesthesia was the 4th commonest direct cause in

this region, and was responsible for 2/11 direct maternal deaths. Causes of these anaesthesia deaths were given as “improper anaesthesia” and failure to use regional anaesthesia[67]

CHAPTER 2

LITERATURE REVIEW

2.1 MATERNAL MORTALITY DUE TO ANAESTHESIA IN SOUTH AFRICA

Early papers reviewing maternal health and factors contributing to maternal mortality in South Africa were largely descriptive. The authors often described the obstetric situation in the hospital or region they were based in and so the information from these studies, whilst interesting to read, may not be applicable to the rest of the nation. A national survey was performed in the 1980's (see XXX) but the response from hospitals was voluntary and response rate of the hospitals was not given. Only with the introduction of the maternal death notification system in 1997 and the formation of the NCCEMD have relatively accurate reports pertaining to maternal deaths in South Africa been available.

2.1.1 Early descriptive studies of South African maternal healthcare and deaths

Connor, in a paper published in the Lancet in 1970, reviews the situation in the Transkei, one of the apartheid-era homelands for the black population[68]. In these areas healthcare was often based at the mission hospitals. One of the suggestions made by the author to improve maternity antenatal care was for these hospitals to set up their own permanent district clinics. However, the author later tells how even if a woman attends for antenatal care, they often did not go to the hospital for the delivery, with only 37% of deliveries being in hospital. Cultural beliefs were given for this preponderance of home births. Other problems found were a high rate of CS's for cephalopelvic disproportion (66% of CS's), a high child mortality (34.3% under 10y of age) and a high rate of tuberculosis (48/1068 of pregnant women x-rayed). Interestingly they found that iron deficiency anaesmia was rare, which they attributed to the use of iron-cooking pots, and preeclampsia was infrequent (19/1714 of women studied). No mention is made of anaesthesia or problems related.

The emphasis made by Connor regarding the importance of extending antenatal hospital care into the community is repeated in Philpott's 1978 paper[69]. He recommends that all women should be within 5km of a clinic providing antenatal care and in sparsely populated areas

mobile clinics should provide this service. Waiting areas close to appropriate facilities are advocated for women in whom delivery problems are anticipated. Further recommendations are then given regarding improving on the poor standard of obstetric services that were in effect at that time. Quality control indicators were suggested to monitor and evaluate the effect of these services. Perinatal mortality was advocated as an indicator of CS rate, with an implication that too low a CS rate was associated with increased perinatal mortality.

One of the earliest papers published from a South African institution on maternal deaths and the contribution that anaesthesia makes regarding these deaths, was published in 1973[70]. Here Crichton describes the 538 maternal deaths that occurred at the King Edward VIII Hospital in Durban from 1953-1971. He tells how he was personally involved in the treatment of many of these deaths and poignantly introduces the study with a quote from Dylan Thomas' *cri de coeur* at the death of his father:

"Do not go gentle into that dark night,
Rage, rage, rage, against the dying of the light"

Crichton felt this "epitomizes the obstetrician's attitude to maternal mortality, which all too frequently plucks young women from their dependent families".

Most of the deaths were due to preeclampsia/eclampsia, haemorrhage, sepsis and ruptured uterus (Table 2.1.1a). In most cases (60%) the women who died had not received any antenatal care and were admitted as emergencies, again reiterating the problem previously mentioned in this chapter of poor antenatal services or/and attendance at this time

	1953-1960 (%)	1961-1971 (%)
PET + eclampsia	28.1	21
Eclampsia alone	23.3	15
Ruptured uterus	6.1	13
Sepsis	7.7	17
Cardiac	3.8	7
Haemorrhage	22.9	7
Anaesthesia	2.6	5
Associated medical and surgical conditions	17.3	8
Thromboembolism		4
Amoebiasis	5.1	2
Other		4

Table 2.1.1a Causes of maternal deaths at King Edward VIII Hospital, Durban, 1953-1971[70]

The authors felt that developing peripheral antenatal clinics and staffing peripheral hospitals was the most important manner by which maternal deaths could be reduced. The maternal mortality rate at this hospital is given as 1.4/1000 (140/100 000) and we are told this is far less than in other less developed parts of Africa because of the strict adherence at this hospital to life-saving "safety rules". An example is given of how every patient must be examined by a doctor within 10 minutes of admission as "many lives will be lost if reliance is placed upon the nursing staff to make the primary assessment of the patient".

The 14 (5%) of maternal deaths related to anaesthesia that occurred from 1961 to 19971 are described (but it is not explained if anaesthesia was given at the hospital before that time or no deaths occurred). The dangers of aspiration from inhalational anaesthetics are emphasised as is the importance of only allowing skilled anaesthetists to administer obstetric anaesthesia. Since forbidding the administration of inhalational anaesthesia on the labour ward, allowing it only in the theatre complex, they had no further anaesthesia deaths. In the conclusion, it is

remarked that if the anaesthetic staff was inexperienced then regional anaesthesia was safer, but what type of regional anaesthesia they recommended was not stated.

Of the papers describing maternal mortality in the 1980's, two are of particular interest with regard to this thesis as they describe maternal deaths in Pelonomi Hospital, which is now one of the teaching hospitals of the University of the Free State, and this PhD study has included data from Pelonomi Hospital. The first paper covers maternal deaths that occurred from 1980 – 1985[71] and the second paper covers the maternal deaths from 1986 - 1992[72]. The main causes of maternal deaths given in these two papers are summarized in Table 2.1.1b

Cause of maternal death	**1980-1985**		**1986-1992**	
	No of patients	**%**	**No of patients**	**%**
Puerperal sepsis	25	30.9	22	24
Postabortal sepsis	12	14.8		
Hypertensive disease	17	21	16	18
Haemorrhage	11	13.6	23	25
Pulmonary embolism	3	3.7	7	8
Anaesthesia	1	1.2	0	0

Table 2.1.1b Causes of maternal deaths at Pelonomi hospital, from 1980-1992[71,72] (note: different methods of data collection were used between the study periods - see text)

From 1980-1985 there were 81 maternal deaths of which 74 (91.4%) were direct obstetric deaths and the maternal mortality rate was estimated at 2.87/1000 deliveries (287/100 000). Sepsis was the most common cause of death (45.7%) with a third developing sepsis after abortion (type of abortion eg. spontaneous or performed legally or illegally, is not given). The anaesthesia complication resulting in the one death that occurred is not detailed, although there is described another death related to a blocked endotracheal tube, but this

does not appear to be the same patient. The authors of this paper again recommended improving antenatal care as a major requirement for reducing maternal deaths. Upgrading some district hospitals to regional level and improving transport services were also recommended due to the long distances for referrals from some areas of the Free State.

In the following paper, covering 1986-1992, there were 91 maternal deaths of which 65 (71%) were direct obstetric deaths. The maternal mortality rate was lower at 171/100 000 live births and the commonest cause was now haemorrhage (25%). This change can be explained by the deaths of women who had not delivered at Pelonomi, but were referred there, being excluded from this data. The authors note that women who died of infection at Pelonomi had often delivered elsewhere and they state 'It is not clear whether this change reflects a true rearrangement of aetiological factors as the method of data collection differed between the two studies". Other than the introduction of a High Care Unit for Obstetrics in 1988 it is not clear in this paper what other interventions to reduce maternal mortality were implemented although several were again recommended.

2.1.2 Maternal Death Survey (1980 – 1982)

The first comprehensive report covering maternal deaths in South Africa was written by Boes in 1982. This investigator initially surveyed over 260 hospitals between 1970 and 1979 and obtained from them information regarding maternal deaths and numbers of deliveries. These hospitals were geographically spread over most of South Africa and included both large and small hospitals. This information was presented in 1982 as an M.D. thesis in Afrikaans[73]. Using a similar method Boes continued the survey over 1980-1982 and reported these statistics in a 1987 paper[74]. From 1980-1982, 812 maternal deaths were recorded and the maternal mortality rate was given as 8.3/10 000 births (83/100 000). Direct obstetric causes accounted for 660 (89.6%) deaths and avoidable factors were implicated in 407 deaths. Hypertensive disorders of pregnancy (30%), haemorrhage (20%) and obstetric infection were the major causes of deaths. Younger, primigravid women were at particular risk for death from eclampsia and older, multiparous women from haemorrhage. Problems identified were the late presentation of women, inadequate treatment being administered and "that therapy deviated from the norm".

Anaesthesia was the cause of death in 35 maternal deaths (5.3% of direct obstetric deaths). In 3 cases it followed the administration of GA for elective CS and in 23 cases for emergency CS. Epidural anaesthesia resulted in 9 deaths, but it is not documented whether the epidurals were administered for operative delivery or for labour analgesia. One assumes for CS as it is then stated that 3 women died after converting from epidural anaesthesia to general anaesthesia. Boes commented that anaesthesia remains a low-grade but potentially lethal factor for maternal deaths and that those involved in its administration, particularly non-specialist anaesthesiologists, should ensure their knowledge is adequate as, for obstetric surgery, anaesthesia can be ”complicated”.

2.1.3 Reports of confidential enquiries into maternal deaths in South Africa

Since maternal deaths became notifiable on 1st October 1997 it has been possible to review data pertaining to maternal deaths due to anaesthesia gathered on a national level.

2.1.3.1 1998 The first Saving Mothers report

The NCCEMD published its first report in April 1998 (the first Interim Report on Confidential Enquiries into Maternal Deaths in South Africa). This and subsequent Interim reports only give statistics related to maternal deaths and are published annually. A more detailed analysis is presented in the Saving Mothers Reports but as these take longer to publish due to their more detailed nature, the value of the Interim reports is to detect any marked trends that need urgent investigation. A more detailed analysis of the maternal deaths for 1998 was subsequently published in “Saving Mothers. Report on Confidential Enquiries into Maternal Deaths in South Africa 1998”[75]. This report contained a chapter “Anaesthetic-related Deaths”. This chapter is written by the National Assessor for maternal deaths due to anaesthesia and is based on their review of maternal deaths due to anaesthesia assessed initially at Provincial level. Here it was noted that “more information is available than in the previous (Interim) report and supports the conclusion made then that there is a considerable problem with the level of training of doctors practicing obstetric anaesthesia”.

A total of 28 deaths was reviewed; one case was subsequently found not to be related to anaesthesia as a subsequent post-mortem revealed an undiagnosed cardiac tumour as the cause of death. This left 27 cases as anaesthesia-related. The main findings from review of

these deaths were that most were due to human error or incompetency rather than lack of equipment or facilities. All the chapters related to specific causes of deaths in this and subsequent Saving Mothers Reports give a list of key recommendations in which the authors of each chapter suggest measures to correct the problems they have identified. These measures should be appropriate for the South African context and their implementation feasible within three years. Here, there is a key recommendation that "All those providing obstetric anaesthesia should have received some postgraduate training in its practice. It is suggested that a National Manpower Survey be conducted to determine the requirements for such training." The chapter concludes with the recommendation that this survey should include the identification of hospitals where operative deliveries are performed and the "number, grades, qualification and experience of those called upon to provide anaesthesia."

Of the 27 deaths, 18 seemed to have been directly due to anaesthesia and in most of these cases problems related to the use of general anaesthesia had occurred, in particular difficult or failed intubation. A key recommendation made in this chapter was thus that regional anaesthesia should be promoted for caesarean section and staff be trained in its use..

The term "anaesthetic death" was initially used by the NCCEMD to "denote a death occurring unexpectedly either during or shortly following anaesthesia, which was either directly attributable to anaesthesia or for which no cause could be found". The authors of this chapter considered this term to be inappropriate and recommended it should be abandoned. They argued that to call a peri-operative death in which the probable cause cannot be found as an "anaesthetic death" was wrong as it "obscures the true cause of death even further and may give a false overestimation of the contribution of anaesthesia to mortality". Hence this term has not been used in subsequent NCCEMD reports and the term "anaesthesia-related death" is used instead.

It was also recommended in this chapter that anaesthesiologists should be involved in the review of maternal deaths related to anaesthesia. At that time the assessors of these deaths were not anaesthesiologists and there was a risk that they may have incorrectly assessed these deaths as well as failed to recognise the contribution that anaesthesia had made to deaths from other causes.

2.1.3.2 1999 -2001 The second Saving Mothers report

From 1999 the maternal deaths were reported by the NCCEMD on a triennial basis. This was because maternal death numbers are relatively small and it was considered better to review the data on a triennial basis in order to demonstrate trends and evaluate avoidable factors. In the preface to the first triennial report, covering deaths from 1999-2001[76] and published in November 2002, the editor, Professor Pattinson, notes that "there has been no epidemiological exercise on maternal deaths in developing countries equivalent to what is being attempted by the NCCEMD in South Africa". He continues to note how the only "benchmark" they had was the Confidential Enquiries from the United Kingdom (UK) and that there were major differences between these two countries which would be likely to affect the success of the NCCEMD's efforts to improve obstetric care in South Africa. These differences included the improvement in socio-economic conditions that had taken place in the UK and the South African AIDS epidemic.

Another problem highlighted by Professor Pattinson is that the number of deliveries is not known for the whole of South Africa. This lack of denominator data for maternal mortality has resulted in an inability to calculate the maternal mortality ratio (MMR) for the country and therefore compare death rates over time. He suggested that the MMR for this triennium could be calculated at 175-200/100 000 live births, an increase from the previous figure of 150/100 000 live births, and that this increase may be related to AIDS and/or better reporting of maternal deaths (lack of denominator data has also been a problem when analysing maternal deaths due to anaesthesia. It has only been recently possible to obtain reasonably accurate data regarding how many caesarean sections have been performed and thereby obtain case-fatality figures).

The Chapter on obstetric anaesthesia of this Second Saving Mothers report reviewed the 76 maternal deaths initially assessed at provincial level as being related to anaesthesia. Of these it was decided that in 22 cases the death was not clearly due to anaesthesia as its occurrence appeared only to be coincidental or due to other causes. This probably reflects poor assessment by provincial assessors although it was highlighted that the assessment process had improved since the involvement in the review process of anesthesiologists.

Demographically there were similarities with the First Saving Mothers Report in that most of the anaesthesia-related deaths occurred in level one hospitals during caesarean section, in young women with no co-morbidities. Anaesthesia was the 4th commonest direct cause of maternal death in a level one hospital and the 5th commonest direct cause of maternal death for all levels of hospitals during this triennium. Although this represents a relatively small number in absolute terms, ie 56 direct deaths from anaesthesia (6% of direct causes of maternal deaths), it is noted here that this is still a large number if compared to the UK or the USA[77]: in the UK there was only one death related to anaesthesia in the triennium 1997-1999[78].

Of the 56 deaths considered directly due to anaesthesia, 31 (58%) were due to complications arising from general anaesthesia and, similar to those occurring in 1998, most were due to problems related to tracheal intubation. Here it was noted that where these deaths occurred there was no evidence that the doctors involved had followed any internationally accepted protocol designed to avoid death by hypoxia in this situation. They had frequently proceeded to actions which were specifically contraindicated in this event eg repeated attempts at intubation without trying to oxygenate the patient and the administration of repeated doses of suxamethonium. In one case a difficult airway was noted before induction of anaesthesia and yet, despite their being no contraindication to RA, the doctor still attempted to give a GA and the patient died from a failed intubation. Here it was commented that “Use of spinal anaesthesia could have averted death in this case”.

As regards death from spinal anaesthesia in this triennium, there were more compared to 1998 (42% versus 21%). The majority were due to high motor block and/or hypotension; the authors of this chapter highlight how these are well recognised complications of obstetric regional anaesthesia which should not lead to mortality. The data from these deaths revealed that “many of the high spinals were detected late and poorly managed”. Furthermore in at least 4 of these cases the terminal event was failed intubation; this suggests additional lack of experience in GA techniques.

Other examples of poor practice leading to RA deaths are the lack of a laryngoscope in theatre when a high spinal developed leading to delay in intubation and the feeding of an elective patient a meat pie before surgery; when this patient developed a high spinal she died from aspiration of stomach contents. These are examples of the failure of practitioners to

recognise that RA is not a completely safe alternative to GA in obstetric anaesthesia. Care must be taken with RA and only those trained in its use, and competent to deal with its complications, should administer it. As conversion to GA may rapidly be required, RA should only be administered by those doctors who are also competent in GA.

There were 15 deaths in this triennium in which anaesthesia, whilst not directly responsible for the death, may have contributed to the death, which was ultimately due to another cause. Analysis of such cases is important as information regarding poor anaesthesia practice can be obtained from these deaths and recommendations made to correct these problems. An example given here was the failure to obtund the hypertensive response to intubation in an eclamptic patient. This resulted in severe hypertension, cardiogenic pulmonary oedema and subsequent death as this was then poorly managed.

The conclusion to this chapter was that there were emerging “two disturbing trends” in this triennium. The first was the apparent increase in the spinal anaesthesia deaths and the second was the increasing number of deaths due to GA techniques “totally inappropriate to the obstetric patient”. These were considered to imply that the doctors administering OA, particularly in the level one hospitals where most of these deaths had occurred, were not competent in OA. It is noted that although the use of RA has been associated with a decline in maternal deaths from anaesthesia in developed countries, in these countries OA is restricted to experienced anaesthesiologists. In countries where relatively inexperienced practitioners administer OA “there may be no overall advantage in safety for either technique”.

The chapter ends with a description of the technical skills community service doctors should be trained in according to the task team appointed by the Minister of Health to investigate the skills and competencies of interns and community service doctors[79]. With reference to OA the only recommendation was that the post-intern should have administered at least 20 spinal anaesthetics for caesarean sections. There was no recommendation regarding experience in GA for OA and no requirement for assessment of competency in either technique or the management of their complications. Finally, it was remarked that the Department of Health published “Guidelines for Maternity Care in South Africa[80]” in which protocols for the management of such anaesthetic complications were given. This was distributed to clinics and level one hospitals only at the end of 2000. It was hoped that the

dissemination of this information and the application of these guidelines might have an impact on maternal deaths from anaesthesia in subsequent years.

The Key recommendations given by the authors of this chapter therefore included the need to ensure that doctors administering OA were competent at both RA and GA, longer training in anaesthesia was required for interns (to improve their competence in OA so when they assumed a post as a Community service doctor they would be better able to administer OA) and that lack of basic equipment and facilities be addressed. There had been problems analysing anaesthesia records as they had been of poor quality or simply absent from the patient's file. Hence another Key recommendation was that a "national standard anaesthetic record form be included in all bed letters *(ie patient case record)*". It was considered that having the anaesthetic record as an integral part of the patient's record then it would not be lost so frequently.

2.1.3.2 2002-2004 The third Saving Mothers report

The Third Saving Mothers Report was published in June 2006. Although 91 maternal deaths had been reported as due to anaesthesia in this triennium, the files of only 72 deaths were available for assessment by the National Assessor to analyse. After analysis, 62 were considered to be directly due to anaesthesia.

Whilst more deaths were due to GA compared to spinal anaesthesia (53% vs 47%), as some of the spinal anaesthesia deaths had followed failed attempt to convert to GA after a complication had arisen, when viewed from the perspective of intention to treat, for the initial anaesthesia administered the rate was higher for spinal anaesthesia when compared to GA (56% vs 44%). The authors of this chapter note that "Although deaths are almost evenly distributed between general and regional (spinal) techniques, the numbers of patients exposed to each technique are unknown, so it is possible that one technique may be inherently safer than the other, but this is unlikely to be by a large factor".

(However, an estimation of these figures can be obtained using the results obtained from this study as a section on the use of RA compared to GA was included (see Chapter 8. Use of regional anaesthesia). These show that for September to November 2004, 84% of CS's in the Free State level one and level two hospitals were performed using RA. The discussion which

then follows regarding the significance of these figures with regard to the number of deaths according to type of anaesthesia and their relationship to safety of each technique is therefore included in Chapter 8 of this study.)

When ascertaining the causes of death after GA, again failed intubation was the commonest cause and occurred in 18 cases (30%); in only one of these cases was an attempt made to follow a failed intubation protocol. In six cases the doctor administering the anaesthesia failed to notice that the intubation had been incorrect; in five cases "the surgeon was the first to notice" (presumably on surgical incision the blood was dark) and in one case the problem was only noticed with the onset of convulsions. The chapter authors remark that "the likeliest explanation in these 5 cases is that not only did the "anaesthetist" fail to check the position of the tracheal tube following insertion but also failed to attach a pulse oximeters, or if one was attached, completely ignored its reading. The authors do not comment here on the use of a capnograph. This provides virtually immediate confirmation of an endotracheal tube in the trachea as exhaled air contained carbon dioxide produced from the lungs, if intubation is oesophageal this carbon dioxide is not seen as it is not produced by the stomach. The reduction in maternal deaths from GA seen in the UK in the 1980's was mostly due to a reduction in the number of cases of unrecognized oesophageal intubation and this has been considered as due to the increased use of capnographs in the 1980's[81].

The deaths related to spinal anaesthesia were again most probably related to poorly treated or unrecognized high motor block and/or hypotension. It was noted that in most cases this was often an assumption as key details were often missing from anaesthesia records and the diagnosis of high spinal/motor block was made as the patient had suffered "catastrophic collapse" shortly after the spinal was inserted. Whilst this was most probably due to high spinal/motor block, there are other more rare causes of collapse after RA eg as in the above cited case in 1998 of the cardiac tumour leading to collapse after RA. Accordingly, it is emphasised in this chapter that good record keeping is of great importance. It enables more accurate assessments of causes of deaths and has medico-legal implications for the doctors concerned if these cases are involved in legal actions.

Of concern was the finding reported in this chapter of an increase in the risk of death from anaesthesia in level one hospitals. For this triennium, anaesthesia was the third commonest cause of a direct maternal death in these hospitals (it was fourth for 1999-2001 and fifth for

1998). Again it was emphasised that the majority of these women who died under anaesthesia were otherwise well and died after developing well recognized complications of anaesthesia, both from RA and GA, due to the poor management they received from the medical practitioners involved. Furthermore, it implies that local administrative issues, such as being unable to transfer sick patients to higher levels of care, could not be blamed.

	2002	**2003**	**2004**	**Total by Level**
Level 1	7	11	25	43
Level 2	10	13	8	31
Level 3	8	3	4	15
Total by year	25	27	37	89

Table 2.1.3.2 Absolute numbers of anaesthetic deaths reported by the DOH, by level of care 2002-2004[76]

The Key Recommendations of this chapter (Appendix A) again recommended better training for doctors administering OA, particularly in level one hospital and the incorporation of the anaesthetic record in the patient's case file. A new recommendation was that there should be outreach programmes from each academic department of anaesthesia in each province, led at "senior level" by a designated person whose sole job it was.

CHAPTER 3

CONCEPTUALISATION OF THE STUDY

3.1 INTRODUCTION

In 2002, I was appointed as the Free State Provincial Assessor for Maternal Deaths Associated with Anaesthesia by the Free State Department of Health, Maternal, Child and Women's Health Directorate (MCWHD). I was subsequently invited to attend a Provincial Assessors Meeting in Pretoria, held by the NCCEMD, in which the annual Interim Reports for maternal deaths were presented and discussed.

At this meeting, the presenter on anaesthesia-related deaths observed that both the 1998 First Saving Mothers Report[75] and Interim Reports for 1999 – 2000[82] (Table 3.1) showed that the Free State was one of the Provinces associated with the highest number of maternal deaths due to anaesthesia in South Africa.

On return to Bloemfontein, I was invited by the MCWHD to attend a Top Management Meeting at the Free State Department of Health, in which statistics related to maternal deaths were presented and discussed. I presented the information as given by the NCCEMD regarding anaesthesia deaths and the relatively high incidence of these in the Free State. Concern was expressed at this meeting at the number of these deaths, and I was asked by those present to investigate this problem.

Province	1998		1999		2000	
	N	%	N	%	N	%
Eastern Province	3	5.6	3	4	1	2
Free State	4	5.1	3	4	10	12
Gauteng	2	1.7	1	1	1	1
KwaZulu Natal	4	2.5	3	1	2	1
Mpumalanga	6	10.9	3	5	5	5
North West	5	14.7	2	4	-	-
Northern Cape	1	4.5	-	-	-	-
Northern Province	1	6.3	9	18	7	11
Western Cape	1	3.6	-	-	1	3

Table 3.1. Anaesthesia-related deaths, according to province 1998-2000.

I then discussed this issue with Professor Diedericks, Head of the Department of Anaesthesiology of the University of the Free State, of which department I am a member, and we decided to formally proceed with this investigation in the form of a PhD study.

3.2 AIM OF THE STUDY

The aim of this study was to investigate quantitatively the factors which have been implicated in maternal deaths from anaesthesia in South Africa within the Free State level one and two hospitals, and then ascertain the impact of interventions subsequently introduced to improve deficiencies elucidated by the initial investigation.

The objectives of Phase 1 were to determine the anaesthesia manpower situation, whether regional anaesthesia was being adequately utilized, whether the anaesthetic drugs and equipment available were adequate, if up-to-date resuscitation protocols were being displayed and whether there were problems with the referral system. Interventions designed to remedy the problems of Phase 1 were then introduced and the objectives of Phase 2 were

to determine whether there had been any improvement in the problems previously identified in Phase 1.

The overall goal of the study was thus to improve the standard of obstetric anaesthesia in the Free State.

3.3 DESIGN OF THE STUDY

The study was designed as an audit cycle, ie an initial audit was to be performed (Phase 1), interventions based on information obtained from the initial audit were to be recommended, and a second audit (Phase 2) was to be performed to ascertain whether the interventions had been implemented and had had any effect on the factors included in the initial audit.

3.4 HOSPITALS STUDIED

Level one and two hospitals were studied as maternal death statistics had shown that the greatest proportion of anaesthetic deaths had occurred in these hospitals prior to the study having been initiated[75, 82] (Figure 3.4).

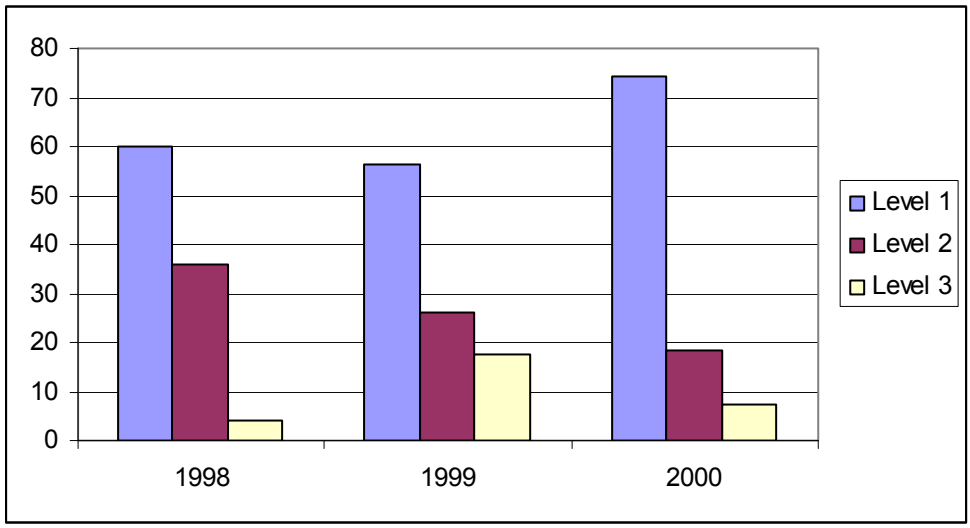


Figure 3.4. Levels of care and number of anaesthesia-related maternal deaths in South Africa: 1998-2000[82].

The finding that level one hospitals had the highest mortality had been contrary to expectation, as only patients who were otherwise well were supposed to have been operated on in level one hospitals. Complicated or ill patients should have been referred to higher

levels of care and operated on in these institutions. Hence, it had been expected that a greater number of anaesthesia-related deaths to occur at level two or three hospitals, where the more difficult cases should have received anaesthesia and been more likely to develop anaesthesia-related complications as a consequence of their underlying medical problems.

The inverse relationship between level of hospital and rate of anaesthetic-related deaths suggested that non-patient related factors at level one and two hospitals eg. problems with doctors administering anaesthesia, equipment and drugs, transport or the referral system, may have been involved in these deaths.

The level one and two hospitals that were visited, and those that were included in the study results, are described below in the section on inclusion and exclusion criteria**.**

3.5 FACTORS STUDIED

3.5.1 Manpower

The only Saving Mothers Report published at the time this study was initiated was the first one, covering 1998. The main factor related to anaesthesia deaths here was *"human error or incompetency"*. There followed a recommendation that a National Manpower survey of obstetric anaesthesia be conducted, which would identify all the hospitals where Caesarean Sections (CS's) were performed, the number of doctors providing anaesthesia in these hospitals and their grades, qualifications and experience.

As no such survey had been done and this factor was deemed highly relevant, a manpower survey was included in this study.

3.5.2 Use of regional anaesthesia

Pregnant women are more likely to suffer death from hypoxia and/or acid aspiration after a difficult intubation than their non-pregnant counterparts[83,84]. Internationally, it has been shown that the increased use of regional anaesthesia (RA) over general anesthesia (GA), when anaesthetising pregnant women, has been associated with a reduced death rate from anaesthesia[85] and the use of RA for obstetric anaesthesia has increased significantly in these countries[86]. Hence, whether RA or GA was being used for CS was studied, a high GA rate being postulated to be associated with increased deaths arising from complications due to failed intubations.

3.5.3 Anaesthetic drugs and equipment

Problems with anaesthetic equipment were implicated in two of the maternal deaths in the 1998 Saving Mothers report. Anecdotally, more cases of faulty equipment, lack of equipment and/or drugs have been described in anaesthetic adverse incidents in the Free State. Availability of anaesthetic drugs and equipment, and their correct functioning, were thus included.

3.5.4 Resuscitation protocols

Skills in resuscitation were found to be lacking in the 1998 Saving Mothers Report (Tables 3.5.4a and 3.5.4b) and implicated in some anaesthesia-related deaths.

Resuscitation problem	% of maternal deaths
Airway not secured	3.7
Breathing not supported	7.1
Circulation not supported	11.2
Drugs not given	4.4
Investigations not done	3.1
Special monitoring not performed	4.4
CVP not inserted	5.4
Ongoing monitoring not performed	5.4
Subsequent management not planned	9.8

Table 3.5.4a Type of resuscitation problems associated with maternal deaths[75].

At the time of the study, the presence of clearly displayed resuscitation protocols was required in each operating theatre and recovery area, according to Council for Health Services Accreditation of South Africa (COHSASA).

As a basic measure of institutional awareness of correct management of cardiac arrest, it was decided to measure how many hospitals had up-to-date resuscitation protocols in their theatres. Where present, this would indicate that personnel with appropriate knowledge of resuscitation and interested in being COHSASA compliant, were likely to be present in the theatre environment. If no protocols were present, this would imply that personnel were less likely to be aware of correct management of cardiac arrest, with the further implication that resuscitation skills were likely to be lacking.

Cause of Direct Death		**No. maternal deaths associated with resuscitation problems**	**% of assessable cases**
Hypertensive disorders of pregnancy		19	26
Obstetric haemorrhage	Ante partum	15	79
	Post partum	22	56
Early pregnancy deaths		8	36
Acute collapse and embolism		2	10
Anaesthesia		Not published	

Table 3.5.4b Type of direct cause of maternal deaths associated with resuscitation problems[75].

3.5.5 Referral system

Most anaesthesia-related deaths had occurred in level one hospitals and the question was raised as to whether this was because there were problems with the referral system, resulting in sick women *having* to be given anaesthesia at an incorrect level of hospital, with anaesthesia-related problems then ensuing.

An attempt was therefore made to include an investigation into the referral system as part of this study, but, as later described, this proved difficult, requiring an extensive additional work-load and was later abandoned as part of this study, being deemed more suitable for a separate study in itself.

CHAPTER 4
STUDY METHOD: THE BROAD PICTURE

4.1 INCLUSION AND EXCLUSION CRITERIA

The Hospitals Statistics database was inspected for 2002. The level one and two hospitals that were performing CS's during 2002 were included in the study.

The hospital managers of those hospitals not shown to be performing CS's during 2002, according to the database, were contacted telephonically and asked whether there were plans for CS's to be performed at their hospital in 2003. Those hospitals in which CS's had not been performed during 2002, but for whom there were plans to provide a CS service in 2003, were included in the study. The only hospital in this category was Hoopstad, therefore it was initially included, as although it was not performing CS's in 2002, there were plans to perform CS's in 2003. However, no CS's were performed at Hoopstad in 2003 or 2004 and so the results from this hospital were subsequently excluded from the study.

The level one hospitals, Elisabeth Ross and Vrede, were excluded from the study as no CS's were performed there during 2002, and there were no plans to start a CS service in 2003.

In conclusion, 21 of the 24 level one hospitals and all 5 level two hospitals in the Free State were included.

For the manpower study, Pelonomi hospital was excluded as it is a University of the Free State training hospital for specialists in anaesthesia, and thus not representative of other level 2 hospitals as regards staffing. Pelonomi hospital was included otherwise.

4.2 PHASE 1 METHOD

An initial study of the above factors was performed in December 2002/2003 (Phase 1 of the study). Manpower was surveyed using questionnaires; anaesthesia drugs and equipment and resuscitation protocols were assessed during visits to each hospital. The details of the

methods used to study each of these factors, both in Phase 1 and Phase 2, is given in the individual chapters relating to these factors.

A complete report of Phase 1 was compiled and presented to senior managers in the FS Dept Health in October 2003 (delay in presentation of this information due to the main investigator being on maternity leave and the FS Dept Health then changing the date from August to October). These senior managers agreed that the findings of this study should be presented to the Top Management of the FS Dept Health, and this took place in December 2003.

At the Top Management meeting it was agreed in principle to fund the interventions suggested in Phase 1 and to perform a second survey (Phase 2 of the study) to analyse the effects of these interventions.

4.3 PHASE 2 METHOD

Phase 2 was planned for late 2004, but as it was only in December 2004 that funds were released by the FS Dept Health for the purchase of the anaesthetic equipment recommended in Phase 1, Phase 2 was delayed until mid 2005. This delay was to allow sufficient time for the anaesthetic equipment to be ordered and delivered to each hospital. Phase 2 was thus performed in May/June 2005, using the same methods as in Phase 1 (see separate chapters for details).

4.4 STATISTICAL ANALYSIS

It was possible to compare the results of Phase 1 to Phase 2 for only 3 of the factors studied, namely “The use of regional anaesthesia”, “Anaesthesia drugs and equipment” and “Resuscitation protocols”. Details of the statistics used are described in the separate chapters on these factors, as are the reasons why it was not possible to compare the factors Manpower and Referral System between the two phases.

CHAPTER 5
REMEDIAL INTERVENTIONS

The following parties were involved in attempts to improve on the deficiencies identified in Phase 1 with remedial interventions:

- Myself and my co-investigators
- Free State Department of Health
- Department of Anaesthesia, University of the Free State (UFS)
- Coincidental interventions by other parties

5.1 INVESTIGATOR INTERVENTIONS

5.1.1 Resuscitation protocols

During each hospital visit, if resuscitation protocols were not already present, we personally gave laminated, up-to-date protocols to the most senior member of theatre nursing staff, one for each theatre in which obstetric anaesthesia was performed and one for the recovery area. In addition, we informed the theatre staff regarding the COHSASA requirement that protocols on resuscitation should be displayed in the operating theatre(s) and recovery area.

5.1.2 Anaesthetic drugs and equipment

5.1.2.1 On-site

Where problems with anaesthetic drugs were noticed during a hospital visit, we not only informed the theatre staff of the nature of the problems and how to correct them (eg incorrect storage method), but also went to the hospital pharmacy and met with the pharmacist to discuss the problems detected. If necessary, the pharmacist was given a copy of the Investigator's check list for anaesthetic drugs.

If problems with anaesthetic equipment were detected, eg. faulty connection of a breathing circuit, the theatre staff were shown the problem and given information on how to correct it.

At the end of each theatre complex inspection, the nurse in charge of theatres for each hospital was given a list of the required anaesthetic drugs and equipment used on the investigators' check lists.

5.1.2.2 Letters to Hospital Management

Within a month of each hospital visit, I sent a letter to the Chief Executive Officer (CEO) of every hospital that had been visited. This letter detailed what problems had been detected, with regards to anaesthetic drugs and equipment, and why these problems should be corrected. A complete list of anaesthetic drugs and equipment required, the same as the one given to the theatre staff, was also included in this letter to the CEO. An example of such a letter, one sent to the CEO of Botshabelo, is to be found in Appendix F.

5.1.3 Presentations and publications

I gave presentations at anaesthesiology meetings, and wrote articles which were published in the medical literature of South Africa, in order to raise awareness amongst health care professionals of the problems with obstetric anaesthesia in the Free State. I used the findings of Phase 1 of this study as the basis for these presentations and publications. I also publicised the importance of being aware of complications associated with spinal anaesthesia and the correct management of these complications.

5.1.3.1 Disseminating information gathered from Phase 1 of this study.

5.1.3.1.1 Presentations (presenter at meeting in bold)

Lamacraft G. Schmidt MJ, Hollingworth S, Dowie JG, Joubert G, Diedericks BJS. *A survey of anaesthetic drugs and equipment in theatres used for caesarean sections in level 1 and 2 hospitals in the Free State.*

University of the Free State Faculty Forum Meeting 2004: (Won Best Clinical Paper Prize)

Hollingworth S, **Lamacraft G**, Dowie J, Schmidt MJ, Joubert G, Diedericks BJS. *A survey of the use of regional anaesthesia for caesarean sections in level 1 and 2 hospitals in the Free State*.

University of the Free State Faculty Forum Meeting 2004

The above two presentations were also given at the Southern African Society of Anaesthesiologists Conference 2004 (Johannesburg), the first by Dr. Lamacraft and the second by Dr. Hollingworth. In addition, another presentation was given by Dr Kenny at this conference:

Kenny P, Lamacraft G, Joubert G, Diedericks BJS. *The Free State Provincial Obstetric Anaesthesia Manpower Survey.*

5.1.3.1.2 Publication

Lamacraft G, Hollingworth S, Dowie JG, Schmidt MJ, Diedericks BJS. *A survey of the use of regional anaesthesia for caesarean section in level 1 and 2 hospitals in the Free State.* S Afr Med J 2004[87].

5.1.3.2 Increasing awareness of problems associated with spinal anaesthesia for CS.

5.1.3.2.1 Conference lecture

Lamacraft G. *Complications associated with regional anaesthesia for Caesarean section* Regional and Pain Symposium: Bloemfontein, Feb 2004

5.1.3.2.1 Publications

Lamacraft G. *Complications associated with regional anaesthesia for Caesarean section.* Southern African Journal of Anaesthesia and Analgesia, 2004; Feb: 15-20

Dyer RA, Rout CC, Kruger AM, Van der Vyfer M, Lamacraft G, James MF. *Prevention and treatment of cardiovascular instability during spinal anaesthesia for Caesarean section*. S Afr Med J 2004; 94(3): 367-372.

5.2 FREE STATE DEPARTMENT OF HEALTH

As described above (see Study Method), I presented the results from Phase 1 to senior managers and Top Level Management of the FS Dept Health in two meetings in October 2003 and December 2003. They were thus made aware of the problems that had been found regarding the safe provision of obstetric anaesthesia in level one and two hospitals in the Free State.

At these meetings, I emphasised that hospital managers should take note of the list of deficiencies regarding anaesthetic drugs and equipment that had been sent to each manager, and ensure that measures were taken in their own hospitals to remedy the problems delineated. In a substantial number of deficiencies, the items were not costly and were well within a hospitals' budget.

Where anaesthetic equipment purchase proved too costly for a small hospital with a limited budget to finance (eg monitoring equipment), a decision by Top Management was made to fund this centrally by the FS Dept Health. I subsequently liaised with the Provincial Bioengineers, and a list of appropriate equipment, including cost quotations, required by specific hospitals was submitted to the FS Dept Health.

Manpower issues were also discussed at these meetings with the top management of the Department of Health, in particular problems with lack of experience amongst those administering obstetric anaesthesia. It was informally agreed that managers would endeavour to appoint medical officers more experienced in anaesthesia, but it was noted that there was a problem regarding recruitment of such doctors in peripheral hospitals. Nevertheless, between Phase 1 and Phase 2 of the study, two Principal Specialists in Anaesthesia were appointed at separate level two hospitals in the Free State, which would have improved supervision of doctors in these hospitals.

5.3 DEPARTMENT OF ANAESTHESIOLOGY (UFS)

5.3.1 iCAM lectures

A series of iCAM (interactive learning communication and management) presentations were made monthly, for six months, during 2003 by me and Dr P. Kruger, also a specialist in anaesthesia from the UFS Dept of Anaesthesia. Here, various issues concerning obstetric anaesthesia were presented, including the management of emergencies. The target audience were the doctors involved in obstetric anaesthesia working in the Level 1 and 2 hospitals in the Free State.

In 2003, most hospitals in the Free State either had an iCAM facility on-site or were within 50km of a hospital which had such a site. The central iCAM studio was in Bloemfontein, where the presenter was televised giving the presentation. This was then broadcast live to the peripheral sites, where the viewers could see and hear the broadcast. Each viewer sat at a special console which was linked to the studio such that they were able to ask the presenter questions during the presentation. Hence the presentation was interactive. This communication system also enabled the presenter to know to how many viewers they were broadcasting, as when each viewer arrived at their specific peripheral iCAM site they logged-on at their console (other details of the viewers eg rank, was not able to be obtained).

For example, for the presentation I gave on 21st January 2003 the following attendance summary was given (Table 5.3):

Site	Viewers
Bethlehem Hospital	2
Bothaville Hospital	2
Botshabelo Hospital	2
Frankfort Hospital	4
Goldfields (Welkom)	1
Moroka Hospital	8
National Hospital	1
Odendaalsrus	4
Virginia hospital	1

Table 5.3. Attendance Summary for iCAM Session: Obstetric Anaesthesia B03/6/1 Dr Lamacraft.

5.3.2 Workshop for General Practitioners

I organised a workshop for General Practitioners (GP's) unfamiliar with spinal anaesthesia. This took place on Saturday, October 18th 2003 in the Clinical Skills Laboratory, Faculty of Health, UFS, and was attended by seven GP's. After this workshop, the GP's then individually attended sessions in the maternity theatres at Pelonomi Hospital, where they were able to give spinal anaesthesia whilst supervised by experienced anaesthesiologists.

Further workshops in obstetric anaesthesia were also given by me at Bongani Hospital (level two hospital) and Thusanong (level one hospital), at the invitation of the management of these institutions. These were attended by the medical officers working at these hospitals.

5.4 COINCIDENTAL INTERVENTIONS.

Whilst these interventions had not been planned or predicted by myself, they occurred during the course of the study and had an impact on the deficiencies found in Phase 1. Therefore they are included in this discussion of interventions.

5.4.1 Intern training.

Prior to the commencement of this study, I presented the problem of lack of obstetric anaesthesia experience in Community Service doctors to Professor Gert van Zyl, Head of the

School of Medicine, UFS, in 2002. From January 2003 (shortly after completion of phase 1 of the study), it was decided by the UFS that Interns should spend four weeks supervised training in anaesthesia (whereas previously only two weeks was required). From January 2005, the Health Professions Council of South Africa (HPCSA) Guidelines for Intern training were changed, with Interns in the two year Internship Group being required to complete eight weeks of anaesthesia.

5.4.2 COHSASA

Throughout 2003, the FS Dept Health encouraged all public hospitals in the Free State to reach requirements for COHSASA Accreditation. One such requirement was to ensure resuscitation protocols were in place and staff were trained in resuscitation.

Whilst this intervention was coincidental and not directly planned for this study, I did meet with the Department of Health members involved in the COHSASA programme, at a MCWHD Committee meeting, in July 2003. Here I gave the findings of the resuscitation protocols survey from Phase 1 of the study, and emphasised the importance of ensuring COHSASA regulations regarding resuscitation were complied with in level one and two hospitals, as resuscitation problems had been implicated in a substantial number of maternal deaths.

CHAPTER 6

MANPOWER

6.1 OVERVIEW

In both Phase 1 and Phase 2 of this study, manpower studies were performed. A pilot study was used to assess the questionnaires before Phase 1. Dr P.Kenny and I designed the questionnaires. When designing these questionnaires we aimed to ask questions that would determine the level of training, experience and supervision of practitioners administering obstetric anaesthesia. We were unable to find any published studies that had investigated this issue previously. Therefore we had to use our own experience for the questionnaire design (Appendix B).

In Phase 1 the method of distribution of the questionnaires proved inadequate (see 6.3.2), with a poor response rate. In order that the data collected be more meaningful, the manpower study was repeated in Phase 2 using a different distribution method (see below). This was successful in that the response rate was more than doubled. However, owing to the poor response rate from Phase 1, it was decided that results from Phase 1 and 2 could not be compared.

Below is briefly described the findings of the Phase 1 manpower study, and then, in more detail, the findings from the Phase 2 manpower study. This is followed by a discussion on interventions required to improve the anaesthesia manpower problems identified to exist in level one and two hospitals in the Free State.

6.2 PILOT STUDY

A pilot study was performed in November 2002, to test the questionnaires used in this manpower study. Six doctors employed as anaesthesiologists at Kimberley Hospital, Northern Cape, were contacted to confirm they were administering obstetric anaesthesia and they verbally agreed to pilot this study. They were then sent the questionnaires and asked to complete them, returning them in sealed envelopes. Of the three that were returned, there

were no problems noted in the completion of these forms or the interpretation of these results.

6.3 PHASE 1 MANPOWER STUDY

6.3 1 Introduction

The Saving Mothers Report of 1998[75] (and later the Saving Mothers Report of 1999-2001[76]) suggested that a major factor contributing to maternal deaths from anaesthesia, was incompetence or inexperience on behalf of doctors administering obstetric anaesthesia (OA). This manpower study was performed in order to evaluate the training and experience of doctors in the Free State level one and two hospitals in OA.

6.3.2 Method

In December 2002 and January 2003, we visited each level one and level two hospital in which CS's were being performed. One level two hospital (Pelonomi) in Bloemfontein was excluded from this aspect of the study, as this is a training hospital for the UFS Department of Anaesthesia and thus not representative of the other hospitals' manpower.

Each hospital manager (or representative) was asked how many doctors were employed by their hospital, whose job it was to provide obstetric anaesthesia services. Informed consent forms for this study (Appendix C) and questionnaires were then given to the managers for them to distribute to all doctors identified as performing OA, to be returned to the investigators in postal prepaid, sealed envelopes.

6.3.3 Results

There were 164 doctors identified by the hospital managers as providers of obstetric anaesthesia. Fifty-four questionnaires were returned (estimated response rate 33%). Rank of responders was: community service doctor 31%, medical officer 32%, general practitioner 37% (there were no specialists).

Twenty-one (39%) doctors had had 2 weeks or less general anaesthesia (GA) training as an intern. Eight doctors (15%) had not been exposed to OA as an intern. Three of these doctors

had had no experience at all in OA before the post in which they were now administering OA and no senior anaesthetist was employed by that hospital to help them. For most doctors (78%) there was no senior anaesthetist employed by the hospital to assist if problems arose.

Only one doctor had a postgraduate qualification in anaesthesia, the Diploma in Anaesthesia. Several doctors commented that they wished further training in anaesthesia but were unable to leave their clinical duties to attend such courses.

Twelve (22%) doctors had never given a GA and sixteen (30%) had never administered spinal anaesthesia for a CS before their present post.

Twenty-five doctors (46%) had to give anaesthesia for CS as well as resuscitate the baby for 6-99% of deliveries and sixteen (30%) had to perform this duty, when required, 100% of the time. Nine (17%) doctors occasionally had to administer anaesthesia and, for the same patient, also perform the CS.

6.3.4 Discussion

This study identified a significant number of doctors administering anaesthesia for CS in the Free State who were inexperienced, inadequately trained and unsupervised.

However the response rate was only a third, so when these results were presented to managers of the FS Dept Health they postulated that the responders may be the doctors who were less supervised or experienced and therefore biased to respond negatively regarding their working conditions. They therefore asked me to repeat the study using a method that would improve the response rate.

Ideally, it would have been better to have immediately repeated the survey as part of Phase 1 using the improved methodology and then to have repeated the survey again in Phase 2 using this methodology. This would have shown whether there was a decline in the number of adequately training doctors administering obstetric anaesthesia during the time course of this study. For example, it was suspected that experienced general practitioners were leaving rural practice, often for posts overseas, and being replaced by relatively inexperienced medical officers. This information was therefore not obtained by this study. (It was not

possible to immediately repeat the survey as part of Phase 1 as this would have meant spending two weeks revisiting all the hospitals previously visited and the investigators were not able to do this owing to clinical work commitments.)

The manpower study was therefore repeated in Phase 2 and an in-depth discussion of the results is given there.

6.4 PHASE 2 MANPOWER STUDY

6.4.1 Method

The same level one and two hospitals as in Phase 1 were visited in May or June 2005. The same questionnaires were used as for Phase 1. The relevant hospitals' management were informed concerning the timing of the visit and the reason for it. They were asked to notify their medical staff that a training lecture on obstetric anaesthesia would be given and their attendance was required.

At each hospital, I gave a lecture to the medical staff present on obstetric anaesthesia. When the lecture was completed, I established from the doctors present the number of doctors administering obstetric anaesthesia in that particular hospital and documented this. I then informed the doctors of the manpower study and gave the required number of questionnaires for this study to the doctors present. After giving informed consent, they were invited to complete the questionnaires confidentially and place them in a sealed envelope which was returned "on the spot" to the investigator. It was emphasised that participation in the study was completely voluntary and the information they gave would be treated confidentially.

The remaining questionnaires were given to one of the doctors present for distribution to the doctors who had not been able to attend the meeting. A stamped and pre-addressed envelope was attached to each questionnaire for return via the post of these questionnaires in the sealed envelope.

6.4 2 Results

There were 148 medical personnel identified as administering obstetric anaesthesia (table 6.4.2). The response rate was 69% with 105 questionnaires being returned. At least one questionnaire was returned from each of the 25 peripheral level one and two hospitals. The response rate was 65% and 71% for level one and two hospitals respectively. In 6 cases, the level of hospital could not be established from the questionnaires.

TOWN	HOSPITAL	Community Service Doctor	Medical Officer	General Practitioner	Specialist	Rank unknown	Total
BETHLEHEM	Dihlabeng					23	**23**
BOTHAVILLE	Nala						**0**
BOTSHABELO	Botshabelo					6	**6**
CLOCOLAN	John Daniel Newsberry					4	**4**
FICKSBURG	Phuthuloha	1	1	4			**6**
FRANKFORT	Mafube	3	0	3			**6**
HARRISMITH	Thebe	1	2	1			**4**
HEILBRON	Tokollo					4	**4**
HOOPSTAD	Mohau						**0**
JAGERSFONTEIN	Diamond	1		3			**4**
KROONSTAD	Boitumelo	8	3				**11**
LADYBRAND	Mantsopa			4			**4**
MANAPO	Mofumahadi Manapo Mopeli	2	4				**6**
MOROKA	Dr. JS Moroka					6	**6**
NATIONAL	National		3				**3**
ODENAALSRUS	Thusanong					4	**4**
PARYS	Parys					4	**4**
PHEKOLONG	Phekolong					8	**8**
REITZ	Nketoana	2	2				**4**
SASOLBURG	Metsimaholo					8	**8**
SENEKAL	Itemoheng	2	3				**5**
SMITHFIELD	Stoffel Coetzee	3	1	1			**5**
VIRGINIA	Katleho	1	5				**6**
WELKOM	Bongani					12	**12**
WINBURG	Winburg	2		3			**5**
ZASTRON	Embekweni						**0**
Total		**26**	**24**	**19**	**0**	**79**	**148**

Table 6.4.2. Number and rank of doctors identified as administering obstetric anaesthesia during hospital visits in May 2005.

6.4.2.1 Rank of respondents and duration in post

The majority of respondents were medical officers (50 doctors). The remainder consisted of 26 community service doctors, 10 interns, 16 general practitioners (GP's) and 3 anaesthetic specialists. Overall, 45% had been at their present hospital for 12 months or less and 23% for more than 5 years.

6.4.2.2 Previous training and experience

6.4.2.2.1 Internship

Most had received limited training in anaesthesia as an intern, with 59% having received 4 weeks or less and 5% not receiving any training in anaesthesia as an intern. Community service doctors had all received anaesthetic training as an intern, 87% for 4 weeks or less. (Table 6.4.2.2.1.a).

Duration	**All Doctors N = 98**	**%**	**Community Service Doctors N = 23 (%)**
None	5	5.1	0 (0)
2 weeks or less	29	29.6	6 (26.1)
3-4 weeks	29	29.6	14 (60.9)
5-6 weeks	8	8.2	0 (0)
7-8 weeks	11	11.2	1 (4.3)
> 8weeks	16	16.3	2 (8.7)
(Did not answer)	(7)		(3)

Table 6.4.2.2.1.a Duration of anaesthesia training whilst an Intern.

Thirteen doctors (12%) had not been exposed to obstetric anaesthesia as an intern. Most had been supervised as interns, although this was by junior medical officers for 20.4%. Four reported no supervision whilst giving anaesthesia as an intern (Table 6.4.2.2.1.b).

Level of Supervision	N (%)
Consultant	25 (24.2)
Registrar	24 (23.2)
Senior Medical Officer	29 (28.2)
Junior Medical Officer	21 (20.4)
None	4 (3.9)
(Did not answer)	(2)

Table 6.4.2.2.1.b Supervision as an Intern

6.4.2.2.2 Anaesthesia experience post Internship, before present post

Some had had experience in anaesthesia since internship, 24% having more than a year unsupervised and 16 % more than a year supervised experience. It was noteworthy that 32% of doctors had had no experience in anaesthesia, supervised or unsupervised, since internship, and 14% had had supervision for 2 weeks or less. These doctors were therefore basing their current practice largely on experience gained as an intern.

6.4.2.2.3 Obstetric anaesthesia experience

Whilst 17.8% of doctors had never provided spinal anaesthesia for CS before their present post and 24% had never given a GA (Table 5.4.2.2.3), closer inspection of the data revealed that 11% (10 doctors) had never given either spinal anaesthesia *or* GA for obstetrics before their present post. This included four doctors who had no senior anaesthetist employed by their current hospital. These respondents were all now administering obstetric anaesthesia. This implies that they were either self-taught or taught by a colleague who was not an experienced anaesthetist.

Six doctors had only given GA for CS before their present post and had never previously given a spinal anaesthesia – four of these were now giving spinal anaesthesia but it is not known how they had learnt to do this as this question was not asked in the questionnaire. The two doctors who still only administered GA were both experienced GP's, employed for over 5 years.

CS's (n)	Doctors who had previously given spinal anaesthesia for CS n (%)	Doctors who had previously given GA for CS n (%)
0	18 (17.8)	24 (24)
1-10	20 (19.8)	30 (30)
11-50	32 (31.7)	23 (23)
51-100	16 (15.9)	8 (8)
>100	15 (14.9)	15 (15)
Did not answer	4	5

Table 6.4.2.2.3. Obstetric anaesthesia experience before present post.

Twelve doctors had only given spinal anaesthesia for CS before their present post and had previously never given a GA for a CS, - five of these had still never administered GA for a CS (it was not asked whether these 5 doctors gave GA for other types of operations although it is assumed that they would do as this is a general requirement for practitioners in peripheral hospitals). Again it is not known why the 7 doctors who had never given a GA before had subsequently done so. It may be that the situation had never arisen previously where a GA was required, as this type of anaesthesia tends to be used in certain emergency situations when a spinal anaesthesia is contraindicated and therefore is used less frequently.

6.4.2.3 Postgraduate qualifications

One non-specialist, a medical officer for 1- 5 years, had the Diploma in Anaesthesia. None of the fifteen medical officers with more than 5 years experience, or the sixteen GP's, had obtained the Diploma in Anaesthesia.

Non-anaesthesia qualifications had been obtained by 50% of doctors, with 43% of doctors having passed courses in Advanced Cardiac Life Support, Advanced Trauma Life Support and/or Advanced Paediatric Life Support. Two doctors had the Diploma in Obstetrics and one in Surgery. Three doctors had successfully completed the Masters in Family Medicine

degree. As regards the long term Medical Officers, who had occupied their posts for more than five years, 47% had no postgraduate qualification of any kind and neither did 37.5% of GP's.

6.4.2.4 Other duties required whilst administering anaesthesia (Table 6.4.2.4)

Only 3% of doctors never had to resuscitate the baby whilst giving anaesthesia for CS and 12% always had to do perform this task when it was required. As regards administering the anaesthesia and then also performing the CS, one doctor had to do this always, 11% frequently and 22% rarely. It was not asked what type of anaesthesia they gave on these occasions and who monitored the mother whilst they were operating. One can only assume that a spinal anaesthetic was given as it is difficult to imagine how a general anaesthetic can be given without the anaesthetist's continual attendance to the anaesthetic. A spinal anaesthetic can be given and once the block has been established, it is not unheard of in remote areas where only one doctor exists, for the doctor to then perform the surgery. However this practice is dangerous as complications of the spinal anaesthetic, or other operative problems such as bleeding, can occur any time during the surgery and this practice exposes the mother to potential life-threatening risks.

Frequency	**Resuscitate baby n (%)**	**Perform surgery n (%)**
Never	3 (2.9)	70 (66.7)
Rarely (<5%)	47 (44.8)	23 (21.9)
Frequently (6-99%)	42 (40)	11 (10.5)
Always (100%)	13 (12.4)	1 (1.0)

Table 6.4.2.4 Other duties doctor must perform whilst administering anaesthesia for CS.

6.4.2.5 Senior anaesthetic supervision

Fifty-four % of respondents said that there was no senior anaesthetist employed by their hospital (Table 6.4.2.5). This included one Intern who was employed by a hospital known to employ a senior anaesthetist. (it is not known why this intern was not aware of the presence of the senior anaesthetist at the hospital) and 56% of community service doctors, four of whom had only two weeks anaesthesia experience as an intern. Three other interns gave anaesthesia without a senior anaesthetist being on the hospital premises. Not one community service doctor had an on-site senior anaesthetist to help, although eleven could call one from home.

Type of supervision	**Doctors** **n (%)**	**Interns** **n (%)**	**Community Service Doctors** **n (%)**
Senior anaesthetist always in theatre complex	5 (4.9)	4 (50)	0
Senior anaesthetist on hospital premises. Comes to theatre when I think I ***might*** need him/her	3 (2.9)	0	0
Senior anaesthetist on hospital premises. Comes to theatre ***only*** if major emergency arises.	2 (2.0)	0	0
Senior anaesthetist on-call from home. Comes to theatre when I ***might*** have a problem	19 (18.6)	2 (25)	6 (24)
Senior anaesthetist on-call from home. Only comes if a major emergency occurs ***during*** operation.	13 (12.7)	1(12.5)	5 (20)
No senior anaesthetist employed by hospital	55 (54.0)	1(12.5)	14 (56)
Other	5 (4.9)		
Did not answer	3	2	1

Table 6.4.2.5. Senior anaesthetic supervision in present hospital post.

6.4.2.6 "Any Suggestions?"

The respondents were asked to suggest how obstetric anaesthesia could be made safer in their hospital. Suggestions were made by 51% of respondents. The most common suggestion (52%) being that a senior anaesthetist should be employed by their hospital. One junior doctor recalled how he had lost a patient after a high spinal anaesthesia had developed in the absence of senior assistance and he was still emotionally traumatised by this experience.

Better training was requested: 18.5% of respondents asked for visits from members of academic institutions for training in obstetric anaesthesia and 11.1% suggested rotation to institutions where medical officers could learn obstetric anaesthesia before taking up posts in rural hospitals. Conversely the rotation of registrars *from* academic institutions *to* peripheral hospitals was also suggested by 3.7%. Three (5.6%) doctors emphasised how there should be proven competency at *both* spinal and general anaesthesia for CS before unsupervised administration of obstetric anaesthesia. Two (3.7%) doctors wanted to train for the Diploma in Anaesthesia. Improved anaesthesia equipment and drugs were advocated by 16.7%.

Other suggestions included the introduction of hospital resuscitation teams, increasing training of interns in anaesthesia, improved referral systems to higher level hospitals and an extra doctor on-call to help with CS and neonatal resuscitation.

6.4.3. Discussion

This manpower survey showed four main manpower problems exist which are relevant to maternal deaths from anaesthesia in the Free State. These problems can be summed up as inexperience, lack of supervision, lack of qualifications and the requirement to perform other tasks synchronous to administering anaesthesia.

6.4.3.1 Inexperience and lack of supervision

This study found some interns were giving obstetric anaesthesia unsupervised. Having the senior anaesthetist on-call from home is inadequate for interns. Anaesthesia emergencies can happen unexpectedly and with startling rapidity. Death can occur within a few minutes. For anaesthesia assistance to be of any value in such a situation, the senior anaesthetist must at least be on the hospital premises, preferably in the theatre complex. The Health Professions Council of South Africa (HPCSA) has guidelines for intern training which state that for anaesthesia “constant supervision of the intern is **critically important** (in bold typing)” and this supervision should ideally be from a specialist but in their absence from a supervisor with a Diploma in Anaesthesia[88]. It follows that if neither of these is employed full-time by a hospital then interns should not be permitted to be trained at these hospitals.

It was found that community service doctors also worked without direct supervision. As 24% only had two weeks of anaesthesia training as an intern (and 56% only 3-4 weeks),

these doctors administering obstetric anaesthesia were also relatively inexperienced in anaesthesia and should have been supervised. Whilst there are no specific regulations concerning the supervision of community service doctors giving anaesthesia, they should still be supported and supervised by senior colleagues (personal communication, Directorate: Workforce Management, National Department of Health). In our study, 56% of community service doctors were giving obstetric anaesthesia in hospitals where no senior anaesthetist was employed, so clearly no support or supervision was being provided for these junior doctors in these institutions.

6.4.3.2 Lack of training and postgraduate qualifications

Some doctors had never administered obstetric anaesthesia (or only one type of obstetric anaesthesia) before being employed in a post in which they were expected to perform this task, sometimes unsupervised.

In the UK it is recommended that junior anaesthetists undergo a "formal assessment" of competence in both regional and general anaesthesia before being allowed to give obstetric anaesthesia with distant supervision (no trainee is allowed to work in a hospital which does not employ a consultant anaesthesiologist). It is suggested that this assessment takes place after about 20 supervised obstetric "sessions" within a four month period[89]. A pre-requisite for this training is that the trainee has already progressed to working with distant supervision in adult non-obstetric practice and most UK trainees work several months in non-obstetric anaesthesia beforehand. The Royal College of Anaesthetists (UK) recommends "at least 1 year's anaesthetic experience" before being allowed to work without direct supervision in obstetric anaesthesia[90].

Whilst one cannot expect a country like South Africa, with less financial and skilled human resources, to be able to reach this level of expertise in obstetric anaesthesia in the near future, this is a model that we should aspire too. There appears to be in South Africa a blend of complacency and ignorance regarding ensuring that only doctors competent at administering obstetric anaesthesia are doing so. Some hospital managers are still under the impression that spinal anaesthesia is a safe procedure which can be performed by anyone that can do a lumbar puncture. These managers have clearly failed to read the Saving Mothers Reports, or if they have, are completely ignoring the importance that has been given in these reports on the dangers of spinal anaesthesia in the unskilled. They have also ignored the emphasis on

skills being in both spinal and general anaesthesia; doctors who administer obstetric anaesthesia must be competent at both types of anaesthesia. Certain obstetric emergencies require spinal anaesthesia and others require general anaesthesia. In some cases a spinal anaesthesia has to be rapidly converted to general anaesthesia. This conversion may have to be performed intra-operatively and if the practitioner can only administer spinal anaesthesia then the mother may die. One still sees advertisements such as that from the CEO of Montebello Hospital, in KwaZulu-Natal, for a medical officer post in a rural hospital where there was an obstetric service, in which only competency at spinal anaesthesia was required, general anaesthesia not even being mentioned (Appendix D).

This ignorance is not simply confined to hospital management; it is even in the higher echelons of Health Care, including the Health Professions Council of South Africa. The 2004/5 intern training manual produced by this body did not stipulate the requirement for the performance of a minimum number of **obstetric** anaesthetics, spinal or general, but only a minimum requirement of 40 general anaesthetics for any type of surgery[88]. It is only in the 2008 intern training manual that the requirement for a minimum of 5 spinal anaesthetics for Caesarean section has been inserted. No competence at general anaesthesia for obstetric anaesthesia is required.

In addition, this survey revealed that almost a quarter of doctors were working long-term (ie more than five years) in peripheral hospitals without a postgraduate qualification in anaesthesia (ie. The Diploma in Anaesthesia). This implies that they had received no, or minimal, training in anaesthesia since Internship.

In 1974 the College of Medicine Diploma in Anaesthesia (DA) was instituted in South Africa. This was aimed at improving the standard of anaesthesia administered by GP's and is an ideal qualification for those doctors administering anaesthesia in level one or two hospitals. A survey conducted in 1999 to determine the role of the DA in South Africa found that 33% of GP's with the DA were working in small town or rural areas[91].

All GP's and long-term medical officers administering obstetric anaesthesia should have the DA and yet in the results of this survey, only one medical officer (in post less than 5 years) had this qualification. None of the GP's or the long-term medical officers had the DA, although a few had non-anaesthesia qualifications (Table 6.4.2.3) and some were even

working in level two hospitals accredited for DA training. It is of concern that these doctors had not taken the DA exam and hospital managers should consider measures and incentives to encourage those doctors they employ long-term to obtain the DA, as this would raise the standard of obstetric anaesthesia in these institutions. It seems that there has previously been little encouragement for this exam, particularly as half of these doctors had other postgraduate qualifications, and this issue certainly needs addressing.

In areas where there are a limited number of skilled doctors, management must seriously consider the risk-benefit ratio of keeping obstetric services at small hospitals. It may ultimately prove safer to transfer obstetric cases to a central institution where human resources are pooled. This would entail improving the transport system considerably and initial expenditure at increasing the number of ambulances and training drivers. However, in view of the number of doctors leaving South Africa, including trained anaesthetists, this solution seems more feasible than increasing the number of anaesthetists at these hospitals. There are simply more people available who can be trained for driving ambulances, than there are anaesthetists. It is also a quicker solution. It takes two years to train an ambulance paramedic and seven years to train a doctor up to community service level, twelve years minimum to specialist level. Moreover, paramedics appear less likely than doctors to leave this country on obtaining their qualification.

This is a solution that was actually used in the UK over thirty years ago to improve maternity services. Until the 1970's, maternity services were provided in "cottage hospitals", small hospitals found in most towns. GP's ran these hospitals and a specialist from a district hospital may visit occasionally. Owing to maternal deaths and serious morbidity (and substantial legal claims), these hospitals were closed for obstetrics and all cases transferred to the central district hospitals. This took a change in mindset of both the public, who had previously enjoyed the convenience of a local hospital for deliveries, and the doctors involved. Obstetric cases in which any danger was anticipated now had to be transferred pre-emptively to the district hospital. Even if this meant the woman remaining in hospital for several days/weeks before delivery. The added costs for these "hotel expenses" have to be compared to that ensuing after an obstetric complication, and are probably substantially less.

6.4.3.3 Other duties required whilst administering obstetric anaesthesia

Quantity as well as quality of manpower is vital for safe obstetric anaesthesia. Of major concern is the frequency with which respondents indicated that they were required to perform both anaesthesia and neonatal resuscitation in the same case. In 2004, a maternal death occurred in the Free State when there was a delayed diagnosis of high spinal anaesthesia because the anaesthetist had left the mother unsupervised in order to resuscitate the baby. In 2009, a similar case occurred in a private sector hospital. There should be sufficient, competent doctors in theatre to prevent the anaesthetist having to perform such emergency duties. As manpower is such a problem in this country, then this is another reason why it may be beneficial to the safety of mothers if smaller hospitals were to merge their resources.

Investigation into causes of maternal mortality in Japan, a developed country with a higher maternal mortality rate than most developed countries, found that in 68% (49 cases) of preventable deaths the doctor was acting both as an anaesthetist and obstetrician[41]. Haemorrhage is the commonest cause of maternal death in this country and in these cases of single operator anaesthetist, 46 women died of haemorrhage and 3 of anaesthesia complications. Certainly in cases of massive haemorrhage, the anaesthetist has to play in major role in maintaining circulating blood volume and maximising oxygen delivery whilst the obstetrician stems the bleeding source. Neither can work in isolation in these cases as without the other without adverse consequences as shown here.

6.4.3.4 Strategies to reduce maternal deaths from anaesthesia

Whilst the Saving Mothers Reports have all given clear recommendations as to strategies to reduce maternal deaths from anaesthesia (Table 6.4.3.4a), the problem has been the **implementation** of these strategies.

This problem was predicted by the Minister of Health in the introduction to the first Saving Mothers Report of 1998[75]. Other than increasing intern training in anaesthesia to two months, none of the other recommendations related to anaesthesia, from the Saving Mothers Reports, have been implemented in the Free State and maternal deaths directly from anaesthesia remain a problem in public hospitals(Table 6.4.3.4b).

1st Saving Mothers Report, 1998	2nd Saving Mothers Report, 1999-2001	3rd Saving Mothers Report, 2002-2004
Staff should be trained in the use of RA.	Skills in both GA and RA required for all giving obstetric anaesthesia	Medical Officers at Level 1 hospitals to have documented obstetric anaesthesia experience and training
Postgraduate training for all those providing obstetric anaesthesia	Specialist at regional level to rotate to hospitals to train junior doctors	Minimum Case-list for Interns
National Manpower Survey should be conducted to determine requirements for above training.	Longer training in anaesthesia for Interns	Outreach programmes for each province, with senior academic to lead, post dedicated.
	Formal accredited resuscitation training	"Tool kit" (details of care and resuscitation) in obstetric anaesthesia for all Level 1 and 2 doctors

Table 6.4.3.4a. Key Recommendations regarding skills in obstetric anaesthesia from Saving Mothers Reports.

For example, in 2004 there were 12 deaths directly due to anaesthesia and 8090 CS's[92] giving a death rate of 14.9/10,000 CS's – over 100 times greater than the rate for the UK.

Year	Total Deaths	Spinal anaesthetic deaths	General anaesthetic (GA) deaths	Level 1		Level 2	
				Spinal	GA	Spinal	GA
1997	6	2	4	0	1	2	3
1998	4	2	2	1	0	1	2
1999	3	1	2	0	2	1	0
2000	9	1	8	1	6	0	2
2001	3	2	1	0	1	2	0
2002	5	0	5	0	4	0	1
2003	3	2	1	1	1	1	0
2004	12	9	3	6	3	3	0
2005	8	6	2	3	1	3	1
2006	8	5	1	2	0	3	1
2007	1	1	0	0	0	1	0
2008	2	2	0	1	0	1	0

Note: No anaesthetic related maternal death occurred at Level 3 from 1997 to 2008

Table 6.4.3.4b. Type of anaesthesia associated with maternal deaths from anaesthesia and level of hospital in the Free State (as reported to Provincial Assessors for Maternal Deaths in the Free State).

In the last two years (2007 and 2008), there does appear to have been a reduction in reported anaesthesia deaths. This coincides with the interns who completed two months of anaesthesia being qualified and commencing their community service. It may be that we are now seeing the long-awaited reduction in anaesthesia deaths. However, it is too soon to be sure of this as deaths may have occurred that have not yet been reported to the Provincial Assessors (some reports have been significantly delayed and some have been found previously to be sent, incorrectly, direct to National Office).

I have recently written, with Professor Christopher Rout, the anaesthesia chapter for the latest Saving Mothers Report for 2005-2007 (in press). For the first time we were able to use data from Provincial Health reports that included not only the number of institutional deliveries in each Province, but also the number of Caesarean deliveries. These figures have previously been inaccurate but since 2001 data has been considered reliable, although they do not include deliveries in the private health sector, or other births outside Provincial institutions (e.g. home births). Using this data we calculated the **national** anaesthesia case-related mortality for this triennium, which was 1.4 anaesthetic deaths per 10,000 Caesarean sections. Using data from the previous triennium, 2002-2004 we also calculated the rate for this triennium and this was also 1.4 anaesthetic deaths per 10,000 Caesarean sections. Thus anaesthesia case-related maternal mortality for Caesarean section probably remains unchanged in recent years despite the increasing numbers of Caesarean sections that are being performed (Figure 6.4.3.4).

The number of Caesarean sections performed in South Africa's Provincial hospitals each year has almost doubled from 85000 in 2001 to 168000 in 2007. This has been due in part to an increase in total deliveries (c. 560,000 in 2001 to 880,000 in 2007) and partly to an increase in Provincial hospital Caesarean section rates (15.2% in 2001 to 19.1% in 2007).

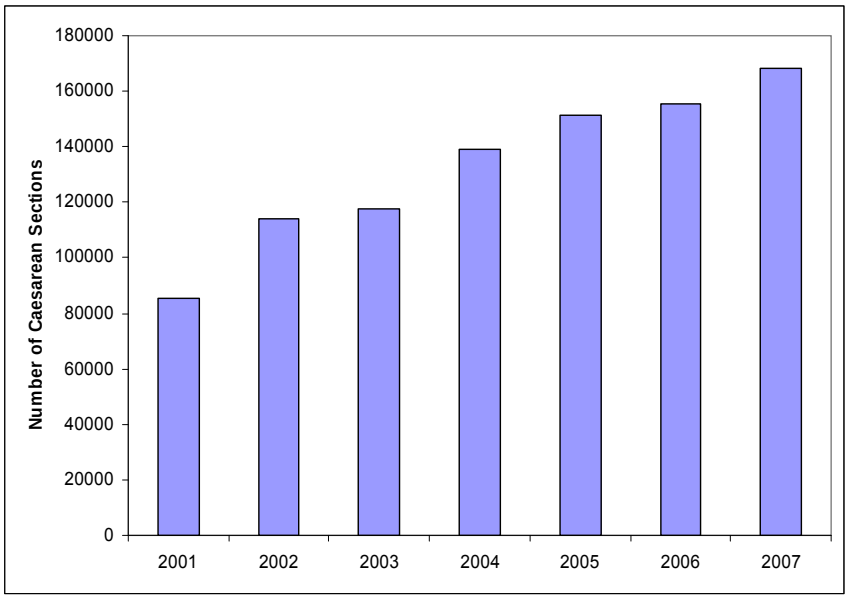


Figure 6.4.3.4a Caesareans sections performed in South Africa from 2001 to 2007.

Why the Caesarean section rate is rising is multifactorial. It may be that more women who require a Caesarean section are having one, due to better access to services and may be an indication of improved health care, although this is controversial[94]. Conversely it may be a detrimental sign. Practitioners may be more fearful of litigation for not performing a Caesarean section and have lowered their threshold for operative intervention. Less consultant supervision may have led to inexperienced junior doctors being over anxious regarding the course of a woman's labour and hence intervening prematurely in a situation where an experienced doctor would have waited longer and the woman delivered normally. It may be a self-fulfilling prophesy, in that once a woman has had one Caesarean section, she is much more likely to require another one due to the risk of uterine scar rupture, and certainly after two Caesarean sections, all further deliveries are usually by Caesarean section.

What the "ideal" Caesarean section rate for South Africa should be is not known. Indeed, what it should be for any country is also not known and is often a strongly contested issue. Some even consider attempts to define an ideal Caesarean section rate as "futile, and should be abandoned". They feel that "The cesarean rate is a consequence of individual value-laden clinical decisions, and is not amenable to the methods of evidence based medicine"[95].

What was of concern from the results of the calculation of anaesthesia case-related mortality for Caesarean section for the 2005-2007 triennium, was that the Free State had a rate over double that of any other province and three times the national average (Figure 6.4.3.4b). This emphasises the importance of this study and the need for the Free State Department of Health to prioritise this problem in their planning of healthcare. Again the emphasis is on the implementation of the recommendations from the Saving Mothers Reports.

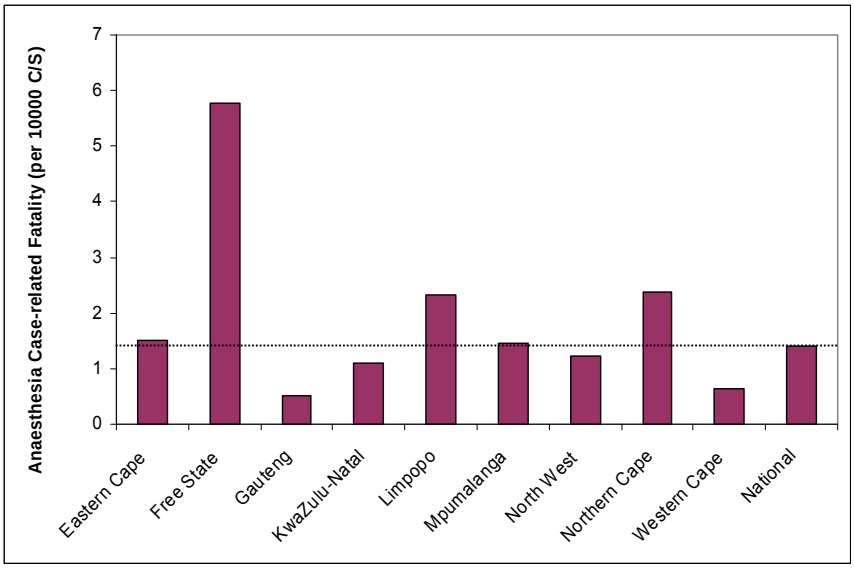


Figure 6.4.3.4.b. Anaesthetic case-related mortality for Caesarean section, by Province 2005-2007

This problem of implementation can be contrasted to the situation in the UK, in which recommendations from the Confidential Enquiries into Maternal Deaths (commenced in 1952) have been implemented, resulting in a high standard of obstetric anaesthesia and reduction in anaesthesia-related maternal deaths. For example, in the UK the rate of direct maternal deaths due to anaesthesia was reduced from 3.6 per 10,000 CS's, in the triennium 1964-66, to 0.1 per 10,000 CS's in the triennium 2000-02[96].

Other African countries are experiencing similar problems to South Africa, related to obstetric anaesthesia, and solutions have yet to be found. A Nigerian teaching hospital reported maternal deaths from obstetric anaesthesia due to inadequate supervision of trainees[97] and as relatively few specialists in anaesthesia are being trained in Nigeria, this problem of supervision may remain for some time. Problems in rural areas are more severe and nurses, poorly trained in anaesthesia, often just give ketamine as the sole anaesthetic for

general anaesthesia with their being no attempt to intubate the patient. This has resulted in deaths from acid aspiration due to an unprotected airway, or cerebrovascular accidents when ketamine was given to patients with pre-eclampsia[98].

Despite the problems noted in Nigeria from nurse anaesthetists, it is frequently suggested at NCCEMD meetings that nurses in South Africa should be trained to administer obstetric anaesthesia. These proponents suggest this would solve the problem of inexperienced junior doctors, who frequently only work short-term in rural hospitals, from being associated with maternal deaths from anaesthesia. They expect anaesthetic nurses to be more likely to stay long-term in rural hospitals and be ultimately more experienced and thus safer in obstetric anaesthesia. This would not necessarily be the case, as there is a similar problem retaining nurses in the public sector, and they have a tendency to leave for the private sector or overseas once they have obtained a qualification.

Nurse anaesthetists in the USA are frequently cited as such a model, as they appear to be as safe in this regard as medically qualified anaesthesiologists. However, proponents of nurse anaesthetists should be aware how costly it is to train these highly skilled nurses in the USA, the duration of their training (four years, post qualification as a nurse) and how well they are reimbursed[99]. Most work in a hospital where there is an anaesthesiologist available if they experience problems, so this requirement must be made where nurse anaesthetists are employed. Furthermore, doctors in level one and two hospitals must perform other medical duties in addition to administering anaesthesia. Employing a nurse anaesthetist who is not qualified to perform the additional medical duties the doctor must perform may not then be cost-effective, particularly in those hospitals where few CS's are regularly performed.

Australia has a geographical problem even greater than South Africa in regards to distances from rural hospitals to referral centers and previously had a problem with the training of general practitioners administering obstetric anaesthesia in rural areas. A training programme specifically developed for those proposing to administer anaesthesia in the rural environment has been developed and has been shown to have improved the skills of those in such practice[100]. Financial incentives for acquiring this skill were provided. In rural areas where specialists in anaesthesia are required and Australian specialists are not attracted to, South African doctors are recruited by offering relatively higher salaries and a safer environment than that in South Africa (personal communication, SA Emigrée)

To summarise, in order for the problem of manpower being a major factor in maternal deaths from anaesthesia to be resolved, the recommendations from the Saving Mothers Reports must be implemented, smaller hospitals must be merged to pool skilled personnel and doctors must be encouraged to remain in South Africa. Proposals to use health care workers other than doctors to administer anaesthesia should be avoided.

6.4.4 Conclusion of manpower study

This Phase 2 manpower study confirms the findings of Phase 1, that there is a substantial lack of training, experience and support for doctors administering obstetric anaesthesia in the Free State.

This is consistent with the Saving Mothers Reports, which found that lack of knowledge was a major factor in most anaesthesia-related maternal deaths.

Training and supervision of doctors administering obstetric anaesthesia needs to be addressed as a priority if maternal deaths from anaesthesia in the Free State are to be reduced. A sufficient number of specialists in anaesthesia need to be appointed at all level 2 hospitals to provide this.

6.4.5 Limitations of the manpower study

Whilst the response rate of 69% is considered adequate for a questionnaire study, it does raise the question of why the other 31% of doctors did not respond. The method used to distribute the questionnaire actually “captured” the doctors who attended the informal lecture I gave on obstetric anaesthesia. All the doctors who attended consented to complete the questionnaire and did so. None of them knew beforehand that they would be given this questionnaire, so it is unlikely that this study over-represent doctors who wished to make known the problems of poor supervision or lack of training in their hospital.

Reasons why some doctors did not attend the lecture could have been:

- They were too busy with clinical duties to attend.

- They thought they did not need to attend because they felt themselves competent enough not to require further education.
- They did not know about the lecture (unlikely in the small hospitals as it is relatively easy to locate people in these and communicate information regarding meetings).
- They knew they were incompetent at obstetric anaesthesia and were apprehensive that this might have been elucidated at this meeting. They might have been worried about potential embarrassment or job loss if this incompetence was made apparent to their peers.
- They might have been on leave.

(The questionnaires were left with colleagues to try and collect information from the doctors who were not present but only about half of these were ultimately returned).

If most of the doctors who did not attend and did not subsequently complete the questionnaire were those who were competent, then the results of this study would potentially over-represent the doctors who did lack knowledge. Conversely if the doctors who did not attend were those who were less competent, then the study over-represented the competent doctors.

Generally speaking, doctors who make the effort to attend teaching sessions are the more personally motivated and competent ones, therefore I expect this study actually has the latter problem and probably under-estimates the lack of training in obstetric anaesthesia in these hospitals.

CHAPTER 7

DRUGS AND EQUIPMENT

7.1 PHASE 1 DRUGS AND EQUIPMENT STUDY

7.1.1 Introduction

This study investigated whether the drugs and equipment available for doctors giving anaesthesia for caesarean sections (CS's) were adequate, with the implication that substandard anaesthetic resources could be related to anaesthetic deaths.

7.1.2 Method

I asked the specialists in the Department of Anaesthesia of the University of the Free State to agree on a list of anaesthetic drugs and equipment considered necessary for safe obstetric anaesthesia at a level 1 or 2 hospital (I based this list on previous SASA, *Southern African Society of Anaesthesiologists,* requirements[101]). They did so, and this list was then used as a standard against which the drugs and equipment of each hospital was checked (Appendix E).

I (or one of my co-investigators) visited the operating theatre complex of each level 1 and 2 hospital in the Free State in which CS's were being performed during December 2002 and January 2003. The hospital CEO's made available a member of that hospital's theatre staff to assist us and they showed us which theatre(s) were currently in use for CS's. They also assisted us in demonstrating where drugs and equipment were to be found, if this was not immediately apparent. We checked not just the presence of drugs and equipment, but that the drugs were not expired and that equipment was functioning.

The checklist included 43 items of anaesthetic drugs and fluids and 58 items of anaesthetic equipment. Some were required to be present in every theatre, as they had to be at hand in the event of acute emergencies, some had to be present in each theatre complex or recovery area and some were required only to be in the hospital itself. If the equipment or drug was not kept in the correct place, was out-of-date or not functioning, it was marked as not

present. We explained to the theatre staff present at the time of the visit, why certain drugs/equipment were required and/or demonstrated why some equipment was malfunctioning, where found to be so.

Shortly after each hospital visit, I sent a detailed report of the findings of these drugs and equipment checks to the CEO of each hospital, so that they would know what deficiencies or malfunctioning equipment had been found in their hospital(s) (example in Appendix F). The reasons for the importance of those drugs and equipment found to be absent were given in these reports. Spare anaesthetic drugs and equipment check lists were included in the reports to the CEO's.

Owing to the substantial amount of data collected in this part of the study, only the major findings are presented and discussed. The complete details of all the items measured are to be found in Appendix H.

7.1.3 Results

Twenty-six hospitals were visited: 5 level two hospitals and 21 level one hospitals. In some hospitals, more than one operating theatre was used for CS, therefore a total of 8 level two theatres and 23 level one theatres were checked.

The results of Phase 1 are given with the results of Phase 2. These results are compared, and discussed in that section.

7.2 PHASE 2 DRUGS AND EQUIPMENT STUDY

7.2.1 Introduction

In May 2005, all the hospitals visited in Phase 1 were revisited. The anaesthetic drugs and equipment were reassessed in order to ascertain whether the remedial interventions (see above) had been effective.

7.2.2 Method

The same checklists were used and the same procedure as in Phase 1 was followed.

7.2.3 Results

The same number of operating theatres, hospitals and items of equipment were checked as in Phase 1. The results are summarised below and compared to the findings in Phase 2.

Statistical analysis of the differences between Phase 1 and Phase 2 were made for all factors for which in either phase the percentage was less than 90%. The only drug for which the change was found to be close to significance was etilefrine. In Phase 1 it was available in 76.9% of hospitals and in Phase 2 it was available in 96.1% of hospitals ($p=0.07$). No significant differences were found for any of the drugs analysed.

For equipment, between the two phases of the study there were significantly more capnographs (35% Phase 1, 70% Phase 2; $p<0.01$), cricothyroidotomy sets (0% Phase 1, 42% Phase 2; $p<0.01$) and laryngeal masks (45% Phase 1, 68% Phase 2; $p=0.02$). Changes close to significance were found for breathing filters (39% Phase 1, 55% Phase 2; $p=0.07$), automated non-invasive blood pressure machines (84% Phase 1, 100% Phase 2; $p=0.07$) and inspired oxygen analysers (23% Phase 1, 40% Phase 2; $p=0.07$).

As in Phase 1, a summary of the results for each hospital was sent to the CEO of each hospital shortly after the theatre inspection (example in Appendix G of letter sent to Botshabelo hospital in 2005).

7.2.3.1 Resuscitation (Appendix H.a)

There was an improvement in the available drugs required for advanced cardiac life support (adrenaline, amiodarone, atropine, calcium, dopamine, lignocaine and sodium bicarbonate), from 78% in Phase 1 to 86.8 % in Phase 2.

In Phase 1, only 2 level one and 2 level two hospitals had all the required cardiac resuscitation drugs. In Phase 2, these drugs were all present in 5 level one and 3 level two hospitals. The commonest drug absent in both phases was still amiodarone, although there was an over 50% increase in the number of hospitals stocking this drug in Phase 2, from 6 to 13 hospitals. Amiodarone was only kept in the pharmacy, not theatres, in 4 level one hospitals in Phase 2.

In Phase 1, a functioning cardiac defibrillator was present in every complex; in Phase 2, defibrillators were again universally present except for Stoffel Coetzee, where the defibrillator had been moved from the theatre to the opposite side of the hospital.

7.2.3.2 Haemorrhage

Results are summarized in Table 7.2.3.2. Further details may be found in Appendix H.b and H.c Equipment 4.

	Phase 1 No. of hospitals (%)	Phase 2 No. of hospitals (%)
Blood (≥ 1 unit)*	16 (61.5)	18 (69.2)
Plasma*	8 (30.8)	5 (19.2)
Colloid*	25 (96.1)	21 (80.8)
Misoprostol*	16 (61.5)	18 (69.2)
Blood giving sets**	27 (87)	28 (90)
IV giving sets 15 drops/min**	30 (97)	27 (87)
IV cannulas 18G or wider bore**	18 (58)	14 (45)

- = per hospital (total hospitals = 26)

  **= per theatre (total theatres = 31)

Table 7.2.3.2. Blood, plasma, colloids, misoprostol and fluid administration equipment: Phase 1 vs Phase 2.

Between Phases 1 and 2, there was a slight improvement in the number of hospitals with emergency blood, with two additional hospitals keeping at least one unit of emergency blood. However, 8 level one hospitals continued to have no emergency blood.

In Phase 2, one level 2 hospital, Bongani, had no emergency blood on the premises when inspected (present in Phase 1). Mofumahadi Manapo Mopeli (level two), which was detected in Phase 1 to have problems maintaining out of hours access to emergency blood, had solved this problem when rechecked in Phase 2.

The three level one hospitals which in Phase 1 had no blood giving sets, had corrected this before Phase 2 and these were now present in every level one and two operating theatre, except Stoffel Coetzee.

Mofumahadi Manapo Mopeli hospital did not store 15 drop/minute IV fluid giving sets in theatres in both phases (60 drops/min sets were available). Diamond hospital now had only 60 drops/min IV sets in theatre whereas in Phase 1, 15 drops/min sets had been available.

In Phase 1, large bore IV cannulae (18G or wider) were not found in twelve level one, and 1 level two operating theatres. In Phase 2, the same number of level one theatres (but different ones) had these cannulae and they were absent now in the 2 theatres at Boitumelo.

Plasma was available in fewer hospitals than previously. Of the level two hospitals, in Phase 2, Mofumahadi Manapo Mopeli had plasma (none in Phase 1), but Bongani did not (present in Phase 1).

Availability of IV colloids was also reduced from Phase 1 to Phase 2. In Phase 2, IV colloids were present at Mantsopa (previously none), but not present at Winburg, Embekweni, Stoffel Coetzee, Diamond and National (previously present).

In addition, there were fewer fluid warming devices in level two hospitals, but more in level one hospitals: in Phase 1 they had been present in all level two theatres, but were not present at Pelonomi, Dihlabeng and Bongani in Phase 2. In Phase 1, 3 level one hospital had these devices and 5 had them in Phase 2.

7.2.3.3 Drugs and equipment for spinal anaesthesia (Appendix G.c. Equipment 3)

In Phase 1, two hospitals were noted to only keep 20G spinal needles, which are inappropriate for use in obstetric patients, and no spinal needles were kept at Winburg, with only GA’s being administered here at the time of the Phase 1.These deficiencies had all been corrected by Phase 2.

7.2.3.4 Post-spinal hypotension (Appendix H.f) (Figure 7.2.3.4)

In Phase 1, 77% of hospitals kept etilefrine (Effortil®). This had improved to 96% in Phase 2. However, there remained a paucity of hospitals in which phenylephrine was available, with only minimal improvement from 2 level two hospitals in Phase 1, to 2 level one and 2 level two hospitals in Phase 2.

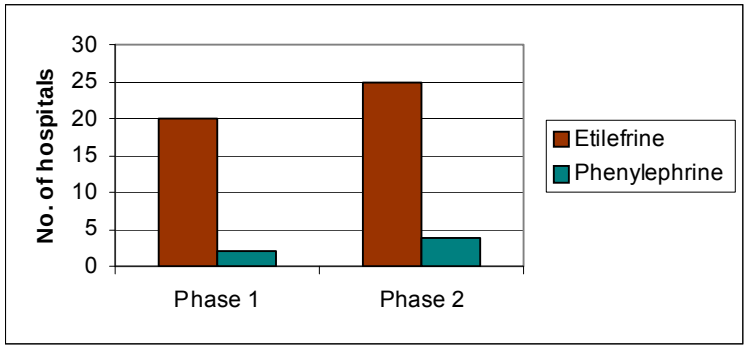


Figure 7.2.3.4. Vasopressors: Phase 1 vs Phase 2.

7.2.3.5 Drugs for general anaesthesia (Appendix H.d) (Figure 7.2.3.5)

In Phase 1 it was noted that Stoffel Coetzee had neither thiopentone nor propofol available, and the thiopentone was out of date at Phekolong. This had been corrected by the time of Phase 2.

In Phase 1, there was no suxamethonium in the theatres at Stoffel Coetzee and Embekweni, and was out of date at Diamond and Phekolong hospitals. In Phase 2, it was not found at Embekweni and, inappropriately, kept locked-up in the pharmacy at Diamond.

Although opiates were available in every theatre complex in Phase 1, none were available in Diamond or Stoffel Coetzee in Phase 2. Opiates were only available on the wards in these hospitals.

Halothane remained universally available from Phase 1 to 2.

Non-depolarising muscle-relaxants were present in fewer hospitals: 76.9% of theatres in Phase 1 and 65.4% in Phase 2. The reversal agent of non-depolarising muscle relaxants, neostigmine, was present more often than the relaxant was, although a decline was noted

from 92.3% of theatres in Phase 1 to 80.8% in Phase 2. Neostigmine was always present where a non-depolarising muscle relaxant was also present.

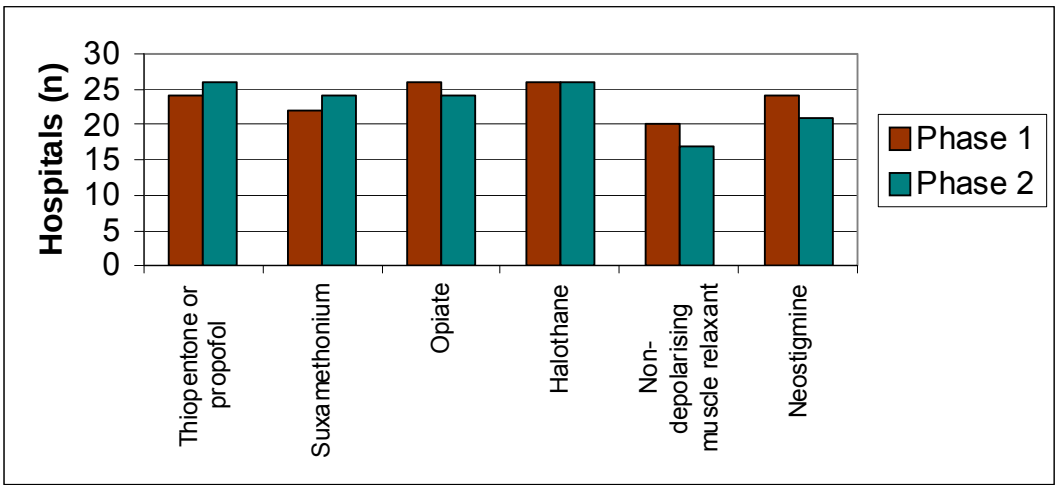


Figure 7.2.3.5. Drugs required for GA for CS; Phase 1 vs Phase 2.

7.2.3.6 Acid aspiration prophylaxis (Appendix H.g)

This requires the availability of oral and IV cimetidine and sodium citrate in the hospital. Overall there was little change in the number of hospitals in which oral cimetidine and sodium citrate was available, and slightly fewer had IV cimetidine:

a) Oral cimetidine

Not available in 6 hospitals in Phase 1 and Phase 2 (not all the same hospitals).

b) IV cimetidine

Not available in 2 hospitals in Phase 1 and these same hospitals as well as a further two, in Phase 2.

c) Sodium citrate

Not present in 20 hospitals in Phase 1 and 21 hospitals in Phase 2.

7.2.3.7 Failed/difficult intubation equipment (Appendix H.c.Equipment 3) (Figure 7.2.3.7)

With the exception of the number of hospitals with intubation stylets, which had remained the same, there were improvements in the other equipment required in the event of intubation difficulties. In particular, laryngeal masks were now kept in every obstetric operating theatre in level two hospitals as well as in 13 level one hospitals, an improvement from 88.9 to 100% for level two and from 40.9 to 56.5% for level one. Furthermore,

cricothyroidotomy sets, which had been completely unavailable in Phase 1, were found in Phase 2 to be present in 13 operating theatres.

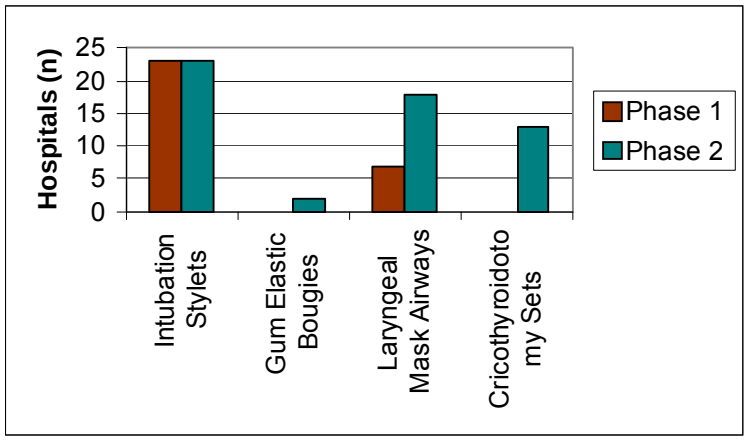


Figure 7.2.3.7. Equipment required for difficult intubation: Phase 1 vs Phase 2.

7.2.3.8 Anaesthetic monitors (Appendix H.h) (Figure 7.2.3.8)

Pulse oximeters were in every operating theatre in both Phase 1 and 2.

Of the five theatres which previously did not have a separate ECG monitor in Phase 1, four now had this monitor in Phase 2. Mafube hospital still only had the defibrillator for intra-operative routine ECG monitoring. The ECG monitor at Diamond was not present in the operating theatre (it was subsequently found in a cupboard).

Capnographs were present in 10 level one theatres in Phase 2. This was an improvement on Phase 1 in which a capnograph had only been in one level 1 hospital, National. All level two hospitals had had capnographs in each theatre in Phase 1 and still had these in Phase 2.

The number of automated non-invasive blood pressure machines had also improved. They had not been present in 4 level one theatres in Phase 1, whereas in Phase 2 every theatre had this monitor.

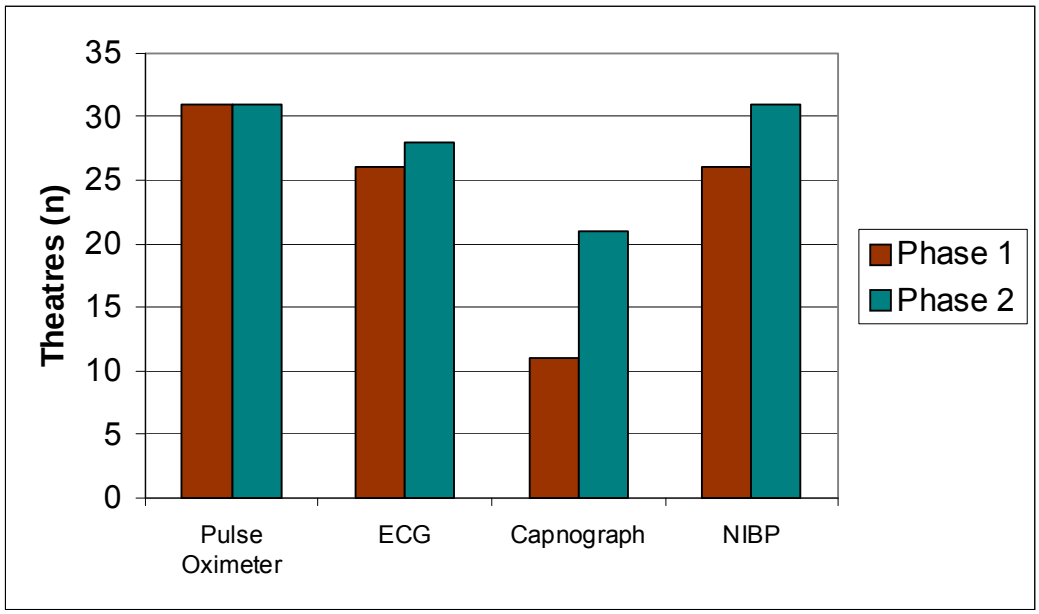


Figure 7.2.3.8. Anaesthetic monitoring equipment: Phase 1 vs Phase 2.

7.2.3.9 Other equipment problems

7.2.3.9.1 Operating tables (Appendix H.c. Equipment 1)

a) Thusanong

The operating table here had been found to be faulty in Phase 1, with a propensity to tip head down spontaneously. Patients here were at risk of sliding head-down off the operating table. By the time of Phase 2, it had been replaced and the new table worked perfectly.

b) Katleho

The operating table had no facilities for the lithotomy position in Phase 1 and this was found to have been corrected in Phase 2.

c) Mantsopa

The operating table was noted to be faulty in Phase 1, as could not be tilted laterally (with no obstetric wedge in hospital), but this was found to be unchanged in Phase 2.

7.2.3.9.2 Anaesthetic machines (Appendix H.i)

a) Parys

The anaesthetic machine in Parys was found to be faulty in Phase 1, with a broken on/off lever for the carbon dioxide absorber. This had been replaced with a new, functioning, machine by Phase 2

b) Itemoheng

The machine (an Ohmeda 900) here was found to be leaking in Phase 1 and had also been replaced by Phase 2.

c) Diamond hospital

This machine (an Ohmeda 900) was in satisfactory order in Phase 1, but found to have a significant leak by Phase 2.

7.2.3.9.3 Servicing of anaesthetic machines (Appendix H.i)

Seven anaesthetic machines were not up-to-date with their six monthly services in Phase 1 and eight in Phase 2, including Diamond hospital

7.2.3.9.4 Laryngoscopes (Appendix H.c. Equipment 3)

There were no functioning laryngoscopes in the operating theatre at Diamond Hospital in either Phase 1 or Phase 2. Every other hospital checked was found to have functioning laryngoscopes in both Phase 1 and 2.

7.2.3.9.5 Anaesthetic machine failure (Appendix H.i and j) (Figure 7.2.3.9.5)

Inspired oxygen analysers were present on 5 more anaesthetic machines in Phase 2 than 1, and mobile oxygen cylinders were present in 3 more theatre complexes.

There were 3 fewer operating theatres with access to an Ambu-bag® in Phase 2 and it was noted that 3 hospitals had Ambu-bags®, but their condition had deteriorated with the result that they were not in working order. In addition, the Ambu-bag® for Mantsopa Hospital had not been returned or replaced since it was used several months previously to transfer a patient to a different hospital.

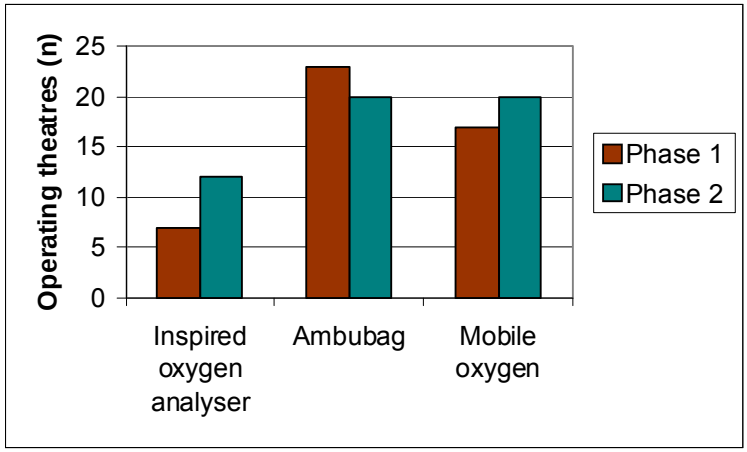


Figure 7.2.3.9.5. Equipment required to detect/manage anaesthetic machine failure.

7.2.3.10 Other drug problems

Medical Emergencies (Appendix H.e)

With the exception of naloxone at Diamond and insulin in other level one hospitals, there had been a slight improvement in the availability of drugs for emergencies.

a) Pre-eclampsia

Magnesium was available in all hospitals in both Phase 1 and 2. Labetalol was available in one more level 2 hospital in Phase 2 (Phase 1: 3 level two and 1 level one hospitals; Phase 2: 4 level two and 1 (a different) level one hospitals).

b) Opiate-induced respiratory depression

This is treated with naloxone. In Phase 1 there had been no naloxone in the theatres at Mofumahadi Manapo Mopeli and Phekolong, but by the time of Phase 2, this had been rectified. In Phase 2, there was no naloxone in the operating theatre at Diamond hospital.

c) Malignant hyperthermia,

The antidote for this is dantrolene. This was present in only 2 level two hospitals in Phase 1 and 4 in Phase 2. No level 1 hospital kept dantrolene in either study periods.

d) Diabetes

Short-acting insulin was present in fewer hospitals in Phase 1 to 2: it was not kept in 2 level one hospitals in Phase 1 and 5 in Phase 2.

e) Other emergencies

Frusemide, diazepam, glyceryl trinitrate, phenytoin, salbutamol, 50% dextrose and hydrocortisone had been missing in a few hospitals in Phase 1, but were all present in Phase 2.

7.2.3.11 Recovery areas (Appendix H.k)

Numerically, this was unchanged, with fourteen level 1 hospitals having no recovery area, or insufficient staff for a separate recovery area, in Phase 1 and 2. Diamond had a recovery area in Phase 1, but insufficient staff to use this in Phase 2, whereas Metsimaholo had insufficient staff to use the recovery in Phase 1, but sufficient in Phase 2. All level 2 hospitals had recovery areas in use in both time periods.

Equipment in the recovery areas had improved slightly, with the exception of Mofumahadi Manapo Mopeli where the suction was not working in the recovery area in Phase 2 but had been in Phase 1.

A cardiac defibrillator and oxygen was available in all these recovery areas in both Phase 1 and 2. There was no blood pressure monitor (automated or manual) at Pelonomi in Phase 1 but was present in Phase 2).

Pulse oximetry was not available in Winburg and Dr JS Moroka recovery areas in Phase 1 and had been corrected at the latter in Phase 2. ECG monitoring was not available at Botshabelo and Dr JS Moroka in Phase 1 but was in both in Phase 2.

7.2.3.12 Summary of results

The above findings are summarized in *Table 7.2.3.12*

Anaesthetic Drugs/Equipment Studied	**Overall change from Phase 1 to Phase 2** *(improvement =↑, decline=↓ and essentially unchanged =↔)*
Resuscitation	↑
Haemorrhage	↑ blood, ↓colloids
Spinal Anaesthesia	↑
Post spinal hypotension	↑
General anaesthesia	↓
Acid aspiration prophylaxis	↓
Failed intubation	↑
Monitors	↑
Other anaesthetic equipment	↔
Other drugs	↑ slight
Recovery	↑ slight

Table 7.2.3.12 Summary of findings of anaesthetic drugs and equipment study: Phase 1 compared to Phase 2.

7.2.4 Discussion

Whilst there had been improvements in drugs required for resuscitation, treatment of post-spinal hypotension and general emergencies, and in equipment for difficult/failed intubation, and monitors in theatres and recovery areas, deficiencies were still present and some aspects had declined. The deterioration of drugs and equipment at Diamond hospital was particularly of note and, owing to these deficiencies being so serious, this problem was discussed with Professor Diedericks (Head of the Department of Anaesthesia at Universitas Hospital). It was then decided to inform the Provincial Department of Health and the CEO of Diamond Hospital that this hospital was unsafe for the administration of obstetric anaesthesia.

The problems were detailed and sent to the CEO. The Provincial Bioengineers were notified regarding the defective anaesthetic machine. Within two weeks the major problems had been rectified, the operating theatre was rechecked and the CEO and the Provincial Department of Health were notified that it was safe to resume administering anaesthesia at this hospital. This event demonstrates that problems regarding anaesthetic drugs and equipment can often be corrected by giving clear information as to what is required. Often the drugs and

equipment are in a hospital but in the wrong place. Equipment that is not working can be repaired, but the problem has to be detected so that the Bioengineers can be notified. The doctors working with this machine did not realize that it was leaking considerably as they did not do the correct machine check, which should be done before starting every theatre list.

Exactly why conditions at the theatre at Diamond hospital should have deteriorated between Phase 1 and 2 is unclear. The CEO of this hospital was new to his post in 2005 and unable to comment on this matter.

This may be contrasted with Thusanong Hospital. Several deficiencies (including the faulty operating table) were demonstrated in Phase 1, but by the time of Phase 2, every anaesthetic drug and piece of equipment was present and functioning (the only exception was dantrolene, which was on order). The reason for this efficiency can largely be attributed to the enthusiasm of the CEO and the theatre nursing staff of Thusanong, who ensured their hospital had all the required anaesthetic drugs and equipment.

Ascertaining exactly why some hospitals had improved and others had deteriorated, or some had improved in some aspects but worsened in others, is difficult. Several external factors other than the interventions planned by this study probably influenced these results. The external factor that had the greatest influence was probably attitude in staff, both in the health care workers responsible for maintaining the correct anaesthetic drugs and equipment in theatre and in the hospital management. Diamond Hospital is an example of a hospital where the management was informed of what standards were required, but this advice was not followed and deterioration of standards occurred. It might have been for this reason that a new CEO had been appointed by the time Phase 2 had begun. This was in sharp contrast to Thusanong hospital, where both the theatre staff and the management showed they were keen to follow all the recommendations and did so. Perhaps more rigorous protocols and enforcement of adherence thereto need to be implemented.

There may have been changes in staff between Phase 1 and 2 for other reasons, which led to failing to hand-over to the new staff the requirements we had issued to the previous staff members. In recent years there has been a move away from rural areas to larger towns and cities, often resulting in considerable staff turnover in the rural hospitals.

Budgetary constraints of some hospitals may have prevented the acquisition of the more expensive drugs and equipment. To assist the hospitals who could not afford new capnographs, ECG's and NIBP monitors, funds were made available from the Provincial Dept of Health. However, the hospital management had to place the order themselves, and despite the Maternal Health Dept contacting them by e-mail and telephonically regarding this, some hospitals failed to place these orders and so did not receive this equipment. This was both surprising and disappointing as both myself and the members of the Maternal Health Dept involved in this, felt that the hospital managers had been offered essential equipment for their hospital at no cost to them and had been too disinterested or inefficient to avail themselves of this offer.

Inaccuracies in this aspect of this study may have arisen because the investigators who were involved may have had different standards when inspecting the drugs and the equipment. In Phase 1 I could only visit half of the hospitals, but in Phase 2 I visited them all. In Phase 2 the results are more likely to be consistent as I was present during all the theatre inspections to maintain an equal standard. However, it is unlikely that there was significant inter-observer variation though, as the check-lists were extremely detailed and clear in what was required. Moreover, the other investigators were all from the same department of anaesthesia and followed the same protocols for checking theatre equipment. The other investigators were chosen by myself to participate in this study as I had previously worked with them and knew that they were reliable and thorough.

South Africa has experienced in the last decade a growing shortage of blood for transfusion. Consequently, despite our efforts, and the efforts of the hospitals involved, to ensure that there is emergency O-ve blood at every hospital where a Caesarean section is performed, there is simply not enough for every hospital. The SA Blood Transfusion Service has been reluctant for blood to be sent to hospitals where few Caesarean sections are performed as it is required so infrequently that it is frequently wasted. Both during and since the period of this study, this topic has been frequently discussed and it appears the only solution is to merge the smaller hospitals to pool resources, as previously discussed for solving the manpower problem. Only in this way will there be enough emergency blood for the hospitals where Caesarean sections are performed.

As regards specific aspects of anaesthetic drugs and equipment:

7.2.4.1 Resuscitation drugs and equipment

Resuscitation equipment and drugs as required for Advanced Life Support and the Emergency Treatment of Dysrhythmias, according to current Southern African Resuscitation Council Guidelines, must be readily available in every level one and two hospital. It is unacceptable for any of these drugs to be kept in the pharmacy, as frequently was found to be the case with amiodarone. Even in working hours when the pharmacist may be on site, the time delay in obtaining these drugs will be detrimental to the chances of successfully resuscitating a patient.

Resuscitation equipment must be dedicated for this purpose and it was also unacceptable that the defibrillator should be used as an anaesthetic ECG monitor in some hospitals. This type of inappropriate use renders the defibrillator more likely to be malfunctioning when it is required for a cardiac arrest. Moreover, the defibrillator is not designed for intraoperative monitoring and is less accurate in the detection of peri-operative cardiac ischaemia than a conventional ECG monitor.

7.2.4.2 Obstetric haemorrhage

Obstetric haemorrhage is the most common direct cause of maternal death in a level one hospital[75]. It is vital that every level 1 hospital stocks adequate fluids and equipment to at least initially resuscitate a hypovolaemic patient prior to transfer to level two. Every level two hospital must be prepared at all times to receive bleeding patients, whose transfer from level one is often delayed such that the patient is severely hypovolaemic on arrival.

Emergency blood should be available at all hospitals where CS's are performed[76], although due to the nationwide shortage of O-ve and O+ve blood this is not always possible, particularly for level one hospitals where few CS's are performed. However, it was notable that in 2005 there was no emergency blood (or plasma) on-site at the level two hospital of Bongani. This matter became a subject of a discussion with the management of this hospital, the Provincial Department of Health and the South African Blood Transfusion Service. In 2007, the SA Blood Transfusion Service moved its blood bank for Welkom from its previous

location in Welkom (approximately 5km distant from Bongani Hospital), onto premises in Bongani Hospital.

7.2.4.3 Pre-eclampsia

Anaesthesia for pre-eclampsia requires administering magnesium and short-acting opioids, to obtund the intubation response if a general anaesthetic is given. Labetalol can additionally be used to control peri-operative hypertension. Pre-eclamptic patients should be transferred to level two for management and all level two theatres must keep these drugs. This study did not specifically enquire as to whether the opiates available at level two were indeed short-acting (ie alfentanil or fentanyl), but this has subsequently been added to the essential anaesthetic drugs lists recommended for these hospitals.

7.2.4.4 Treatment of hypotension from spinal anaesthesia

Spinal anaesthesia is the commonest type of obstetric anaesthesia used for CS in the Free State (see Chapter 8: Use of regional anaesthesia). Hypotension is a well-known side-effect of spinal anaesthesia and if treated inadequately or only recognised late, can be so severe that death can result. For these reasons, hypotension is one of the commonest causes of maternal deaths from anaesthesia in South Africa[76]. Spinal anaesthesia should never be administered if the vasopressors required to correct hypotension are unavailable. Etilefrine must be available as must adrenaline. Phenylephrine may be preferable to etilefrine, but as use of this potent drug requires greater knowledge of anaesthesia, it is only currently recommended for use in level two hospitals and only at level one if the operator has experience in its use.

7.2.4.5 Failed intubation equipment

Failed intubation equipment should be available in every level one and two operating theatre complex, without exception. It was encouraging to see that there had been a substantial improvement in the number of theatres where laryngeal masks and cricothyroidotomy sets were available from 2002/3 to 2005. However, efforts must be continued to ensure every theatre has all the required equipment as the commonest cause of death from general anaesthesia for CS is failed intubation[75, 76].

7.2.4.6 Anaesthetic machine failure/malfunction

When checking an anaesthetic machine, prior to administration of any type of anaesthesia, one of the first steps is to use an oxygen analyzer to check that the fresh gas flowing through the oxygen rotameter is indeed 100% oxygen and there has not been inadvertent switching of the pipe-line supply of gases such that nitrous oxide (or air) is actually now flowing instead. Efforts must be continued to ensure oxygen analysers are fitted on every anaesthetic machine because deaths have resulted from hypoxia subsequent to undetected pipe-line misconnections.

An anaesthetic machine can fail to function at any time and equipment to maintain ventilation of a patient with oxygen, which is completely separate to the anaesthetic machine, must always be available in the theatre complex. An Ambu-bag and mobile oxygen cylinder are required for this. It was disappointing to find fewer theatres with Ambu-bags in Phase 2 and that still not all theatres had mobile oxygen cylinders (although present in 3 more theatres).

7.2.4.7 Equipment for general anaesthesia

Although the commonest type of anaesthesia performed in most level one and two hospitals is spinal anaesthesia, there is always the possibility that an emergency case may arise which requires a general anaesthetic at short notice eg cord prolapsed. In addition, a spinal anaesthetic can unexpectedly fail or develop into a high spinal, requiring immediate intubation and conversion to general anaesthesia. Hence, equipment for GA and intubation must always be at hand in every operating theatre.

Most theatres were fully compliant with this, with Diamond being a notable exception. The doctors administering anaesthesia here were using IV induction with thiopentone, followed by spontaneous respiration with halothane only. This method of GA fails to protect the airway from aspiration, as it does not include intubation of the patient. The aspiration of stomach contents during obstetric anaesthesia is known as Mendelson's syndrome and was first described as a cause of maternal death in 1946[102]. To prevent this, it has been standard practice in developed countries to intubate patients for CS for the last 50 years. It is not

known why some doctors in the Free State were not intubating patients for CS and using considerably out-dated and unsafe methods of obstetric anaesthesia.

7.2.4.8 Anaesthetic monitors

Money had been available by the FS Department of Health to purchase the anaesthetic monitors that were not present during the inspections of Phase 1(see remedial interventions). The hospitals CEO's had been informed of this via e-mail and again telephonically by the Liaison Officer of the Provincial Maternal and Women's' Health Directorate. Despite these measures, Mafube hospital failed to avail itself of this fund and had still not ordered an ECG monitor or a capnograph by the time of the hospital visit in 2005. Eight other hospital managers had also failed to utilize this fund and purchase a capnograph. Whilst one can understand that a CEO of a small hospital is limited in the amount of expensive monitoring equipment he/she is able to purchase on a restricted budget, it was disappointing that not all CEO's made use of funds allocated for this purpose centrally from the FS Dept Health and obtained, at no cost to their own hospital, vital anaesthetic monitoring equipment. The question then arises as to what the problems were that resulted in this failure and this may be the subject of a future investigation.

7.2.4.9 Anaesthetic machines

Anaesthetic machines require servicing every six months and the FS Dept Health has a contract with a bioengineer to perform this task. However, the contract is such that this bioengineer is only able to service a machine when the hospital management notifies him that a service is due and request he comes to that hospital. Failure to make that request resulted in the equipment not being kept up-to-date with servicing and machines developing leaks unnoticed. It would be beneficial to change the contract so that the Bioengineer routinely visits each hospital, every six months, without having to be contacted first. The Dept of Health has agreed to make this change when the contract is renewed.

Over 50% of the anaesthetic machines in use were Ohmeda System 900's, which were purchased over 20 years ago for use in most Free State hospitals. They are now reaching the end of their expected life span and are known to be developing leaks. They have also been noted to develop problems with the safety mechanism designed to prevent the administration

of hypoxic gas mixtures. Inspired oxygen analysers should always be used with these machines but in 2005, this was the case only for 4 of the 19 Ohmeda System 900's in use. Almost all of these machines in the Academic complex have now been replaced and those in peripheral hospitals will probably all need replacing in the next few years. Funds need to be made available for the purchase of these machines and staff still using them have to be vigilant lest they develop leaks.

7.2.4.10 Treatment of malignant hyperthermia

There remains a problem with ensuring access to dantrolene for the treatment of malignant hyperthermia throughout the Free State level one hospitals, as none stored the drug. Although this is a rare condition, with an incidence in the population of only 1 in 10,000[103], it is often not predicted in a specific patient pre-operatively, and without treatment with dantrolene is 100% fatal. If diagnosed and treated correctly, 100% of patients can recover. In level one hospitals other types of operation are performed under GA, in addition to some CS's, and these patients might also develop malignant hyperthermia.

The main problem is the cost of this drug, which is now approximately R1400 per vial. Moreover, its shelf-life is only 18 months, and up to 32 vials of the drug may be needed for one patient. To solve this problem, hospitals in close proximity eg private and public hospitals in Bloemfontein, share the costs by each stocking only a few vials of dantrolene and when a case arises the vials are gathered for the treatment of that patient. They are later replaced by the hospital in which the dantrolene was originally required. Whilst this is possible in a city, it is not possible to implement this plan throughout the Free State, although "dantrolene-sharing" is practiced by all the level two hospitals in conjunction with local private hospitals. Mofumahadi Manapo Mopeli is the level two hospital that is an exception to this, with there being no private hospitals in the same town. Patients at this hospital who develop malignant hyperthermia must rely on dantrolene being fetched from Bethlehem, which is about one hour's drive away. This a similar time for transport faced by many level one hospitals for accessing level two care. Some are even further away. Again, this is another reason for merging smaller hospitals. Expensive but potentially life-saving drugs can then be available in the fewer hospitals where anaesthesia is administered.

7.2.5 Conclusion

Whilst some hospitals had followed the recommendations made from Phase 1, and had improved the anaesthetic drugs and equipment required for CS anaesthesia, a significant number had failed to follow the recommendations and deficiencies remained present, or new ones had developed.

Whilst most of these deficiencies (Diamond hospital being the exception) would not necessarily pose an immediate threat to life during an uncomplicated CS, they may render the treatment of anaesthetic complications inadequate, and in this respect have the potential to contribute to anaesthesia-related maternal deaths.

CHAPTER 8
USE OF REGIONAL ANAESTHESIA

For this aspect of the study, an audit cycle was again successfully completed. Phase 1 identified which hospitals had an acceptable rate of RA use (see 8.1.1) and an overall rate of RA use was established for the Free State. Interventions (see Chapter 5: Remedial Interventions) were implemented and Phase 2 measured subsequent change in rate of use of RA.

The results of Phase 1 were published in the South African Medical Journal[87] and those of Phase 2 in the Southern African Journal of Anaesthesia and Analgesia[104]

8.1 PHASE 1 REGIONAL ANAESTHESIA STUDY

8.1.1 Introduction

A Caesarean section (CS) may be performed using either general anaesthesia (GA) or regional anaesthesia (RA). The most common types of RA are spinal, epidural or combined spinal-epidural. RA has many advantages over GA for CS (Table 8.1.1) and is widely recommended in many countries throughout the world as the preferred method of anaesthesia for CS[105, 106].

Advantages of RA over GA for Caesarean Section
Reduced maternal mortality and morbidity[105, 107]
Less blood loss[108]
Obtunds maternal stress response[109,]
Quicker return of gastro-intestinal function post operatively[110]
Does not impede breastfeeding[111]

Table 8.1.1 Advantages of regional anaesthesia for Caesarean section.

One of the ten key recommendations from the Saving Mothers Report of 1999-2001 was "regional anaesthesia be promoted in all sites performing caesarean sections". It gave a target of 75% of CS's being performed under RA by 2004[76].

Maternal safety was the most important reason for promoting RA: GA has been associated with higher death rates, usually from intubation problems resulting in hypoxia and/or aspiration[112, 113]. In the USA and UK, there is evidence that in the last twenty years there has been a substantial reduction in the anaesthetic related maternal death rates, and this has been attributed to both more experienced anaesthetists performing obstetric anaesthesia and the wider use of RA in these countries[85, 81].

RA was therefore promoted in South Africa in the first Saving Mothers Report of 1998 as a method by which the maternal death rate from anaesthesia may be reduced[75]. However, there has been a lack of data concerning how frequently which type of anaesthesia is being used in this country. If GA was still being widely used as the foremost type of anaesthesia for CS, as it had been in the past[114], then I postulated that teaching practitioners to use RA would have a beneficial effect on the anaesthesia- related maternal death rate.

The purpose of this part of the study was therefore to ascertain which method of anaesthesia was being used in the level 1and 2 hospitals of the Free State for CS's. This was in order to determine whether there was a higher usage of GA than recommended and a need to teach practitioners to use RA for CS's.

8.1.2 Method

This study was performed retrospectively. During the hospital visits of December 2002 or January 2003, we examined the theatre record books from 1st September 2002 to 30th November 2002. These theatre books document the type of anaesthesia administered for every operation performed in operating theatres, including CS. They are completed by the nursing staff in theatres. Information was gathered from these records regarding the type of anaesthesia of all patients who had received a CS in the Level 1 and 2 hospitals in the Free State during the above time period.

Some patients had ultimately required a GA, due to failure of spinal anaesthesia. These cases were still included under RA, as this had been the initial intent of the practitioner.
As regards type of regional anaesthetic technique, both spinal and epidural techniques were recorded as RA.

8.1.3 Results (Table 8.1.3)

During the study time period of 1st September 2002 to 30th November 2002, CS's were performed in 19 level one hospitals and all 5 of the level two hospitals in the Free State (no CS's were performed at the level one hospitals of Phumelela (Vrede), Mohau (Hoopstad), Elizabeth Ross, Stoffel Coetzee (Smithfield) and Embekweni (Zastron).

In total 1734 CS's were performed. There was a failure to record the type of anaesthesia administered for 5 CS's. Of the remaining 1729 CS's, 1231 (71.2%) were performed using RA. Most of these were spinal anaesthetics with only 4 being recorded as epidural anaesthetics.

In the Saving Mothers 1999-2001 report[76], it was recommended that in South Africa the target for CS's performed using RA should be 75%. Our results show that this target was achieved in 3/5 level two hospitals (60%) and 8/19 (42%) level one hospitals in the Free State.

When the results of the hospitals in which RA is not used at all, or rarely (<10% of cases) are inspected, one can see that of these six hospitals, five performed few CS's (9-28) in the 3 months of the study, but in one of these Thusanong (Odendaalsrus) a relatively large number were performed (81 cases).

Level	TOWN/CITY (name of hospital)	RA (02)	GA (02)	TOTAL (02)	RA (04)	GA (04)	TOTAL (04)	% RA USE (02)	% RA USE (04)
1	CLOCOLAN (John (Daniel Newsberry)	3	15	18	0	8	8	*16.7*	*0.0*
1	LADYBRAND (Mantsopa)	0	13	13	0	13	13	*0*	*0.0*
1	WINBURG	0	9	9	0	16	16	*0*	*0.0*
1	JAGERSFONTEIN (Diamond)	0	8	8	3	12	15	*0*	*20.0*
1	HEILBRON (Tokollo)	2	26	28	5	6	11	*7.1*	*45.5*
1	BOTHAVILLE (Nala)	0	17	17	10	6	16	*0*	*62.5*
1	FRANKFORT (Mafube)	15	23	38	22	12	34	*39.5*	*64.7*
1	ODENDAALSRUS (Thusanong)	5	76	81	90	23	113	*6.2*	*79.6*
1	SASOLBURG (Metsimaholo)	64	44	108	75	9	84	*59.3*	*89.3*
1	BLOEMFONTEIN (National)	26	2	28	45	4	49	*92.9*	*91.8*
1	VIRGINIA (Katleho)	1	0	1	36	2	38	*100.0*	*94.7*
1	HARRISMITH (Thebe)	29	16	45	46	2	48	*64.4*	*95.8*
1	THABA N'CHU (Botshabelo)	111	11	122	116	4	120	*91.0*	*96.7*
1	REITZ (Nketoana)	15	3	18	58	1	59	*83.3*	*98.3*
1	MOROKA (Dr. JS Moroka)	45	11	56	85	1	86	*80.4*	*98.8*
1	SENEKAL (Itemoheng)	11	3	14	25	0	25	*78.6*	*100.0*
1	FICKSBURG (Phuthuloha)	20	2	22	26	0	26	*90.9*	*100.0*
1	PARYS (Parys)	20	1	21	8	0	8	*95.2*	*100.0*
1	BETHLEHEM (Phekolong)	23	0	23	67	0	67	*100.0*	*100.0*
2	GOLDFIELDS (Bongani)	162	60	222	156	53	209	*73.0*	*74.6*
2	KROONSTAD (Boitumelo)	123	22	145	117	25	142	*84.8*	*82.4*
2	MANAPO (Mofumahadi Manapo Mopeli)	139	58	197	230	44	274	*70.6*	*83.9*
2	BLOEMFONTEIN (Pelonomi)	327	55	382	362	67	429	*85.6*	*84.4*
2	BETHLEHEM (Dihlabeng)	90	23	113	103	12	115	*79.6*	*89.6*
TOTAL		1231	498	1729	1685	320	2005	*71.2*	*84.0*

Table 8.1.3. Use of regional anaesthesia and general anaesthesia for Caesarean sections in Free State Level 1 and 2 Hospitals (Sept 1st-Nov 30th 2002 and Sept 1st-Nov 30th 2004).

8.1.4 Discussion

This is the first survey to quantitatively investigate the type of anaesthesia used for CS in South Africa. The Saving Mothers 1999-2001 report, in the chapter on obstetric anaesthesia, states: “we lack denominator data regarding the number of each type of anaesthetic used in operative deliveries throughout the country”. These results supply data for this in the Free State.

Theatre record books are generally meticulously completed by the nursing staff and so one can consider this data to be reasonably reliable, although it was of note that for five cases the type of anaesthesia was not described. It is extremely unlikely that any cases were not recorded at all. This would be considered a serious disciplinary offence for the theatre staff concerned. Some nurses do not know the difference between a spinal anaesthetic and an epidural, and may have erroneously classified a spinal as an epidural. This is more likely than the converse, misclassifying an epidural as a spinal, as during our hospital visits not one practitioner we met routinely gave an epidural for a Caesarean section (one GP in Clocolan occasionally gave an epidural for labour analgesia but then converted to GA if a CS was required). We did not see any epidural needles elsewhere. As we classified both spinal anaesthesia and epidural anaesthesia as regional anaesthesia, if the nurse did erroneously document a spinal instead of an epidural or vice versa, it would not have impacted on our results.

We only used data for three months of the year, September to November. This was because for the hospitals in which a large number of CS’s were performed, we did not anticipate having sufficient time to count all the cases from the theatre books during our hospital visit. We used statistics from the FS Dept Health hospital statistics database for the first 6 months of 2002 to estimate how many CS’s were likely to be performed during the study period.

One possible problem with only using data from these three months is that at one hospital, Metsimaholo (Sasolburg), the senior doctor there, who teaches new doctors anaesthetics, likes to teach them how to do a general anaesthetic first and only when they are competent at that, do they learn spinal anaesthesia. His rationale is that major emergencies often require general anaesthesia, and spinal anaesthetics sometimes have to rapidly be converted to general anaesthesia. Hence he feels that competence at general anaesthesia is required before

competence at spinal anaesthesia. This results in more operations at the beginning of the year being done under general anaesthesia, although by the time the study took place, which was towards the end of the year, this potential bias probably was not relevant, as general anaesthesia was probably only done for the normal emergency indications, the junior anaesthetists being competent at spinal anaesthesia by then.

Overall, this Phase 1 study found that although there were 6 hospitals in the Free State in which RA was never/infrequently used, in the majority of the other hospitals RA was used, although in only 12 of these the target of 75% was reached. The problem now was how to get practitioners in the Free State to use RA more without paradoxically precipitating an increase in the maternal death rate from complications of spinal anaesthesia. In recent years there has been a very worrying rise in maternal deaths after spinal anaesthesia in South Africa. In 1999-2001, there were 76 reported anaesthesia-related deaths, of which 25 (33%) were directly attributed to complications arising from spinal anaesthesia, with 21 deaths from a high motor block[76]. This may be compared to the 1998 Saving Mothers report, where there were only 6 deaths (21%) from spinal anaesthesia, 3 as a result of a high spinal[75]. However, the author of this report's chapter on anaesthesia did note that there may have been under-reporting or inaccurate reporting of anaesthesia-related deaths at this time, particularly as anaesthetists did not analyse maternal death reports at that time.

There may be a learning curve regarding use of RA for CS. Hawkins et al, in the USA, found that prior to 1985, a GA was twice as likely to be associated with maternal mortality as RA, with there being several deaths from treatable complications of RA eg. high motor block. After 1985, this increased risk from GA compared to RA rose to almost seventeen-fold. There were a similar number of deaths from GA, but substantially fewer from RA, as training and experience with the use of RA improved[36].

Who were the doctors administering obstetric anaesthesia that we needed to focus on and what was their training? The answer to the second question was suggested by the Phase 1 manpower study, which found that not only Community Service Doctors, but also established Medical Officers (MO's) and General Practitioners (GP's) were giving anaesthetics for CS. Therefore there was a need to train both "new" and "old" doctors how to safely use RA.

"New" doctors, the pre- and post graduate medical students and Interns at the University of the Free State, have been trained to routinely give RA for CS (unless there is a specific indication for a GA) for approximately the last ten years. As these have progressed to their Community Service year and worked in the peripheral level 1 and 2 hospitals in the Free State, they have been able to demonstrate this technique to other doctors in these hospitals. Some "new" doctors working in the Free State may have been trained elsewhere in South Africa, or another country, where the preference of RA is not stressed.

Training the "old" doctors was more of a challenge. Most of these were GP's and MO's with busy working schedules, unable to leave their practices and hospitals and travel to the Academic Teaching Centres in Bloemfontein. To send an experienced anaesthesiologist to where these doctors worked was not considered cost-effective; in some of the more distant hospitals in which only GA was being administered, there was on average only one CS every 10-11 days (and usually non-elective and so not predictable).

To update doctors in peripheral hospitals, it was decided in 2003 to give a series of iCAM (5.3.1 Remedial Interventions) teaching sessions on obstetric anaesthesia. These televised sessions were broadcast to peripheral hospitals in the Free State. In these sessions RA was promoted, the advantages and complications of this technique discussed and the need emphasised for supervised training before isolated practitioners attempted this technique for the first time.

In addition, teaching on spinal anaesthesia for CS was given (5.3.2 Remedial Interventions) to GP's. Participants attended the University for a theoretical teaching morning on a Saturday, followed by individuals returning for "hands on" teaching days, where they were supervised in administering RA for patients having elective CS in the Academic Complex level 2 hospital (Pelonomi). This programme was tailored for the busy GP's in that the theoretical and practical sessions were held on Saturdays, so they were not hampered by their work commitments and could attend. It involved close liaison with the Obstetric department and nursing staff to enable elective patients to be admitted and operated on a Saturday.

As regards endeavouring to reach the target of 75% for RA use in the other hospitals, which did not quite reach this target, doubt was initially raised over whether this would be possible. The target of 75% was an arbitrary one set to encourage the use of RA in South Africa (see 8.2.3 Discussion), but it must be recognised that RA is not an appropriate anaesthetic technique for all obstetric patients. In areas where health care is less accessible it is not unusual for a patient to present in extremis after a prolonged labour, shocked from haemorrhage or septic, and these patients should not be given a spinal anaesthetic. However, in 3/5 level 2 hospitals the RA use was over 79%, and in the other two the rates were 69% and 72%. As these hospitals deal with the more complicated cases, then this 75% rate did seem achievable and was maintained as the required goal.

It must be emphasised that it was strongly advocated that practitioners administering obstetric anaesthesia should be competent at both GA and RA[115]. It was stressed that circumstances may arise perioperatively in which immediate conversion to GA is required and that some emergency cases were not suitable for RA (eg major haemorrhage).

8.2 PHASE 2 REGIONAL ANAESTHESIA STUDY

8.2.1 Method

The survey was performed in May 2005, again retrospectively and using the same method as for Phase 1. Permission to visit each hospital and inspect their theatre record books again was obtained from the FS Dept Health and the individual hospital mangers. Each of the nineteen level 1 and five level 2 hospitals performing CS's in the Free State was visited and theatre record books for September 1st to November 30th 2004 were inspected. All hospital managers gave permission to inspect their theatre record books and none were missing for the required time periods.

8.2.2 Results (see above: Table 8.1.3)

In 2004, during the three month study period of September to November, there were 2005 CS's performed. Compared to 2002, when 1729 CS's were performed at the same time of the year, this was an increase of 16.0%.

In 2002, the type of anaesthesia was not recorded for 5 CS's and in 2004, for 2 CS's. In all cases where RA was used, this was spinal anaesthesia (epidural anaesthesia was not recorded as being used). Conversion rate of RA to GA was 1.3% (22 cases) in 2002 and 1.4% (28 cases) in 2004.

For level one hospitals the RA rate increased from 58.2% in 2002 to 85.8% in 2004 ($p<0.0001$, Mantel-Haenszel relative risk 1.41; 95% CI 1.32; 1.49) and for level two hospitals the rate increased from 79.4% in 2002 to 82.8% in 2004 ($p = 0.0421$, Mantel-Haenszel relative risk 1.04; 95% CI 1.00; 1.09). Overall, the RA use rate for all the Free State hospitals studied increased from 71% to 84%. ($p<0.0001$, Mantel-Haenszel relative risk 1.16; 95% CI 1.12 to 1.2).

Four hospitals did not use RA for CS in 2002 and in 2004 three did not. Of the four that did not use RA in 2002, two had cases being performed under RA in 2004. Conversely, one hospital that did use RA in 2002, only used GA in 2004.

In 2002, **eight** level 1 hospitals performed >75% of CS's using RA, including two that used RA for 100% of CS's. In 2004, the RA use for CS's was >75% in **twelve** level 1 hospitals and included four hospitals where the RA use rate was100%.

In 2002, three level 2 hospitals were above the 75% target and the other two were close at 73% and 71%. In 2004 all five reached the required target. In neither time period did the use of RA exceed 90% in any level 2 hospital.

8.2.3 Discussion

The recommended target of 75% RA use for CS in the 99-01 Saving Mothers Report was in fact an arbitrary one and set at a time when there were considerably more deaths in South Africa from GA than RA complications . Prior to this GA had been the favoured technique for CS anaesthesia and was used in the majority of cases, despite increased use of spinal anaesthesia being advocated over 20 years previously[114]. The 75% target was set in order to encourage institutions, which at that time were doing no or very few cases under RA, to increase use of this technique and it was hoped that this would be a "realistic" target to aim

for (personal communication with Prof Rout, Anaesthesia Member of National Committee on Confidential Enquiries into Maternal Deaths).

In 2006, the Royal College of Anaesthetists (UK) proposed that >95% of elective CS's and >85% of emergency CS's should be performed under RA, owing to "unequivocal evidence that RA is safer than general anaesthesia (GA) for CS"[116]. However, a Cochrane Review of RA versus GA for CS, other than finding less blood loss with RA, did not otherwise find any major differences in either maternal or neonatal outcomes[117]. It must be noted though that a limitation of critical reviews of the Cochrane type with regards to safety issues in procedures associated with a low mortality, is the reliance on meta-analyses of many, often small, studies that would not individually have the power to detect complications. Anaesthesia-related mortality is a rare event and no individual centre, nor even multi-centre study, would be able to use mortality as a primary outcome. A more recent article specifically investigating neonatal outcomes of RA compared to GA for Caesarean section has found that in the compromised foetus, as shown by foetal distress, GA resulted in a higher risk of an adverse outcome for the foetus, There was a recommendation that the increased rate of adverse neonatal outcomes should be considered when deciding whether to use RA or GA for a CS[118].

The literature on which technique to use for CS in African countries frequently recommends increased use of RA over GA[97], (and by RA, spinal anaesthesia is usually meant as epidural anaesthesia is rarely used in the African setting) but there remain many questions as to which is the best technique. The answer may be that the optimum technique depends on the skills and training of the healthcare practitioners involved and resources available

Safety issues are pertinent to both mother and baby. There is evidence from Malawi that use of spinal anaesthesia has led to better outcomes for both mother and baby[119]. This can be contrasted with other clinical studies that have shown spinal anaesthesia to be associated with a greater degree of neonatal acidosis[120], although the significance of this acidosis is uncertain in otherwise healthy babies as it is only a small difference. It is possible that in the compromised foetus, who is acidotic for other reasons, this small increase in acidosis may be more clinically relevant.

The foetal acidosis observed after spinal anaesthesia has been attributed to the use of ephedrine to maintain maternal blood pressure, which frequently falls with spinal anaesthesia. Ephedrine crossed the placenta and increases the metabolic rate of the foetus, which causes the acidosis[121]. Consequently, there is a tendency for anaesthesiologists to now use phenylephrine to treat maternal hypotension as this does not stimulate the foetus to cause foetal acidosis[122]. Phenylephrine has inherent dangers though, particularly when used by the inexperienced. It is manufactured in a highly concentrated form and if incorrectly diluted can cause a dose-dependent depression of maternal cardiac output[123]. In the developing world situation where access to tests of patients' cardiac function are not readily available (and there is a high incidence of HIV which is associated with cardiac dysfunction (see below)), it may be more prudent to treat spinal anaesthesia induced hypotension with ephedrine which stimulates cardiac function, than phenylephrine[124].

RA is frequently advocated after there have been deaths from airway problems after GA was administered. A paper from Zimbabwe described how RA may be of benefit in preventing airway problems, as these were frequently the cause of death after GA. McKenzie reported that in the triennium 1992-94 there were seven deaths directly due to anaesthesia at the Harare Central Hospital. Six deaths were associated with GA and in five of these GA cases respiratory problems resulted in death. In three of these five cases associated with respiration the initial problem was related to failure to intubate the trachea. In the discussion he asks "what is the safest anaesthetic for caesarean section in Africa?" He comments that one of the deaths was from spinal anaesthesia but these deaths are potentially avoidable if the anaesthetist "remembers the contraindications, is meticulous in recording the blood pressure and poised to administer a vasopressor drug if necessary." If these criteria are met, he considers that "spinal anaesthesia should be the safest option." Further caveats are then discussed which include the recognition that in Zimbabwe (as in many developing countries) patients often present late, dehydrated and perhaps in shock, and in these circumstances RA is often not appropriate and GA is the preferred technique[125].

Pre-eclamptic patients can develop gross facial oedema which can make intubation almost impossible. Furthermore, repeated intubation attempts can exacerbate the hypertensive response to laryngoscopy frequently seen in pre-eclampsia, and this hypertensive responsive can lead to death from intracranial haemorrhage. Anaesthesiologists have previously been concerned over inducing severe hypotension after spinal anaesthesia in pre-eclamptic

patients, but this has now been shown not to occur, even in severely pre-eclamptic patients, providing they are not dehydrated pre-operatively[126],[127].

A Nigerian study recommended greater use of spinal anaesthesia in pre-eclamptic patients, one of the commonest causes of maternal death in Africa. The author of this study tells how in Nigeria, GA is given using ketamine, but this has resulted in deaths from severe hypertension when given to pre-eclamptic patients[128]. Ketamine is known to have the side-effect of increasing blood pressure and is contraindicated in hypertensive disorders. The problem is that in Nigeria, especially in rural areas, there is a shortage of skilled anaesthesiologists and anaesthesia for CS is mostly given by non-medical personnel. In these cases, ketamine is the safest intravenous induction agent because it supports the blood pressure, depresses respiration and laryngeal reflexes less (intubation is generally not performed) and has the additional property of analgesia, so opiates which depress respiration are not required. The problem is that whilst ketamine is safe for the majority of CS's in this scenario, in certain cases such as pre-eclampsia, its hypertensive response can be fatal. Here the problem lies in educating those non-medical personnel who are administering ketamine as to when it is unsafe to use ketamine and how to use an alternative technique such as RA.

There is more evidence regarding airway problems causing deaths after GA and the suggestion that the increased use of RA in Nigeria should be encouraged in Enohumah's paper[62]. Here all six of the anaesthetic-related deaths he describes where due to GA and airway problems occurred in five. As regards which is the best technique for CS though, he considers that "the arguments on both sides are strong and valid" and notes that there are circumstances in which one technique may be preferable to the other.

One cannot simply look at when RA was introduced into a hospital and assume that a subsequent drop in anaesthesia-related maternal deaths confirms that RA is safer than GA. Okafor (see 1.1.2.3.3.) describes how in a Nigerian tertiary hospital, for 2003 the rate of RA use for CS was only 18%. This increased to 71% in 2006. From 2003 to 2006 there was a substantial decline in anaesthesia-related maternal deaths at this hospital. However, the introduction of RA was coincidental with better working conditions for doctors and more supervision of junior staff which could also have contributed to the decline in the number of maternal deaths from anaesthesia in this time period[63]. Other factors affect anaesthesia-related deaths and must be taken into account when studying the mortality of one anaesthesia

technique compared with another. The reduction in maternal deaths from anaesthesia that occurred in the UK and the USA when RA use increased happened at a time when there was an expansion of obstetric anaesthesia as a specialist-based service and trainees were supervised more strictly[129]. It may be that the safety associated with RA may require a simultaneous increase in obstetric anaesthesia expertise to be equally safe in a different environment.

As well as pre-eclamptic patients, the anaesthetist in South Africa has to increasingly anaesthetise patients with HIV/AIDS. Whilst some authors recommend RA as being the preferred technique for most HIV infected patients, as their general obstetric problems are frequently similar to those not infected with HIV, one has to consider each HIV-infected patient individually and fully evaluate them for complications of HIV or complications of the treatment they are receiving[130]. It is becoming increasingly recognised that cardiomyopathy complicates HIV infection; in one study up to 40% of patients infected with HIV were found to have some degree of cardiac dysfunction and this must be considered when deciding on anaesthesia technique[131]. Patients with severe cardiomyopathy can collapse after spinal anaesthesia and a careful GA with haemodynamic monitoring, or a slow onset epidural, are required in these patients and therefore they need to be transferred to a level of hospital where there are the resources to use these more complicated anaesthesia techniques.

In a Johannesburg study, of 106 maternal deaths reviewed, in 59 cases (56%) the mother was infected with HIV; in 70% of these cases the maternal death was related to, or caused by, the HIV infection, with 21/59 (36%) deaths being from tuberculosis and 12/59 (20%) from pneumonia[132].

Women with HIV frequently present for CS with co-existing severe sepsis and pneumonia[133]. As previously mentioned, septic patients with haemodynamic instability are not suitable for spinal anaesthesia as they could suffer a precipitous drop in their blood pressure from sympathetic blockade after spinal anaesthesia is administered[134], and patients with severe pneumonia may suffer an acute exacerbation of respiratory failure after RA, as spinal anaesthesia reduces lung volumes[135]. Consequently, these patients, who frequently present acutely to level one hospitals with foetal distress, may require GA for an urgent CS at these level one hospitals, before being transferred to a higher level hospital. This

necessitates practitioners at level one hospitals being competent at both spinal anaesthesia and GA.

One therefore needs to be aware there are specific clinical situations which necessitate spinal anaesthesia and specific clinical situations which necessitate general anaesthesia. It follows that clinical problems will arise if practitioners are only able to administer one of these two types of anaesthesia. The chapter on Obstetric Anaesthesia in the 99-01 Saving Mothers Report emphasised in its key recommendations that practitioners of obstetric anaesthesia in South Africa must be skilled at both RA and GA.

Whilst one might be pleased that the target set of 75% RA use had been achieved during the time period of this study. One might infer that the educational interventions may have contributed to this. However, one must note that in three hospitals RA was still **never** used and, conversely, that it was used **100%** of the time in four hospitals. Were the doctors in these hospitals able to use both techniques but there was no indication to use the other technique owing to small numbers? Or were they only able to use one technique and used it regardless of the clinical condition of the mother and baby? This may have been the case for the level 1 hospitals which seemed to do entirely RA's as they each had less than 70 cases in the three month study time period. Perhaps they had time to send sicker patients, for whom GA may have been required, to a level two hospital for CS, and this may be why there were GA's performed at all the level two hospitals. Closer inspection of data collected found that in two of the hospitals shown only to use RA, cases were converted to GA during the operation, showing GA skill was present but only used when necessary in two of the four hospitals where RA was only used.

It should be noted that this study was not specifically investigating the rate of conversion of RA to GA. In some, but not all, theatre record books it was noted that a RA had been converted to GA. One cannot be certain that the theatre nurse always recorded this conversion. The theatre nurses were not instructed in the data collection method for this study and may have recorded every case that was converted to GA, but started as a RA, as a GA. This is unlikely to have occurred in significant numbers, as the theatre record book details the anaesthetic drugs given and it was quite easy to see where spinal anaesthetic drugs had been given followed by general anesthetic drugs when checking the theatre record books and obtaining the data for this study. In all of these cases it was clearly documented

that RA had been converted to GA. However it is accepted that a very few cases may have been misclassified with neglect to record the RA drugs and only the GA ones and so the RA rate may actually have been slightly higher.

We noted during our visit that in the level one hospital that had some CS's done under RA in 2002 but not in 2004 (John Daniel Newsberry), the Community Service doctor in 2002 had been able to do RA's. By 2004 this doctor had moved on, leaving no-one able to give RA as the technique had not "caught on" here.

Relatively few CS's were performed in each of the hospitals only giving GA's so they are not ideal hospitals in which one can frequently demonstrate a new anaesthetic technique to colleagues. Moreover, whilst visiting these hospitals in the course of this study, I found that the older practitioners, whilst never having been trained to do RA's, were generally experienced and competent at administering GA for CS. With the above cited Cochrane Study showing no major maternal or neonatal benefits to RA (in otherwise uncomplicated patients) it could be argued that it would be inadvisable to actively encourage practitioners to change an anaesthetic technique that they were comfortable and safe with. These doctors often work in relative isolation and would probably (and understandably) be reluctant to change to an anaesthetic technique in which they had little experience, and was associated with possible fatal complications. Even if they managed to come to a teaching unit and gave 20 spinal anaesthetics supervised, this would probably still not be enough to be fully competent at managing complications of spinal anaesthesia as they occur infrequently, although dramatically. Would such a change cause more harm than good, considering there are few reasons why a RA *must* be performed, rather than a GA, in most emergency situations?.

This survey did find a significantly increased use of RA from 2002 to 2004. Whilst this was seen in most institutions it was most notable for the level one hospitals (here the rate increased from 58.2 to 85.8%). The smaller rise in RA use for level two hospitals (79.4% to 82.9%) could be attributed to there being less room for improvement in the first place, with GA been given appropriately when required.

Whether the increase in RA use can be attributed to the remedial interventions is debatable. These interventions were severely limited by staff shortages at our institution and we have

been unable to continue them since. The workshop only gave a few doctors brief, supervised RA training and even here most were general practitioners, unable to leave their busy rural practices for long enough to perform the recommended 20 cases for basic competence[76]. The '02-04 Saving Mothers Report recommends that outreach programmes in anaesthesia should exist in each province[3]. Clearly this is required to provide on-site training in RA to those hospitals where it is not used.

Another factor which probably had more influence on the rise in RA use was that there may have been a shift from older practitioners (largely trained to give GA's) to more recently qualified ones (trained more in RA) giving obstetric anaesthesia in rural hospitals. The manpower studies suggest that from 2002 to 2004 there were fewer GP's working in peripheral hospitals and a larger proportion of more recently qualified doctors, although the results from Phase 1 and 2 manpower studies are not directly comparable due to different response rates (Chapter 6 Manpower).

Whilst promoting increased use of RA in South Africa, we must note that as use of RA is now so widespread in developed countries, there are now concerns in these countries as to whether junior anaesthetists have sufficient training in GA[136]. The use of simulators to provide such training in GA has even been advocated. Whether it is ethical to follow the training methods of the doctor at Metsimaholo and first train new doctors to give GA first, before training them in RA is debatable. If a patient having a CS dies from a failed intubation in a situation where the doctors were only practicing GA and could have given RA then the medico legal implications are serious. Likewise, it will cause problems now instructing trainers in anaesthesia to only train in the use of GA. In this study, the GP's who gave GA regularly were mostly highly experienced and knew how to deal with complications such as a difficult intubation. Sending Community Service doctors to work in unsupervised operating theatres and having them give GA routinely would lead to an upsurge in the number of deaths from failed intubations and probably other complications of general anaesthesia such as incomplete reversal of neuromuscular blockade.

Indeed, it would be shortsighted to suggest we in South Africa should return to GA being the mainstay of obstetric anaesthesia just because spinal anaesthesia is associated with an increasing number of deaths. Even though the latest Saving Mothers Report for the triennium 2005-7 (in press) has found that the proportion of deaths due to spinal anaesthesia

has continued to increase and 71.6% of anaesthesia-related deaths were related to spinal anaesthesia, these were still mostly due to operator error. If these same unskilled practitioners in anaesthesia had all given only GA's then it can be speculated that the death rate for GA could have been much higher. GA is inherently more complicated to administer than spinal anaesthesia and there are many potentially fatal complications that can arise during its administration. Our challenge in South Africa is to ensure that RA, a technique which is internationally recognised as safer than GA, is taught properly and that only doctors competent in administering obstetric anaesthesia are allowed to do so.

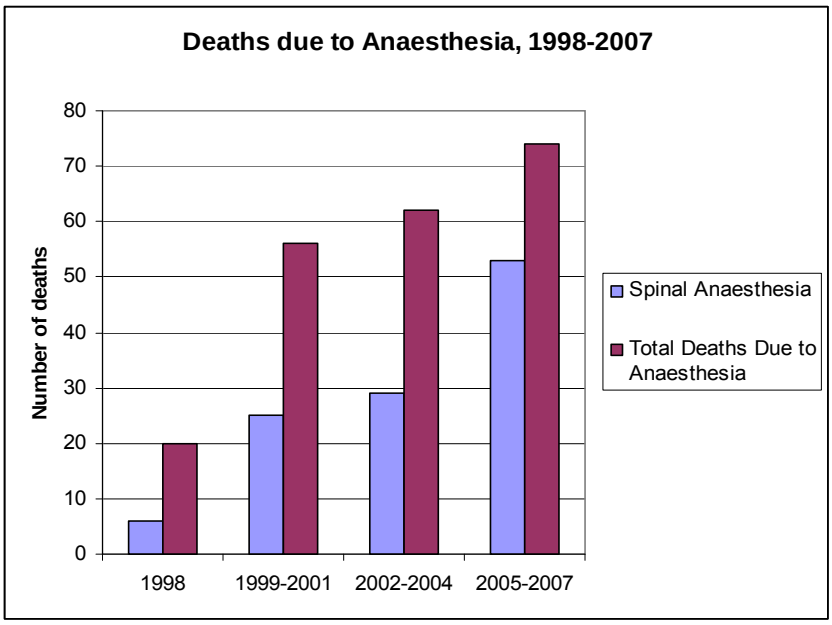


Figure 8.2.3 Maternal deaths due to anaesthesia, and spinal anaesthesia in South Africa, 1998 to 2007[137].

8.2.4 Conclusion

There was a significant increase in RA use for CS in the Free State from 2002 to 2004. This increase may have been due to the effects of the remedial interventions or coincidental to other changes in training.

Whether this increased use has prevented maternal deaths from anaesthesia is unknown, as the numbers of anaesthesia related maternal deaths in Free State has not been shown to have improved noticeably (Table 6.4.3.4b).

CHAPTER 9

RESUSCITATION PROTOCOLS

9.1 INTRODUCTION

Data from the maternal death notification system has shown that resuscitation problems are related to maternal deaths. In the 1998 Saving Mothers Report, the only one published at the time this study was planned, in each chapter on direct causes of maternal deaths, resuscitation problems were shown to have been contributory to a significant number of deaths (Tables 3.5.4.1 and 3.5.4.2).

As an initial investigation into reasons for these problems with resuscitation, it was decided to perform a survey of resuscitation protocols during the hospital visits in which the other factors related to maternal deaths, as above, were measured.

It is a COHSASA regulation that protocols on resuscitation should be displayed in operating theatre complexes. It was postulated that if they were not displayed, then this was an indication of lack of interest and/or lack of knowledge in resuscitation in addition to non-compliance with COHSASA regulations, and interventions would be required.

9.2 METHOD

The same method was used for both Phase 1 and Phase 2. During each hospital visit in which the theatre complexes were inspected (see above), we recorded if an up-to-date resuscitation protocol was on display in the operating theatre(s) where CS's were performed, and the recovery area (if such an area was present and in use).

"Up-to-date" was defined as being from 1998, as significant changes to recommended resuscitation protocols had occurred since that time. For the purpose of this study, either a protocol on basic or advanced life support was recorded as a protocol being present.

If the correct protocols were not present, then the investigators distributed the appropriate number of correct protocols to the theatre staff present, with instructions that they were to be displayed in the operating theatre(s) and the recovery area in accordance with COHSASA recommendations. The protocols were distributed where required in both Phase 1 and Phase 2. They had been compiled by the 2002 Resuscitation Council of Southern Africa and consisted of algorithms for Basic Life Support, Advanced Life Support, Neonatal Resuscitation, Emergency Arrhythmia Management and Treatment of Severe Anaphylactic Reactions. They had all been laminated so as to comply with theatre regulations for notices on display.

9.3 RESULTS *(Table 9.3)*

In Phase 1, in only one of the 31 operating theatres in the 26 hospitals where CS's were being performed was there a resuscitation protocol on display. This was in Phuthuloha Hospital (Ficksburg). It was up-to-date. Out of 13 hospitals with recovery areas, six had resuscitation protocols on display in the recovery area, but none of these were up-to-date. One dated back to 1993. Three others had protocols which are known to be now out-of-date, but there was no date displayed on them.

In Phase 2 it was found that of the 31 operating theatres where CS's were being performed, 12 now had resuscitation protocols on display and these were all up-to-date. There were 14 hospitals with recovery areas and 10 had the protocols on display, with 9 of these being up-to-date. The same out-of-date resuscitation protocol remained on display in the recovery area at Metsimaholo Hospital (Sasolburg) from Phase 1 to Phase 2.

Level	Town/City (name of hospital)	Phase 1			Phase 2		
		In theatres (n=31)	In recovery (n=13)	Protocol in date (n=7)	In theatres (n=31)	In recovery (n=14)	In date (n=22)
1	CLOCOLAN (John Daniel Newsberry)	0	-	-	0	-	-
1	LADYBRAND (Mantsopa)	0	-	-	0	1	1
1	WINBURG	0	0	-	0	0	-
1	JAGERSFONTEIN (Diamond)	0	-	-	0	-	-
1	SMITHFIELD (Stoffel Coetzee)	0	-	-	0	-	-
1	ZASTRON (Embekweni)	0	-	-	0	-	-
1	HEILBRON (Tokollo)	0	-	-	0	-	-
1	BOTHAVILLE (Nala)	0	-	-	1	-	1
1	FRANKFORT (Mafube)	0	-	-	1	-	1
1	ODENDAALSRUS (Thusanong)	0	-	-	1	-	1
1	SASOLBURG* (Metsimaholo)	0	1	0 (undated)	0	1	0 (undated)
1	BLOEMFONTEIN (National)	0	0	-	1	1	2
1	VIRGINIA (Katleho)	0	-	-	0	-	-
1	HARRISMITH (Thebe)	0	1	0 (1997)	0	1	1
1	THABA N'CHU (Botshabelo)	0	0	-	0	1	1
1	REITZ (Nketoana)	0	-	-	1	1	2
1	MOROKA (Dr. JS Moroka)	0	1	0 (1995)	1	0	1
1	SENEKAL (Itemoheng)	0	-	-	0	-	-
1	FICKSBURG (Phuthuloha)	1	-	1	1	-	1
1	PARYS	0	0	-	1	0	1
1	BETHLEHEM (Phekolong)	0	0	-	1	-	1
2	GOLDFIELDS (Bongani)	0	1	0 (undated)	2	1	3
2	KROONSTAD (Boitumelo)	0	1	0 (1993)	0	1	1
2	MANAPO (Mofumahadi Manapo Mopeli)	0	1	0 (undated)	0	0	-
2	BLOEMFONTEIN (Pelonomi)	0	0	-	1	1	2
2	BETHLEHEM (Dihlabeng)	0	0	-	0	1	1
TOTAL		1 (3%)	6 (46%)	1 (14%)	12(39%)	10(71%)	21(95%)

Table 9.3 Resuscitation Protocols in Theatre Complex: Phase 1 vs Phase 2.

****recovery area not in use in Phase 1.***

There was a substantial increase in the number of hospitals where up-to-date resuscitation protocols were on display in the operating theatre and recovery areas between Phase 1 and Phase 2 ie from 1 to 21. But there still remained 61% of theatres and 29% of recovery areas without these protocols on display. There was a substantial improvement in the proportion of protocols that were up-to-date, from 14% (1/7) to 95% (21/22). These numbers are too small for meaningful statistical analysis.

9.4 DISCUSSION

Although there was a significant improvement in both the number and quality of resuscitation protocols on display, there remained institutions where these protocols were still not displayed. This was despite the laminated resuscitation protocols being given personally to the theatre staff, and in adequate numbers, during the Phase 1 hospital visits, with instructions that it was a COHSASA regulation that they be displayed.

The question then arises as to what had happened, between Phase 1 and Phase 2, to the protocols which had been distributed. This question was raised at the institutions during the Phase 2 hospital visits and in most cases no answer could be given by the theatre staff present. At one institution the investigators were informed that no protocols were permitted on the theatre walls, lest dust gathered on them and then there would be an infection risk in theatre. The investigators informed these personnel that this was the reason why all the protocols had been laminated, as these posters could be wiped clean and are permitted in operating theatres. In another hospital, the protocols were eventually found in a file stored in a cupboard in the theatre complex.

Whilst this was a very simple method of attempting to ascertain knowledge regarding standards of resuscitation and the effect of a simple intervention ie distributing resuscitation protocols, it does give one some knowledge regarding the poor attitude to standards of resuscitation at several hospitals. One would have thought that by telling the theatre staff why the protocols were required and giving all the hospitals the required protocols, in the required form (laminated), that we would have seen almost 100% of hospitals displaying these protocols. One compares this to the similar attitude of the hospital management who were allocated funds for the purchase of expensive anaesthetic equipment, informed they could do so and were told how to place these orders, but then failed to do so. One readily

comes to the conclusion that there is a lack of willingness to improve standards to acceptable levels.

However, there may be other less apparent reasons for this failure to display the protocols given. As mentioned above, some staff subsequently thought it was “against the rules” to display protocols in theatres for hygiene reasons. These issues were not raised when they were initially informed in Phase 1 that they should display the protocols and it may be that other staff had a negative attitude to displaying protocols or were misinformed about regulations. This was clarified during the Phase 2 visits. It may be that the protocols were initially displayed but then lost or damaged and not replaced. This would be a poor excuse as none of the hospitals asked us between Phase 1 or 2 for replacement protocols and the protocols can easily be accessed using the internet. The SA Resuscitation Council has a web site where these protocols are accessible and can easily be downloaded.

Conversely, one could argue that as we informed the hospitals that we were coming again for Phase 2, some of the theatre staff may have remembered that we checked for resuscitation protocols in Phase 1 and may have stuck up protocols which had not been otherwise displayed, solely for the purpose of our visit. There was no way that we could check for this potential problem. Perhaps we could have asked the doctors in theatres where the resuscitation protocols were and briefly tested them on what was written on them.

Merely having resuscitation protocols on display does not necessarily mean that they are read or that the health care professionals who have access to these protocols know how to follow them. An improvement of this aspect of the study would be to actually test the knowledge and ability of these professionals on resuscitation. To then educate them on deficiencies found and retest their retention of such knowledge after 6-12months. This was not practically possible for this study. Owing to constraints on the University Dept of Anaesthesia being able to permit me or my co-investigators from being away from our clinical duties for long, two or three hospitals had to be visited each day. By the time the anaesthetic drugs and equipment in theatres had been checked, the theatre record books inspected and the doctors given a lecture on obstetric anaesthesia and the manpower questionnaires, little time was left for anything else.

This relatively brief survey of the resuscitation protocols was therefore chosen as a quick way to gather relevant information which would also stimulate those present in peripheral hospitals to be aware of the importance of resuscitation and following up-to-date-protocols.

9.5 CONCLUSION

The interventions had a significant effect on improving the quality and quantity of resuscitation protocols on display in the operating theatres and recovery areas. However, there still remained at the time of Phase 2, ten hospitals with no up-to-date protocols for resuscitation on display in either the operating theatre or recovery area. This suggests that there may be a lack of interest or knowledge regarding resuscitation in these hospitals, resulting in failure to display protocols distributed. Further interventions to improve knowledge regarding the importance of displaying up-to-date resuscitation protocols are required in these institutions. Further investigation is required to ensure that health care professionals are cognizant of these protocols and able to follow them.

CHAPTER 10
REFERRAL SYSTEM

10.1 INTRODUCTION

In the 1998 Saving Mothers Report[75] there is a chapter on Epidemiology (p26). Here "lack of transport available to transfer" was cited as a possible cause of poor referral from lower to higher levels of care. Transport problems between institutions was implicated as a contributory factor in 13.6% of assessable deaths in 1998, and 12.9% between 1999 and 2001**Error! Bookmark not defined.**.

In Phase 1 an attempt was made to investigate transport problems from level 1 and 2 hospitals to higher levels of care. This was in order to determine if sick women were inappropriately being given anaesthesia for Caesarean sections at level 1 and 2 hospitals, due to being unable to timeously refer these women to a more appropriate level of care.

It turned out that there were methodological problems with this part of the study, with only 4 level one and 3 level two hospitals responding. It was decided that correcting this response rate to a valid level would be a major undertaking and therefore should be a separate study in itself. This aspect of the study was therefore not pursued further in Phase 2 and only the data obtained from the seven responding hospitals in Phase 1 is presented.

10.2 METHOD

During the aforementioned hospital visits, the doctors involved in obstetrics were informed regarding this investigation on the referral system and asked to complete the required data collection form when a patient had a CS. These forms essentially asked whether the doctor performing the CS had access to referral criteria, whether the patient being operated on was considered for transfer and for what reason, and if the patient was then not transferred, for what reasons should this transfer not take place (Appendix I).

As estimated from the number of CS's performed at each hospital from the Hospital Statistics Database, the required number of forms for each hospital were then left in the obstetric theatre(s) of each hospital. These forms were to be completed for the following

three months, after which the hospital manager of the hospital was to ensure that the data forms were then returned in the post to me. The hospitals managers had been informed of this investigation when the request to visit each hospital had been made and had been asked to ensure the return of these forms.

10.3 RESULTS

Seven hospitals responded (four level 1 one and 3 level two) and for these 34.1% of the expected number of forms, as estimated from the Hospital Statistics Database, were returned (Table 10.3).

Hospital	**Level of hospital**	**Returned forms N**	**Returned forms expected N (%)**
Bongani (Welkom)	2	16	**222 (7%)**
Thebe (Harrismith)	1	15	**47 (33%)**
Botshabelo	1	39	**122 (32%)**
Dihlabeng (Bethlehem)	2	113	**113 (100%)**
Boitumelo (Kroonstad)	2	36	**147 (24%)**
Thusanong (Odendaalsrus)	1	20	**81 (25%)**
Winburg	1	14	**9 (156%)**
Total		**253**	**741 (34.1%)**

Table 10.3 Hospitals returning referral system survey forms.

A total of 253 forms were received. Only 16% of doctors responding had written guidelines as to referral criteria.

In 7 cases there was an indication for transfer, but due to urgency of clinical situation there was no time for this transfer. There was only one incident of a delay with transfer and this was from Thusanong to Bongani (ie Odendaalsrus to Welkom). This patient was bleeding and emergency blood was being given at the level one hospitals but urgent transfer was required to level 2, presumably because it was anticipated that further blood would be

required which was not available at this hospital (her Hb was 5.5g/dl) and exploratory surgery to control the haemorrhage required, none of which would be possible at level one.

It is recorded that the ambulance control officer informed the doctor requesting the urgent transfer “the patient is not a priority, there are patients outside the hospitals who need help. The patient is in hospital so can never have a problem”. The doctor then reports “this is a problem we face very day”.

The ambulance arrived two hours after initially being called. The fate of the patient is unknown.

10.4 DISCUSSION

Owing to the significant number of maternal deaths in which problems with the referral system and transport between institutions have been implicated (see introduction), the Key Recommendations from all the Saving Mothers Reports to date have included both a recommendation that criteria for referral and referral routes be established, and a recommendation that emergency transport be available for pregnant and post-partum women, from any site.

It may be that these recommendations had some effect as in the 2002-2004 Saving Mothers Report, there were slightly fewer deaths associated with transport problems between institutions (9.7%), although this number is still unacceptable.

The problem with emergency transport services not understanding why maternity cases may require urgent transfer to another hospital, particularly in cases of haemorrhage, has been addressed by the FS Maternal Health Dept since the above incident was noted, and it is hoped that the scenario described is now a thing of the past.

In addition, guidelines for referral criteria should now be in place. The Dept of Obstetrics has sent doctors to the peripheral hospitals to distribute these guidelines. Despite the poor response to this part of the study, it was of note that only 16% of doctors responding had access and used established referral criteria. This should now have improved considerably.

A further study is required to determine whether all hospitals now have these referral criteria in place and they are being used, as well as to whether problems with the emergency transport system have truly improved.

Such a large scale study would involve considerable resources, as well as compliance by the medical practitioners and managers in the hospitals involved. A study performed in Zambia to investigate referral systems for maternity cases used information gathered from five sources[138]:

a. The distribution of births across levels of facility, and poplation coverage of the maternity services.
b. The use of EOC (essential obstetric care) facilities by women with complications.
c. The inappropriate use of the Comprehensive EOC level facility.
d. Progress towards a reduction of maternal mortality at referral facility level.
e. Perinatal outcomes at peripheral facility level.

Whilst much of this data is routinely gathered as hospitals statistics, it does not address the clinical decision made by the doctor who considers that a patient should be transferred for surgery or other treatment to a higher level of care. These decisions are often complex and may involve a variety of factors such as the doctors on duty at that time not been skilled at the surgery/treatment required or the hospital had run out of a an essential drug that day or equipment was malfunctioning.

The problem with this much simpler study was that there was not enough time during the brief hospital visits to thoroughly explain the nature of this study to all the theatre staff and doctors involved. The doctors involved are mostly the same ones that also give anaesthesia, and there was better access to these doctors owing to the lecture given on obstetric anaesthesia emergencies. There were several doctors absent though, some of whom only performed obstetrics and they missed this part of the study being explained to them. The theatre staff were often busy with cases during our visits and could not necessarily all have this study explained to them.

The method of data collection could be improved. I relied on them using their own initiative to provide a box in which to place the completed forms. This largely did not happen, so next time one should provide a data collection box for each hospital. The hospital managers

probably forgot to ensure that the forms were returned to me. It would be an improvement if there was a person allocated as assistant researcher to this study, who could regularly contact the theatre staff of the hospitals concerned to ensure that the forms were returned.

It would be of value to design a more detailed data collection form to include such information as reasons given by the Emergency Transport System why they were unable to transfer the patient or it was delayed, and what was the outcome to the patient. The information requested in this study was kept to a minimum to encourage data collection and might be viewed as a pilot study of this problem.

Previous chapters of this study have recommended the merging of hospital services for a particular region in order to pool vital resources that are currently scarce and unlikely to be improved upon in the near future eg manpower and blood. Whilst there have recently been moves nationally to improve the transport of blood to locations where it is urgently required, this is not always the solution to a patient's problem and urgent surgery may also be required. The introduction of an Air Ambulance Service in the Free State to expedite transfer of patients to hospitals with appropriate surgical and intensive care facilities may in the future ameliorate some of these emergency transfer problems. Another proposal has been to introduce a "Flying Squad" in which the doctors from a higher level of hospital go to a lower level of hospital to assist in an emergency. This would only be feasible if there were sufficient doctors available to leave their own hospital when required. The critical shortage of doctors working in public health hospitals has prevented this proposal been carried through.

10.5 CONCLUSION

A further study is required to determine whether referral criteria are available and are being implemented, and emergency services are available and able to transfer patients appropriately according to the degree of medical urgency.

CHAPTER 11

FACTORS PERTAINING TO OBSTETRIC ANAESTHESIA DEATHS: SYNOPSIS AND CONCLUSION

This study only partially achieved its goal of investigating the five main factors considered to be relevant in anaesthesia-related maternal deaths and the effect of measures taken to correct these problems.

The results of the five factors considered likely to be implicated in maternal deaths from anaesthesia and the effects of the remedial interventions instituted can be summarised thus:

11.1 MANPOWER

The response rate of 33% to the Phase 1 manpower survey was too poor for the FS Dept Health Managers to deem that action should be taken based on these results (see 5.2 Free State Department Of Health). Hence Phase 2 was only a repeat of the survey of Phase 1 using improved methods and no remedial interventions took place between the Phases that could be measured. Indeed, even though the FS Dept Health was informed of the results of Phase 2, in which the response rate was satisfactory at 69%, and the considerable problems caused by employing doctors unskilled at obstetric anaesthesia, no significant action has been apparent, although the manpower survey has not been repeated since. The medical media were shocked by these data[16], but there remains a continued lack of visible response to this problem by the FS Dept Health.

However, this has not been completely unexpected as manpower is both scarce and costly. To persuade hospital managers to recruit better qualified staff would be difficult, as these staff would mostly be at higher salary levels and their budgets would have to be increased to cover the cost of these doctors. Indeed, there might now not be suitably qualified doctors to appoint even if they had tried to, as such doctors are continually becoming scarcer in the public sector.

There are several countries now “supplying” doctors to work in rural areas of South Africa to compensate for this lack of South African trained doctors. Tunisia is one such recent example. In some of these countries anaesthesia is not taught at undergraduate level so general practitioners from these countries have often not learnt anaesthesia. The manpower survey did not specifically address this issue and it would be of benefit in further surveys to enquire where the doctors had been trained.

The Health Professions Council change in requirements for Intern Training is something that is likely to have had a beneficial effect on quality of manpower. It is to be hoped that newly qualified doctors in South Africa are better trained in anaesthesia than their predecessors as two months training is likely to be better than two weeks.

11.2 DRUGS AND EQUIPMENT

This aspect of the study was more successful in that a thorough audit of the drugs and equipment for obstetric anaesthesia was performed in Phase 1, remedial interventions then took place and the effects of these were evaluated in Phase 2.

It was found that in the majority of level one and two hospitals, a significant number of deficiencies regarding anaesthetic drugs and equipment remained between Phase 1 and Phase 2. Overall, there was a global improvement for some hospitals and deterioration for others.

It was concluded in the discussion section of this Chapter that the remedial interventions had the maximum effect in the hospitals in which the staff and management took note of the investigator’s recommendations and least effect in which these recommendations were ignored. This raised the question as to why some hospitals were able to take note of the recommendations and make the required improvements and some did not. Factors that may have played a role is training and morale in a stressed system, but this was not investigated. The problem could be explored by investigating the perceptions of the staff involved of the need to improve their hospital’s equipment and anaesthesia drugs, and theatre safety. Costs could be explored and the budget of the hospitals could be related to the deficiencies found and whether the hospitals had sufficient finances to correct their problems.

It would be relevant to determine in such a study whether there was somebody in each hospital responsible for ensuring that the required standards were met. Certainly lack of accountability for the deficiencies found probably played a role in the failure in some hospitals for these problems to be corrected.

11.3 USE OF REGIONAL ANAESTHESIA

This was another factor investigated in this study in which the required data were collected in Phase 1, remedial interventions were then instituted and the effect measured by the collection of data in Phase 2.

It was found that there was a significant increase in the rate of use of regional anaesthesia for Caesarean section in Free State level one and two hospitals, from 2002 (Phase 1) to 2004 (Phase 2), ie from 71.2% to 86.2%. A closer inspection of these results and the interventions that had been instituted, determined that the increase may have been as a result of the remedial interventions or due to coincidental interventions from other sources (which have previously been discussed in Chapter 8).

When performing this study again it would therefore be of benefit if one could ask the doctors concerned, between Phase 1 and Phase 2, if they changed the type of anaesthesia they used and if so why. It would be of value to find out if the doctors were the same in Phase 1 and Phase 2 or what proportion were the same. Community service doctors are only in post one year and medical officers often only stay in their posts for one or two years. This would help determine the effect of the remedial interventions separate from the coincidental ones.

A coincidental intervention that may have influenced these results is the greater number of newly qualified doctors trained now to give spinal anaesthesia preferentially to general anaesthesia. Along with the decline in number of GP’s in rural areas, who tend to favour general anaesthesia, and their replacement with Community service doctors, who favour spinal anaesthesia, this may have resulted in some of the increased use of RA seen in this study.

What can be concluded from this aspect of the study is that the rate of use of RA is at a recommended level. Inadequate rate of use of spinal anaesthesia is therefore unlikely to be a factor in anaesthesia-related maternal deaths in the Free State.

This aspect of the study did not investigate the skills of those administering spinal anaesthesia. This was studied in the manpower section and showed that those administering obstetric anaesthesia may not be competent, either in spinal or general anaesthesia.

11.4 RESUSCITATION PROTOCOLS

There was a marked improvement in the number of up-to-date resuscitation protocols on display in theatres from Phase 1 to Phase 2. It is not known why the remaining hospitals failed to display the protocols they were previously given.

Whilst this improvement may largely have been due to the interventions of the investigators, it is hoped that there has been an increased awareness of resuscitation issues. Improved treatment of cardiac arrests as a result of these protocols being more available is also hoped for but has yet to be proved.

A more detailed study examining the knowledge and practical skills of the health care professionals in resuscitation would provide further valuable data.

11.5 REFERRAL SYSTEM

Due to inadequate return of data forms, and only performing this part of the study in Phase 1, few conclusions can be reached from this part of the study. It can be used in future as a pilot for a more definitive study investigating this problem.

There was a suggestion from the small amount of data that was gathered that there was a lack of clear, written guidelines concerning referral criteria. There was an incident recorded that showed a lack of awareness on the behalf of emergency transport personnel regarding the importance of inter-institution transport of maternity cases.

These issues have been addressed recently by the FS Maternal Health Dept and should have improved since this study was performed. A further, separate study into the referral system is required.

11.6 CONCLUSION OF INVESTIGATION OF THE FACTORS

This study partially achieved its aim of investigating the five main factors considered most likely to be related to maternal deaths from anaesthesia in the Free State and the effect of interventions to improve on deficiencies found.

Of the five factors studied, the manpower study demonstrated the problems likely to cause or be implicated in maternal deaths from anaesthesia. These problems were lack of training, experience and supervision of doctors administering obstetric anaesthesia. The Free State Department of Health must correct this problem if anaesthesia-related maternal deaths are to be prevented in the Free State.

Deficiencies were also demonstrated in anaesthetic drugs and equipment. Most of these were not directly life-threatening but could be so if complications were to arise during anaesthesia.

It is imperative that the Free State Department of Health takes cognisance of the problems demonstrated by this study if maternal deaths related to anaesthesia are to be reduced in this Province.

The goal of this study was to improve the standard of obstetric anaesthesia in this province (see 3.2). Whether this has been achieved is debatable. Although this study has raised awareness amongst health care professionals and managers that there is a problem with obstetric anaesthesia in this province, there is yet to be evidence of improved standards. The most recent Saving Mothers Report for 2005-2007 still shows the Free State as having one of the highest maternal death rates from anaesthesia in South Africa[137].

11.7 DISCUSSION OF STRENGTHS AND LIMITATIONS OF EVIDENCE OBTAINED FROM STUDY

11.7.1 Manpower study: strengths and limitations

The strengths of the evidence gained from the manpower study include the likelihood that it is a true reflection of the training, skills and experience of the doctors administering obstetric anaesthesia in the Free State. Data were captured from all the level one and two hospitals in the Free State in which obstetric anaesthesia was administered. There may have been a few doctors absent on the particular days when the questionnaires were given to the doctors to complete but for each hospital there was representation in the results.

The results were similar from Phase 1 to Phase 2 which also confirms consistency of the results. The higher response rate in Phase 2 adds to the confirmation of the result's validity.

As previously discussed regarding the limitations of this study in *5.4.5 Limitations of the manpower study*, it unlikely that only disenchanted doctors completed the questionnaires as they were given out at the end of a tutorial on obstetric anaesthesia and the doctors attending this tutorial did not know beforehand they would be asked to complete the questionnaire. Conversely, one could argue that only the less experienced doctors attended the tutorial as the more experienced ones may have felt they did not need to attend, or they may have allowed their more junior colleagues to attend whilst they continued with the clinical duties of the hospital.

The questionnaires were devised by myself and one of the co-investigators, Dr P. Kenny. We did not have a prior model to base this questionnaire on and in retrospect it would have been of value to have asked where the doctors had obtained their basic medical education. Anaesthesia training in South African medical schools starts at undergraduate level. Many of the doctors now working in rural hospitals come from other countries which do not necessarily incorporate anaesthesia as a pre-graduate subject. Neither are they exposed to anaesthesia as an Intern. It would have been of value to document these completely untrained doctors in anaesthesia as this would have implications when devising future training programmes.

In addition, whilst the questionnaires did inquire as to whether the doctor had the Diploma in Anaesthesia or other postgraduate anaesthesia qualification, it did not ask the doctors who did not have this qualification why they had not obtained it. The study showed that there were some doctors who had been administering obstetric anaesthesia unsupervised for many years in peripheral hospital, without this qualification. Some were even working in or close to institutions that were recognized for DA training. Whilst one encourages the doctors working in this situation to obtain the DA, it would have been of value to know why the doctors had not taken this examination, or if they had sat this examination but had failed it. Were these doctors of a lower academic ability or disinterested in furthering their abilities?

11.7.2 Drugs and equipment study: strengths and limitations

This study has considerable strengths regarding the evidence obtained in that it was a highly detailed study, meticulously performed. There were very few instances in which the required information was not obtained.

A possible limitation was that the inspections of the theatre were not random. The theatre staff knew in advance that their hospitals were going to be inspected and could have artificially prepared the theatres so all the drugs and equipment would be available and functioning on the day of the visit. This advance warning was clearly not of benefit at Diamond Hospital were the anaesthesia equipment was in disarray and monitors hidden in cupboards at the time of visit. Only the threat of declaring the theatre unsafe for anaesthesia motivated the staff to correctly assemble the required drugs and equipment, and find the monitors required.

Another limitation was that the list of problems detected in Phase 1 was sent to the hospital manager for corrective actions to be taken. Some of these managers were less interested in improving their anaesthesia services than others and it may have been better if the theatre managers were also sent a copy of the deficiencies detected as they had direct, “hand-on” knowledge of the situation in theatre and may have been more motivated to make the improvements suggested.

There are always debates regarding what exactly are the essentials for anaesthesia drugs and equipment in level one and two hospitals and should the list be the same for both levels of

hospital. The list of essential drugs and equipment used for this study was taken from a list of minimum requirements for safe anaesthesia, written for the South African environment, and to which colleagues in the Free State University Department of Anaesthesia suggested changes or additions regarding requirements specifically for obstetric anaesthesia (see 6.1.2 Method). As medical knowledge develops there are always evidence-based changes that should be made to such lists although over the course of the study none were apparent to the investigators and it was of value that the same items could be compared between the two phases of the study.

Economic factors and availability are relevant to what is present in the operating theatres and hospitals. Blood is often in short supply nationally and it was not inquired if it was not present at a hospital because of lack of availability from the central blood bank which dispenses it to peripheral hospitals. Likewise, expensive drugs which are infrequently used but may be life-saving when specific emergencies arise, eg dantrolene for malignant hyperthermia, not have been stocked simply because one of the people involved in ordering the drug may have decided it was too expensive and the cost-benefit ratio too poor for that environment. Further investigations the reasons why a drug or item of equipment is not present may be added to further studies on this issue.

11.7.3 Use of regional anaesthesia study: strengths and limitations

This is one of the few studies performed in obstetric anaesthesia in South Africa in which data regarding a factor implicated in maternal deaths from anaesthesia includes denominator data and is not merely a series of numbers. By using the theatre record books to obtain the number of different types of anaesthesia used, we also obtained the number of CS’s performed. This was the denominator data we used.

Theatre record books are almost without exception meticulously completed by theatre nursing staff. From my experience of working in theatres in different countries, this appears to be a universal phenomenon and it is recommended that this source of data should be kept in mind when devising studies regarding obstetric anaesthesia.

One of the problems with this record keeping and obstetric anaesthesia is that there are several instances in which a spinal anaesthetic is recorded as an epidural and vice versa. This

is generally due to lack of knowledge that the two techniques are different. Nursing staff often consider all injections in the back an epidural and some doctors also do not know the difference. When a spinal anaesthetic fails and a GA is used instead, there may have been instances where this failure was not recorded and it was only documented that GA was used. However, it appears that in most cases there was documentation that both types of anaesthesia were used, as the drugs used have to be listed, and the cases in which this conversion was required appeared small.

In the cases in which only one type of technique was used, it would have been interesting to have linked this to the skills of the doctors working in that hospital. If only spinal anaesthetic was administered, was this because no-one in the hospital could give general anaesthesia? Were there maternal deaths as a result of only administering spinal anaethesia? Numbers of maternal deaths though, are quite small and it would be difficult to statistically correlate these issues.

Another limitation here was being able to determine what intervention(s) resulted in the significant increase in RA use between the two study phases. Whilst the investigators implemented some interventions, the study took place at a time when medical schools were advocating spinal anaesthesia as the preferred technique for obstetric anaesthesia and young graduates therefore felt more confident in this technique than their predecessors. There was in addition a loss of the older doctors from the rural areas at this time, particularly owing to District Surgeon posts being abolished. They were more skilled in GA. As their places were taken by the younger doctors then use of spinal anaesthesia could have increased for this reason alone.

11.7.4 Resuscitation protocol study: strengths and limitations

This study was of limited strength as it only covered one aspect of assessing whether there were resuscitation skills present among theatre staff ie the display of protocols. Whilst the presence of up-to-date protocols could imply that staff had read them, it does not necessarily follow that this happens. For protocols to be used they should be explained to the staff relevant and training in their use given. Those who had read the protocols may not have understood how to use them.

A further study evaluating resuscitation skills would be of value on this issue. It would take much longer to perform such a study and the value of this much simpler study was that it could be performed within the limited time constraints of each hospital visit. At least some indication regarding resuscitation skills at each hospital was provided.

Conversely, staff may have all been skilled at resuscitation but simply had not thought there was a need to display these resuscitation protocols. In some institutions posters are banned from theatre walls as they are thought to harbour bacteria. This is why the protocols we distributed were laminated so they could be kept clean and it was explained that these would comply with theatre hygiene regulations.

Moreover, only one aspect of resuscitation is covered by these protocols, that is cardiac arrest. Other issues relevant to obstetric anaesthesia such as the resuscitation of the parturient with massive haemorrhage and post-resuscitation care were not covered in this study.

11.7.5 Referral system study: strengths and limitations

Whilst this aspect of the study could have provided important information regarding whether transport problems or the communication between levels of hospital was problematic, it soon became apparent that there were major problems in ensuring the required information was returned from the peripheral hospitals.

The other data required for the other factors studied were largely obtained during each hospital visit. Study of the referral system was to be prospective with ongoing data collection requiring the co-operation of staff who may not have been present at the time of the hospital visit and therefore not be aware of the study or the reasons for it. When it became clear that the data returned was limited to only a few hospitals it was decided not to repeat this study in Phase 2 as the results were inadequate. To perform this study a team of researchers would be required who could continuously monitor data collection and perform repeated visits to the institutes involved to ensure their collaboration. Due to the constraints of the time allowed away from clinical duties, the investigators of this study were not able to perform such an ongoing study.

11.8 IMPLEMENTING INTERVENTIONS IN HEALTH CARE

This study used an audit cycle method to investigate a health care problem. The use of audit with feedback is often used in countries with limited resources to improve obstetric care and has been successful in many cases[139,140]. As a tool for intervention it tends to be inexpensive and simple to use[141]. The interventions shown to be most effective when attempting to improve maternal health services in South Africa have been shown to be programme-specific (eg training in prevention of mother-to-child transmission of HIV) and specific interventions (eg. use of routine data for monitoring purposes) rather than system-wide interventions which attempt to improve programmes as a whole[142].

As part of this study we attempted to influence clinical practice with regard to increasing RA use by implementing interventions aimed at practitioners who were previously unfamiliar with this technique.

Changing clinical practice requires a comprehensive approach and it is recommended that for such a change to occur, not just the doctor but the team with whom the doctor works, other personnel in the hospital and the wider environment are included[143]. We often found that theatre nursing staff who had never or rarely seen a CS under spinal anaesthesia, were almost disgusted at the thought that the mother could be awake during abdominal surgery. In the social environment of the mother, there requires acceptance of the use of RA as unwarranted anxiety can be generated by people who have misconceptions regarding this technique. Conversely, when RA becomes known to be a safe technique in an environment, maternal distress can result when a patient has a contraindication for this technique and was specifically was looking forward to being awake for the birth of her baby.

Complex changes in clinical practice are required when attempting to increase the use of RA or GA. It is not a case of simply telling a practitioner to do something differently For a clinical recommendation to be successful and there to be compliance, there should not be any required changes to the fixed routines of those involved. However, where a recommendation is not compatible with clinician values, audit and feedback result in greater change in practice than merely issuing guidelines[144].

To implement change here, practitioner has to be taught a new technique in a supervised environment as errors whilst learning the technique could lead to mortality or serious morbidity to the patient. The hospital has to purchase the new drugs and equipment required and the nursing staff, obstetricians and patients have to be educated. Understanding these obstacles to change are required when attempting to implement a change in obstetric anaesthesia technique[145].

Recommendations were given by the investigators to the hospital managers regarding which anaesthesia drugs and equipment should be available in the hospital theatres. These recommendations would have to be considered by the managers in terms of their costs and consequences (eg potential for a recommended drug to harm) when deciding at their particular institution what their policy should be towards the essential lists we gave them[146]. We formulated the lists based on the best clinical evidence that we had at the time, but the costs of these drugs were not our top priority when advocating them. For example, we recommended that dantrolene be available at every hospital lest a case of malignant hyperthermia develops. This is an expensive drug and malignant hyperthermia is a rare although potentially fatal complication of anaesthesia. A hospital manager in a low resource setting may then decide that the money could be spent better by purchasing a drug to treat a more common condition. In environments where there is a greater risk of legal action being taken against a hospital for not having dantrolene when a case of malignant hyperthermia occurs, then the manager might decide it would be worth the costs of keeping dantrolene.

Policymakers place a high value on research evidence[147]. To persuade a hospital manager to ensure dantrolene is kept at their hospital one therefore has to inform him about the research evidence for the efficacy of this drug to treat maliganant hyperthermia, the dangers of not treating hyperthermia and the costs involved not only of the drug, but the pay-outs to the injured parties that could result if dantorlene was not stocked, For obstetric cases harm could result to the mother and to the baby and pay-outs in such cases are larger than if just one party was involved.

CHAPTER 12

RECOMMENDATIONS

Developing an efficient obstetric health care system for South Africa is an issue that has been discussed for many years. From Philpott's recommendations in the 1970's for the improvement of community obstetric services[69] to the current recommendation made by the NCCEMD from the Saving Mothers Reports. Much of the recommendations made by these reports are similar from one to another. Indeed many of the recommendations regarding the structure of the system as a whole are similar to those made by Larson in 1991, in which he recommended regional hospitals staffed by specialists as the focus of obstetric care in a region. He emphasised that these regional hospitals should be training centres, as well as service institutions, and their location conducive to staff working there[148].

There has been less literature written regarding how to improve the obstetric anaesthesia services in this country. Most of the discussions centre around which anaesthesia technique to use rather than evaluating the system as a whole. The recommendations made from the Saving Mothers Reports provide most of the literature which concentrates on reducing mortality from obstetric anaesthesia in South Africa.

The following recommendations are the authors own but have been influenced by information gained from the Saving Mothers reports and the experience gained from investigating the causes of maternal deaths from anaesthesia in the Free State.

12.1 INTERN TRAINING IMPROVEMENT

Intern training must ensure adequate, supervised training specifically in obstetric anaesthesia. Minimum case numbers should be set for obstetric anaesthesia. An appropriate assessment of theoretical and practical competence should be included, with a requirement that such competence is required before completion of internship and commencing community service. Similar requirements should be set for foreign trained doctors that work in the Free State.

12.2 EFFICIENT USE OF MEDICAL MANPOWER

Use of currently available medical manpower needs to be made more efficient. Suitable manpower is a scarce commodity that is unlikely to become more abundant in the foreseeable future.

12.2.1 Consolidation of resources

Smaller level one hospitals should be downgraded to the clinic level and there should be only one level one or two hospital in a particular geographical region to provides operative obstetric services services. Medical manpower, blood and anaesthetic drugs and equipment would thus be consolidated at this hospital. Emergency transport services would have to be upgraded to ensure patients without their own transport were able to access this hospital.

12.2.2 Incentives to work in rural areas

At present there is a small financial incentive, amounting to 18% of the basic salary, to work in rural areas. This has proven insufficient to attract health care professionals to these areas and an increase should be considered.

Previously, General Practitioners in rural areas were able to supplement their incomes with private facilities at the district hospitals or District Surgeon work. Since these were both stopped by the Dept of Health, their incomes have declined substantially. As a result many GP’s have left rural practice and have either emigrated or returned to our academic institutions for specialist training in other fields. There are several such doctors currently being trained in various specialist posts at our University.

To encourage doctors to work as GP’s in rural areas, reversing the decision to stop such private work and reinstating District Surgeon posts should be considered.

The decline in living standards in rural areas is related not only to lack of doctors willing to working in these places (and vice versa) but other social factors such as decline in the standards of the schools and other community services. The issue of attracting doctors to work in rural areas therefore needs to be addressed jointly with the Ministry of Human Settlement (previously known as Housing), as the whole standard of living in rural areas needs to be improved in order to attract doctors back to these areas.

12.2.3 Diploma in Anaesthesia

Doctors employed long-term in a post in which they are required to administer anaesthesia should be given incentives to obtain the Diploma in Anaesthesia. Promotion to higher posts, or obtaining a higher salary level within the same post, or performance bonuses could be made dependent on obtaining the DA.

12.3 ACCOUNTABILITY OF HOSPITAL MANAGERS

Hospital Managers must be held accountable for deficiencies in the anaesthetic equipment and drugs in their hospitals. In particular, it is vital that level one hospitals maintain appropriate fluids (including emergency blood), drugs and equipment to be able to primarily manage obstetric haemorrhage, which remains the main cause of direct maternal death in a level one hospital.

They should ensure that the doctors they appoint to a post are able to perform the duties required. Doctors unskilled at anaesthesia should not be forced to do so. Appropriate training must be made available to such doctors until they are shown to be competent.

12.4 RESUSCITATION COMMITTEES

Each hospital should have a resuscitation committee led by a member of staff in charge of resuscitation at the hospital. The role of the committee is to ensure all hospital staff have an up-to-date knowledge of resuscitation and that protocols are clearly displayed in appropriate areas, including operating theatres and recovery areas.

12.5 REFERRAL SYSTEM: SEPARATE STUDY

A separate study into the referral system is required.

12.6 CENTRALISED SUPPORT OF OBSTETRIC ANAESTHESIA SERVICE

Centralised support to assist maintenance of structure, where administrative or managerial capacity is lacking, could be provided eg. a person or unit specifically tasked with the maintenance and development of an obstetric anaesthesia service.

This recommendation has previously been made in the Saving Mothers Report of 2002-4. Although agreed in principal, funding delays and slow appointment processes by the FS Dept of Health led to a situation where this post is still not yet filled.

CHAPTER 13
EPILOGUE

The fifth Millenium Development goal of the World Health Organisation is to reduce maternal mortality by 2015. To achieve this in South Africa we must focus on preventing avoidable deaths. Whilst anaesthesia only contributes to 2.7% of all maternal deaths in South Africa, over 90% of these deaths were avoidable[3]. No other cause of maternal death in South Africa has been shown to be as preventable as those due to anaesthesia. Taking measures to prevent these deaths will be a major step towards improving maternal health in this country.

Since Phase 2 of this study was completed I have continued my endeavours to disseminate information obtained from this study to the medical fraternity in South Africa. I have had the results of the Use of Regional Anaesthesia Phase 2 study published in the Southern African Journal of Anaesthesia and Analgesia[104]. At the Southern African Society of Anaesthesiologists Congress held in Port Elizabeth, in 2006, I presented the results of the whole study in a lecture entitled *"The Free State Level 1 and 2 Hospitals Obstetric Anaesthesia Audit: 2002/3 versus 2005"*.

A synopsis of my conclusions was published in the South African Medical Journal last year[149]. Here I outlined the problems with anaesthesia manpower that were probably the main cause of anaesthesia deaths. The Southern African Journal of Anaesthesia and Analgesia published my findings of the manpower study at a similar time[150]. This paper was read by a medical journalist, Mari Hudson who subsequently contacted me. She was so astounded at the lack of training in obstetric anaesthesia that was given to doctors who were then sent to work unsupervised in peripheral hospitals, that she titled her leading article in the new "What's New Doc" journal for doctors, "Anaesthesia shock. Fatal decisions": Here she described my findings, my reaction to these results and her interviews with other senior anaesthetists in South Africa who felt similarly about this problem. Ms Hudson informed me she had personally sent a copy of her article to Barbara Hogan, the Minister of Health at that time. My results have shown what should be done to improve obstetric anaesthesia. Only by making decision makers in health care aware of them will the situation change.

I have continued to educate doctors on the safe administration of obstetric anaesthesia. I lectured on this topic on the Family Medicine Courses held in Bloemfontein in 2005 and 2006. At the request of the NCCEMD I wrote a chapter on obstetric anaesthesia emergencies which was issued in 2007 to all new interns as a pocket handbook[151]. In 2008, the SA Journal for Continuing Professional Development devoted its March edition to anaesthesia, to time with the World Congress of Anaesthesiologists, being held in Cape Town that month. This journal is well read by general practitioners. I wrote an article in this edition on the sick obstetric patient, what we had learnt from the Saving Mothers reports from these patients and gave advice on the anaesthetic management of these cases[152]. At the World Congress of Anaesthesiologists I lectured to an international audience, including doctors from various African countries, on "Anaesthesia for the Sick Obstetric Patient in Developing Countries". A consequence of this lecture has been an invitation to contribute to a proposed new textbook designed for developing countries by the editor, Dr IH Wilson.

The latest work I have been involved with is writing the chapter on anaesthesia-related deaths for the fourth Saving Mothers Report 2005-2007 with Prof Rout. This is due for publication this year. As previously mentioned, the most recent data shows that South Africa (and particularly the Free State) still has a problem with obstetric anaesthesia. Of concern is that spinal anaesthesia is now associated with more deaths than general anaesthesia in this country. South Africa is the first country in the world for a publication to show this to occur.

The World Health Organisation has noted that in Sub-Saharan Africa maternity services have deteriorated since the introduction of the Millenium Development Goals. In other developing countries they have improved[153]. Anaesthesia services have also been deteriorating in these sub-Saharan countries[154]. A **teaching** hospital in Togo reported a death rate of one per 133 anaesthetics with almost half of the anaesthesia deaths during Caesarean section, highlighting how frequently it is mothers who suffer when the anaesthesia services of a country decline[155]. Analyses of causes of anaesthesia-related deaths in these countries generally come up with the same answers as this study, namely lack of skilled manpower. Training more anaesthetists in these countries is only the answer to this problem if they can be persuaded to remain in the public health sector of that country. Recognising the importance of good anaesthesia services when budgeting for health-care is paramount to reducing maternal deaths from anaesthesia in South Africa. "There is much to be done, but the journey is well signposted"[154].

Appendix A. Key recommendations from Chapters on Anaesthesia-related Deaths of the Saving Mothers Reports

(a) Saving Mothers 1998

i. The term “anaesthetic deaths” as used in this review should be abandoned.
ii. Deaths associated with caesarean section and deaths due to anaesthesia should be reviewed as separate sections. An anesthesiologist should be involved in the review process.
iii. Facilities for the provision of regional anaesthesia, including staff trained in its use, should be available at all hospitals where caesarean delivery occurs.
iv. All those providing obstetric anaesthesia should have received some postgraduate training in its practice. It is suggested that a National Manpower Survey be conducted to determine the requirements for such training.
v.

(b) Saving Mothers 1999-2001

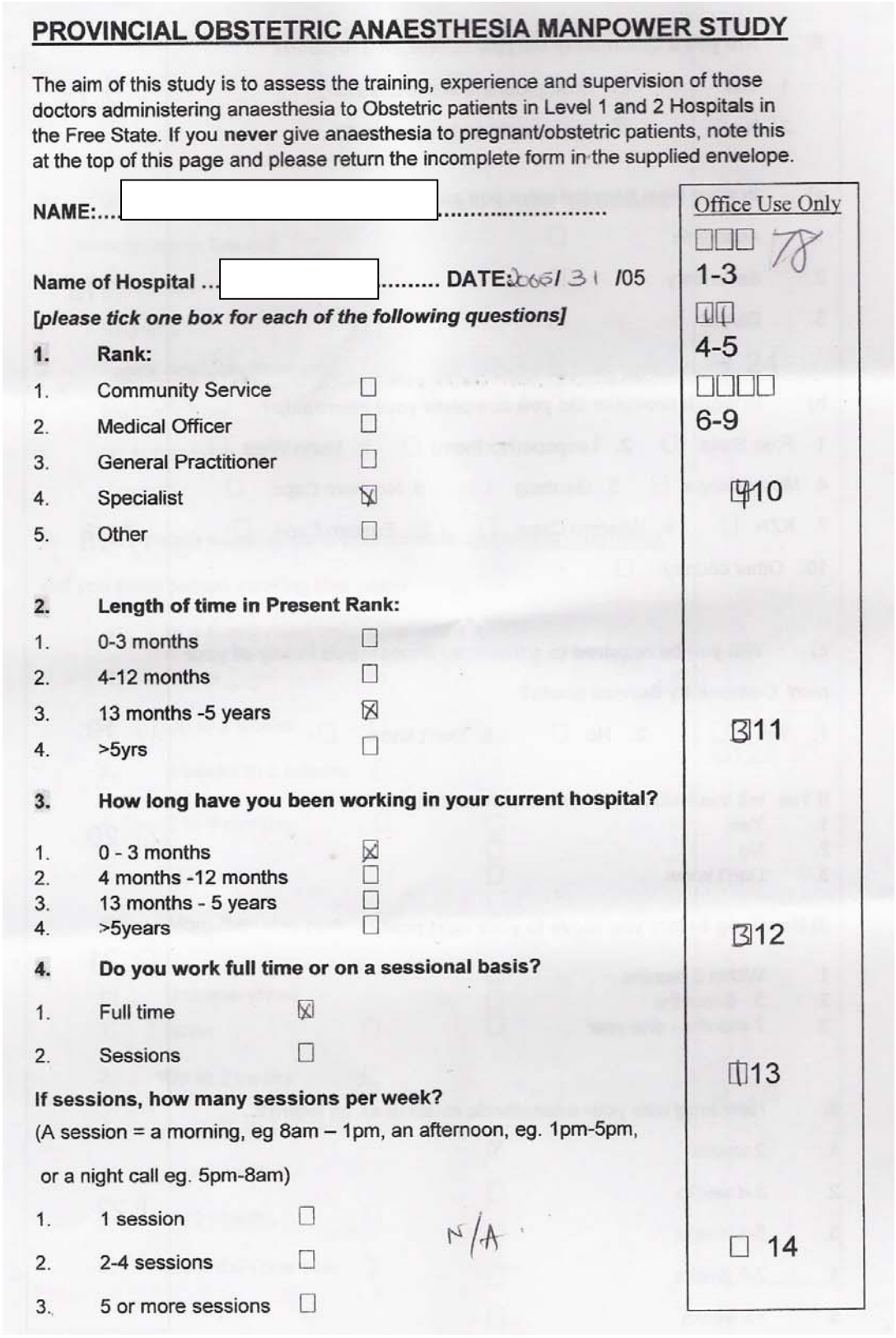
i. Doctors working in the field of obstetric anaesthesia need appropriate skills in both general and regional anaesthesia. A specialist anaesthesiologist at a regional level should rotate to hospitals o train junior doctors.
ii. Longer training in anaesthesia is needed for interns.
iii. Formal accredited resuscitation training is recommended for all doctors ie. Both anaesthetists and obstetricians.
iv. Lack of basic equipment and facilities must be addressed.
v. In an effort to improve record keeping, it is proposed that a national standard anaesthetic record form be included in all bed letters.

(c) Saving Mothers 2002-2004

Skills in anaesthesia should be improved at all levels of health care particularly at level 1 hospitals

i. Medical officers appointed at level 1 hospital must have documented anaesthetic experience and training in obstetric anasthesia
ii. Current anaesthesia curricula for medical students and interns must include “hands-on experience. (Guaranteed by a case-list minimum signed by the supervisor.)
iii. Appropriate courses must be available, additional to those on current curricula, to improve basic anaesthetic and resuscitation skills.
iv. Outreach programmes in anaesthesia should exist in every province. Leadership should be provided by a designated post (new or existing) at senior level, exclusively devoted to this purpose, within each academic department of anaesthesia.
v. A “tool-kit” (containing details of standards of care and resuscitation algorithms) for obstetric anaesthesia should be developed and provided to all doctors at level 1 and 2 institutions.
vi. A uniform case-note book for obstetric patients should be introduced nationally and incorporate a standardised anaesthetic record form.

Appendix B. Manpower Study: Data Collection Form



PROVINCIAL OBSTETRIC ANAESTHESIA MANPOWER STUDY

The aim of this study is to assess the training, experience and supervision of those doctors administering anaesthesia to Obstetric patients in Level 1 and 2 Hospitals in the Free State. If you **never** give anaesthesia to pregnant/obstetric patients, note this at the top of this page and please return the incomplete form in the supplied envelope.

NAME:.....

Name of Hospital ..... **DATE:** 2005/ 31 /05

[please tick one box for each of the following questions]

Office Use Only

□□□ 78 1-3

□□ 4-5

□□□□ 6-9

1. Rank:

1. Community Service ☐
2. Medical Officer ☐
3. General Practitioner ☐
4. Specialist ☒
5. Other ☐

☒ 10

2. Length of time in Present Rank:

1. 0-3 months ☐
2. 4-12 months ☐
3. 13 months -5 years ☒
4. >5yrs ☐

☒ 11

3. How long have you been working in your current hospital?

1. 0 - 3 months ☒
2. 4 months -12 months ☐
3. 13 months - 5 years ☐
4. >5years ☐

☒ 12

4. Do you work full time or on a sessional basis?

1. Full time ☒
2. Sessions ☐

☐ 13

If sessions, how many sessions per week?

(A session = a morning, eg 8am – 1pm, an afternoon, eg. 1pm-5pm, or a night call eg. 5pm-8am)

1. 1 session ☐
2. 2-4 sessions ☐
3. 5 or more sessions ☐

N/A

☐ 14

5. Are you a Community Service doctor on a rotation?

1. Yes ☐ (complete a-d of this question)
2. No ☒ (go straight on to question 6)

☒ 15

a) In what level hospital were you an intern?

1. Academic ☐
2. Secondary ☐
3. District ☐

☐16

b) In which province did you complete your internship?

1. Free State ☐ 2. Limpopo(Northern) ☐ 3. North West ☐
4. Mpumalanga ☐ 5. Gauteng ☐ 6. Northern Cape ☐
7. KZN ☐ 8. Western Cape ☐ 9. Eastern Cape ☐
10. Other country ☐

☐☐ 17-18

c) Will you be required to administer anaesthesia in any of your *next* Community Service posts?

1. Yes ☐ 2. No ☐ 3. Don't know ☐

☐ 19

If Yes, will this include any obstetric anaesthesia?

1. Yes ☐
2. No ☐
3. Don't know ☐

☐ 20

d) How long before you move to your next post?

1. Within 3 months ☐
2. 3 - 6 months ☐
3. 7 months - one year ☐

☐ 21

6. How long was your anaesthetic rotation as an Intern?

1. 2 weeks ☒
2. 3-4 weeks ☐
3. 5-6 weeks ☐
4. 7-8 weeks ☐
5. >8 weeks ☐

☒ 22

7. Were you exposed to obstetric anaesthesia as an Intern?

1. Yes ☐
2. No ☒

☒ 23

8. What was your main level of supervision in your anaesthetic training as an Intern?

1. Consultant ☐
2. Registrar ☐
3. Senior medical officer ☐
4. Medical officer ☒
5. No supervision ☐

☒ 24

9. How much experience in anaesthesia, <u>excluding Internship</u>, did you have before starting this post?

a) In a supervised training post?

1. None ☐
2. Up to 2 weeks ☐
3. 3 weeks to 2 months ☐
4. 3 to 6 months ☐
5. 7-12 months ☐
6. More than one year ☒

☒ 25

b) Unsupervised

1. None ☐
2. Up to 2 weeks ☐
3. 3 weeks to 2 months ☐
4. 3 to 6 months ☐
5. 7-12 months ☐
6. More than one year ☒

☒ 26

Describe this unsupervised experience if it was on an irregular basis, ie. less than once a week. (Use an extra sheet of paper if needed)

10. What was your *obstetric anaesthesia* experience prior to your present hospital post?

a) Caesarean sections – General anaesthesia

1. None ☐
2. 1-10 ☐
3. 11-50 ☐
4. 51-100 ☒
5. >100 ☐ 27

b) Caesarean sections – Spinal anaesthesia

1. None ☐
2. 1-10 ☐
3. 11-50 ☐
4. 51-100 ☒
5. >100 ☐ 28

11. What has been your *obstetric anaesthesia* experience since in your present hospital post?

a) Caesarean sections – General anaesthesia

1. None ☐
2. 1-10 ☐
3. 11-50 ☐
4. 51-100 ☒
5. >100 ☐ 29

15. How often do you have to administer the anaesthesia for a Caesarean Section and perform the surgery?

1. Never (0%) ☒
2. Rarely (<5%) ☐
3. Frequently (6-99%) ☐
4. Always (100%) ☐

39

16. Anaesthetic Supervision in this Hospital Post:

In the event of a serious obstetric anaesthetic complication, in what way is a senior anaesthetist available to assist you?
(choose only the one most applicable to your situation)

☐ 1. A senior anaesthetist is always in the theatre complex when I am administering anaesthesia.

☐ 2. A senior anaesthetist comes to theatre when I think I ***might*** have a problem with a case. He/she is otherwise available to be called and is always on the hospital premises.

☐ 3. A senior anaesthetist is available on the hospital premises, but they only assist me if a major emergency arises perioperatively.

☐ 4. A senior anaesthetist is on-call from their home and will come to theatre when I think I ***might*** have a problem with a case.

☐ 5. A senior anaesthetist is on-call from home but will only come to the hospital if a major emergency develops perioperatively

☐ 6. There is no Senior Anaesthetist employed by this hospital

☐ 7. Other I am the supervisor

(describe if other)

40

Do you have any suggestions as to how the safety of obstetric anaesthesia can be improved in your hospital? (attach sheet of paper if you wish to write more)

Provide more Anaesthetic Doctors both medical officers and consultants.

Thank you for your time taken in completing this form.
Please return it in the envelope provided.

Appendix C. Informed Consent Form

PROVINCIAL OBSTETRIC ANAESTHESIA MANPOWER STUDY: INFORMED CONSENT FORM

The purpose of this study is to assess the previous training, clinical experience and current supervision of doctors administering obstetric anaesthesia in Level 1 and 2 hospitals in the Free State.

The potential advantages of the study are that the information obtained may be used to motivate for increased training for Interns in obstetric anaesthesia, and improved supervision of those doctors with little clinical experience in obstetric anaesthesia. This may ultimately lead to a reduction of maternal deaths from obstetric anaesthesia in the Free State.

Information from individuals participating in this study will be treated as strictly confidential and no individuals will be referred to by name in reports or publications of this study. There are therefore no risks from participating in this study.

Completing this study is voluntary and you may withdraw from this study at any time. However, we need as many doctors as possible to participate so as to have valid data for the study. If you feel you need more information before participating in the study, please contact Dr Lamacraft or Dr Kenny at the number below.

The contact persons for this study are:

1. **Dr Gillian Lamacraft** (Principal Specialist, Department of Anaesthesia, University of the Free State, Bloemfontein) 051 405 3307
2. **Dr Phillip Kenny** (Specialist, Department of Anaesthesia, 3 Military Hospital, Bloemfontein) 051 402 1841 or Cell 0834424347

Please sign this consent form if you agree to participate in this study. Complete the attached questionnaire and return it to the visiting person concerned.

I, the undersigned, Dr…….(Name), hereby consent to participation in the Obstetric Anaesthesia Manpower Study. As has been explained above, I am aware that any information that I supply in the questionnaire is strictly confidential and that my name will not be used in any report or publication that arises from this study. There are thus no risks to me in my participation in this study.

Signature:

Date:

PROVINSIALE OBSTETRIESE NARKOSE MANNEKRAG STUDIE: INGELIGTE TOESTEMMINGSVORM

Die doel van hierdie navorsing is om die vorige opleiding van, kliniese ondervinding van en huidige toesighouding oor dokters wat obstetriese narkose toedien in vlak 1 en 2 hospitale in die Vrystaat, te bepaal.

Die potensiële voordele van sodanige studie kan gebruik word om te motiveer vir verbeterde Internopleiding in obstetriese narkose. Bykomstig kan gepoog word om verbeterde toesighouding oor dokters met min kliniese ondervinding in obstetriese narkose, te voorsien. Dit kan gevolglik lei tot 'n verlaging in moederlike sterftesyfers te wyte aan obstetriese narkose in ons provinsie.

Enige inligting verkry van deelnemende dokters sal as streng vertroulik beskou word. Geen individue sal blootgestel word in enige verslae of publikasies wat mag voortspruit uit hierdie studie nie. Daar is dus geen risiko's verbonde aan enige deelnemers aan hierdie studie nie.

Voltooing van hierdie vraelys is vrywillig en u mag u onttrek van hierdie studie op enige tydstip. Ons het nietemin soveel dokters moontlik nodig om deel te neem aan die studie om geldige data te verkry vir verwerking.

Indien u egter voel dat u het meer inligting benodig alvorens u sal deelneem aan die studie, is u welkom om Dr Kenny of Dr Lamacraft by die onderstaande telefoonnommers te kontak.

Kontakpersone vir hierdie studie is:

1. **Dr Gillian Lamacraft** (Eerstespesialis in Narkose, Departement Anestesiologie, Universiteit van die Vrystaat, Bloemfontein) 051 405 3307

2. **Dr Phillip Kenny** (Spesialis in Narkose, 3 Militêre Hospitaal, Bloemfontein) 051 402 1841 of sel 083 4424347.

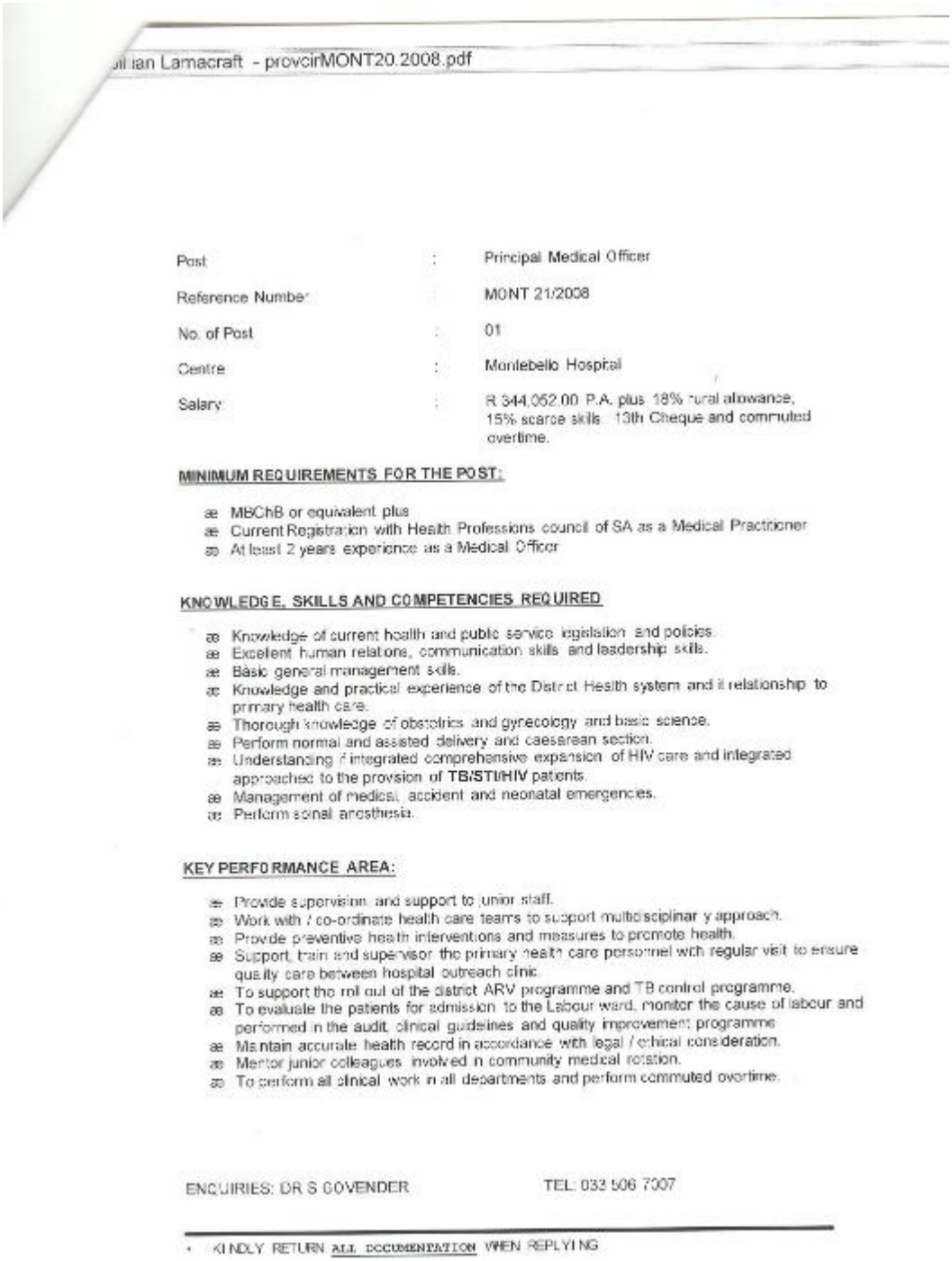
Onderteken asseblief hierdie toestemmingsvorm indien u instem om deel te neem aan hierdie studie. Voltooi dan die aangehegte vraelys en besorg dit terug aan die betrokke besoekende persoon.

Ek, die ondergetekende, Dr ..... (Naam), gee hiermee my toestemming tot deelname aan die Obstetriese Narkose Mannekrag Studie. Ek verstaan die bogenoemde verduideliking en is bewus daarvan dat alle inligting wat ek mag voorsien, streng vertroulik is. Ek verstaan ook dat my naam nie gebruik sal word in enige verslag of publikasie wat uit sodanige inligting mag voortspruit en dat daar geen risiko's vir my bestaan om aan hierdie studie deel te neem nie.

Handtekening:

Datum:

Appendix D. Advertisement for Principal Medical Officer Post



...ilian Lamacraft - provcirMONT20.2008.pdf

Post	:	Principal Medical Officer
Reference Number	:	MONT 21/2008
No. of Post	:	01
Centre	:	Montebello Hospital
Salary	:	R 344,052.00 P.A. plus 18% rural allowance, 15% scarce skills 13th Cheque and commuted overtime.

MINIMUM REQUIREMENTS FOR THE POST:

- MBChB or equivalent plus
- Current Registration with Health Professions council of SA as a Medical Practitioner
- At least 2 years experience as a Medical Officer

KNOWLEDGE, SKILLS AND COMPETENCIES REQUIRED

- Knowledge of current health and public service legislation and policies.
- Excellent human relations, communication skills and leadership skills.
- Basic general management skills.
- Knowledge and practical experience of the District Health system and it relationship to primary health care.
- Thorough knowledge of obstetrics and gynecology and basic science.
- Perform normal and assisted delivery and caesarean section.
- Understanding of integrated comprehensive expansion of HIV care and integrated approached to the provision of TB/STI/HIV patients.
- Management of medical, accident and neonatal emergencies.
- Perform spinal anesthesia.

KEY PERFORMANCE AREA:

- Provide supervision and support to junior staff.
- Work with / co-ordinate health care teams to support multidisciplinary approach.
- Provide preventive health interventions and measures to promote health.
- Support, train and supervisor the primary health care personnel with regular visit to ensure quality care between hospital outreach clinic.
- To support the roll out of the district ARV programme and TB control programme.
- To evaluate the patients for admission to the Labour ward, monitor the cause of labour and performed in the audit, clinical guidelines and quality improvement programme.
- Maintain accurate health record in accordance with legal / ethical consideration.
- Mentor junior colleagues involved in community medical rotation.
- To perform all clinical work in all departments and perform commuted overtime.

ENQUIRIES: DR S GOVENDER TEL: 032 506 7007

- KINDLY RETURN ALL DOCUMENTATION WHEN REPLYING

Appendix E. Anaesthetic Drugs and Equipment Checklists

1. Anaesthetic Drugs Required for Operating Theatres used for Caesarean Sections in Level 1 and 2 Hospitals.

1 = Must be kept in each theatre

2 = Must be kept in theatre complex

3 = Must be available within the hospital eg. kept in pharmacy or labour ward

Anaesthetic Drugs

Adrenaline (1)

Non-depolarising, medium duration, muscle relaxant eg. atracurium (fridge) (2)

Aminophylline (2)

Amiodarone (2)

Atropine (1)

Bupivacaine 0.5% with dextrose, spinal (1)

Calcium (1)

Dantrolene (3)

Diazepam (2)

Dopamine (2)

Etilefrine (1)

Phenylephrine (1)

Frusemide (1)

Glyceryl trinitrate IV. (2)

Halothane/Isoflurane (1)

Hydrocortisone (1)

Insulin, short-acting (fridge) (2)

Ketamine (2)

Labetalol (Level 2 hospitals) (2)

Lignocaine 2% IV (1)

Lignocaine 1% subcut (1)

Magnesium (1)

Metoclopramide (1)

Morphine/Pethidine (2)

Fentanyl (2)

Naloxone (1)

Oxytocin (fridge) (2)

Phenytoin (3)

Promethazine (2)

Salbutamol, inhalational and IV(2)

Sodium bicarbonate (1)

Sterile water ampoules (1)

Suxamethonium, fridge (2)

Thiopentone (2)

Glucose 50% (2)

IV Fluids

Ringers Lactate/Normal saline (1)

Colloid (Voluven/Gelofusine) (1)

O negative blood 2 units (3)

Dried Plasma (3)

Acid Aspiration Prophylaxis

Cimeditine oral and IV (3)

Sodium citrate oral (2)

Misoprostol(3)

2. Anaesthetic Equipment Required for Operating Theatres Used for Caesarean Sections

Operating table:

Can tilt head up and head down

Tilt laterally/obstetric wedge used

Permit lithotomy position

Operating theatre light

Lateral arm support

Anaesthetic Machine (service 6 monthly)

With: inspired oxygen analyser

scavenging of anaesthetic gases

Peripheral nerve stimulator (in theatre complex)

Oxygen:

pipeline and cylinder attached to anaesthetic machine AND one full spare oxygen cylinder

OR two cylinders attached to anaesthetic machine AND two full spare cylinders per machine

Nitrous Oxide:

Pipeline and cylinder attached to anaesthetic machine AND one full spare cylinder

OR two cylinders attached to anaesthetic machine and one full spare cylinder per machine

Vapouriser (Halothane and/or Isoflurane) (service 6 monthly)

Ventilator (service 6 monthly)

Anaesthetic breathing circuits:

Magill and Bain Or Humphrey ADE Or circle system with carbon dioxide absorber.

Suction equipment (separate from surgical suction)

Halothane free breathing circuit (in theatre complex)

Connectors, valves and reservoir bag for each anaesthetic circuit

Spare reservoir bag

Face masks (sizes 3,4,5)

Endotracheal tubes (sizes 5.0 to 7.5 including half sizes, cuffed)

Clear venturi type oxygen mask and administration set including connection to anaesthetic machine,

Oral Guedel airways (sizes 2 and 3)

Laryngoscopes:

- Handles x2
- Blades (corresponding to above handles) sizes 3 and 4
- Batteries and bulbs working

Difficult intubation equipment

- Intubation stylet, adult size, semi-rigid
- Long flexible, gum elastic intubation bougie
- Laryngeal mask, size 3 and/or 4
- Cricothyroidotomy set (in theatre complex)

Equipment for spinal anaesthesia:

- Sterile packs with drapes, swabs and bowls
- Chlorhexidine or aqueous iodine (skin preparation
- Sterile spinal needles (22g, but preferably finer eg 25G)

Intravenous cannulas:

- 14/16G, 18G, 20G

Anaesthetist's chair/stool

Anaesthetist's drug trolley

IV infusion pole

Adhesive surgical tape

Intravenous fluid giving sets, with ports for IV access, 15/20 drops/minute

Blood administration sets, with standard 170µmesh filter

Blood /fluid warming apparatus (in theatre complex)

Theatres masks

Sterile surgical gloves (sizes 6½, 7, 7½, 8)

Sterile syringes (sizes 2, 5, 10, 20ml)

Monitors:

- Electrocardiograph
- Non-invasive automated blood pressure machine, with both adult and large adult sized BP cuffs

Pulse oximeter

Capnograph

Emergency Equipment (In theatre complex)

Adult ambubag with mask

Mobile oxygen cylinder

Defibrillator (test daily and after use)

Patient transport trolley

Moveable sides or safety belt

Head up/down facility

Recovery Area (if used)

Must be close to operating theatre

Oxygen supply

Suction

Non-invasive blood pressure monitoring device (preferably automated)

Easy access to:

Electrocardiograph (ECG monitor)

Theatre defibrillator

Ambubag with mask

Note:

Theatres in Level 2 Hospitals should also have

1. Automated intravenous fluid administration devices (eg. IVAC's), for the monitored administration of inotropes in critically ill patients.
2. Facilities for invasive (arterial) blood pressure monitoring
3. Facilities for central venous pressure (CVP) monitoring
4. Forced Air Warming Blanket (Bair Hugger®)
5. Isoflurane and Sevoflurane vapourisers

Appendix F. Letter to Botshabelo hospital 2003

BOTSHABELO HOSPITAL: REPORT ON AUDIT OF DRUGS AND EQUIPMENT AVAILABLE IN THEATRES USED FOR CAESARIAN SECTION
(COMPONENT OF MATERNAL DEATHS STUDY AUDIT)

Date of Visit: December 30th 2002

It was observed that the temperature in the theatre environment was 32°C and that there was no air-conditioning available. This is well above the maximum 25°C permitted for the safe storage of drugs and for a healthy working environment for theatre staff.

The following drugs were not available and we strongly recommend that they should be purchased as no satisfactory alternatives are available in Botshabelo Hospital:

1. **Amiodarone** (intravenous): first-line drug treatment for ventricular fibrillation (see SA Resuscitation Council Guidelines 2002).
2. **Phenylephrine** (intravenous): second-line treatment for hypotension (page 63 "Guidelines for Maternity Care in South Africa – Department of Health 2000).
3. **Bupivacaine 0.5% in dextrose ("heavy macaine")**: for C.Sections under spinal anaesthesia. The use of "normal" macaine is associated with a higher incidence of high spinals.
4. **Glyceryl trinitrate** (intravenous): to provide rapid uterine relaxation in an emergency situation, in addition to the treatment of cardiac ischaemia.
5. **Salbutamol/other β2 agonist** (nebules and intravenous): for the treatment of severe asthma.
6. **Phenytoin** (intravenous): for the treatment of status epilepticus.
7. **A short-acting insulin eg Actrapid**: to treat hyperglycaemia.
8. **Sodium citrate** (oral): should be given to all patients having caesarian section, for the prophylaxis of acid aspiration (page 60 of above guidelines).
9. **Dried plasma eg. "Bioplasma"**: for the treatment of severe obstetric haemorrhage.
10. **O-ve blood**: two units are required as a minimum standard; at present only one unit of blood is kept at this hospital.

The following drugs were not available and we recommend that they should be purchased if possible, although it is acknowledged that less satisfactory alternatives are available in Botshabelo Hospital:

1. **Labetalol** (intravenous): for the treatment of severe pre-eclampsia. This drug provides better control of severe hypertension than dihydralazine, which has a slower action.

We note that **Dantrolene** is not available at this hospital. One must check that it is present at the Level 2 hospital for this region (Pelonomi). If not then action will need to be taken to ensure that it is available in this region for the treatment of Malignant Hyperthermia.

We noted that the muscle-relaxant, alloferin was not being kept in the fridge; with the high theatre temperatures, we recommend it is kept in the fridge.

There were no significant problems detected during the equipment check, however, it is recommended that the following items of equipment should be purchased:

1. **An inspired oxygen analyser***: this is essential to check that the patient is not receiving a hypoxic mixture of anaesthetic gases.
2. **A laryngeal mask***(size 3 or 4): to be used in the event of a failed intubation.
3. **A capnograph***: to detect oesophageal intubation and as an overall important monitor for safe general anaesthesia.
4. **Leads for the ECG machine in the recovery area*.**
5. A peripheral nerve stimulator: this should always be available where muscle relaxants are used.
6. A wider range of endotracheal tubes: sizes 5.0 to 7.5mm internal diameter in 0.5mm steps, with cuffs, should be available.
7. Breathing filters: to prevent patient-to-patient transmission of infections via the anaesthetic machine/equipment eg TB.
8. A long flexible intubation bougie: to assist with difficult intubations.
9. A cricothyrotomy set: to be used in the event of failed intubation and ventilation (this is quicker to obtain a surgical airway with than a tracheostomy) – see Page 65 of above Guidelines for Maternity Care.
10. Blood filters: 20μ microaggregate filters- to be used when large volume blood transfusions are required.
11. Blood warming apparatus: where rapid transfusion is necessary (see page 11 “Clinical Guidelines for the use of Blood products in South Africa, 2nd Edition, 2001 – South African National Blood Service).

In addition, we noted that airways were not being kept in the recovery area; this needs correcting.

* = high priority

Appendix G. Letter to Botshabelo hospital 2005

Level 1 And 2 Hospital Visits For Obstetric Anaesthesia Drugs And Equipment Report 2005

BOTSHABELO HOSPITAL

Date of Visit: 24th May 2005

Anaesthetic Drugs/Fluids

The following essential drugs and fluids were not available in the operating theatre or indeed the entire hospital:

1. **Amiodarone.** First line drug treatment of shock resistant ventricular fibrillation (see Southern African Resuscitation Council Guidelines for Cardiac Arrest, 2000)
2. **Dantrolene**. This is required for the emergency treatment of malignant hyperthermia and sufficient for a "starter dose" should be kept in every hospital where general anaesthesia is performed.
3. **Phenylephrine**. Vasoconstrictor required to treat hypotension after spinal anaesthesia or to provide cardiovascular support to septic patients prior to transfer to intensive care.
4. **Lignocaine 1% (subcut)**: to provide skin analgesia prior to spinal needle insertion.
5. **Salbutamol (IV).** To treat perioperative bronchospasm eg. exacerbation of asthma.
6. **Sodium citrate.** Given immediately before caesarean section, this helps to neutralise acidity of gastric contents, reducing incidence of pneumonitis if aspiration occurs. Only Mis Pot Citrate was available. This is unpalatable. Citrus soda is a more palatable, suitable alternative, provided it has been left to stand and "de-fizz".
7. **Bupivacaine 0.5% in dextrose (spinal, 4ml/ampoule).** Used for spinal anaesthesia for caesarean section. At present 10ml plastic ampoules, formulated for epidural use are used. These should not be used for injections directly into the csf, as this preparation uses a different bupivacaine salt, not designed for this use.
8. **Dried plasma.** Required for the emergency treatment of obstetric haemorrhage with disorder of coagulation.

The following drugs/fluids were available in other parts of the hospital, but it is recommended that they should be kept in the operating theatre where they can be immediately available for intra-operative use:

a. **Phenytoin.** To treat status epilepticus
b. **Salbutamol inhaler.** For perioperative treatment of asthma.
c. **Lignocaine 1% (subcut).** To provide skin analgesia prior to spinal anaesthesia.

The following drugs were found freely in the theatres, although they are controlled drugs and should be kept locked in a secure cupboard and a record kept of their use:

i. **Thiopentone**
ii. **Halothane**

Anaesthetic Equipment: Problems detected

1. *Servicing: Too infrequent*
   Anaesthetic machine, ventilator and vapourisers are only being checked annually; they should be checked 6 monthly.
2. *Scavenging for anaesthetic gases: Not connected*
   Required by Health and Safety to prevent operating theatre pollution with anaesthetic vapours.
3. *Nitrous Oxide : Inadequate supply*
   Only pipeline supply was present. There should also be a cylinder attached to the anaesthetic machine and a full spare cylinder available.
4. *Breathing filters:*
   Required to prevent patient to patient transmission of infections from the anaesthetic breathing circuits eg. tuberculosis.
5. *Endotracheal tubes: Insufficient sizes*
   Cuffed ET tubes, sizes 5 to 7.5mm (in half sizes) are required; sizes 7.0 and 7.5 were absent.
6. *Difficult intubation equipment: Inadequate*
   Failed intubation is one of the main causes of maternal death from general anaesthesia. Equipment must be readily at hand lest a difficult intubation arises.
   a. Long flexible gum-elastic intubation bougie – needs purchasing.
   b. Laryngeal mask (size 3 and/or 4) – needs purchasing.
   c. Cricothyroidotomy set – needs purchasing.
7. *Intravenous cannulas: Insufficient sizes (no14/16G or 20G)*
   Large bore cannulas 14/16G should be available for severe hypotension/haemorrhage rapid fluid administration. 20G are required for adults with difficult veins.
7. *Defibrillator: Not tested daily*
   This should be tested daily and after each use. At present it is only tested monthly.

Written by: Dr. G. Lamacraft, Principal Specialist in Anaesthesia, University of the Free State. 9th June 2005.

Appendix H. Anaesthetic Drugs and Equipment Results

(a) Resuscitation Drugs (adrenaline was available in all hospitals, both in Phase 1 and Phase 2)

TOWN	HOSPITAL	Amiodarone 02/03	Amiodarone 05	Atropine 0203	Atropine 05	Calcium 0203	Calcium 05	Dopamine 0203	Dopamine 05	Lignocaine 0203	Lignocaine 05	Na Bicarb 0203	Na Bicarb 05	Total 0203	Total 05
BETHLEHEM	Dihlabeng	0	1	1	1	1	1	1	1	1	1	1	1	5	6
BLOEMFONTEIN	National	0	1	1	1	1	1	1	1	1	1	1	1	5	6
BLOEMFONTEIN	Pelonomi	1	0	1	1	1	1	1	1	1	1	1	1	6	5
BOTHAVILLE	Nala	1	0	1	1	0	1	1	1	1	1		1	4	5
BOTSHABELO	Botshabelo	0	0	1	1	1	1	1	1	1	1	1	1	5	5
CLOCOLAN	John Daniel Newsberry	0	0	1	1	1	1	1	0	1	1	1	1	5	4
FICKSBURG	Phuthuloha	0	1	1	1	1	1	1	1	1	1	1	1	5	6
FRANKFORT	Mafube	0	0	1	1	1	1	0	1	1	1	0	1	3	5
HARRISMITH	Thebe	0	0	1	1	1	1	1	1	1	1	1	1	5	5
HEILBRON	Tokollo	0	0	1	1	1	1	1	1	1	1	0	1	4	5
JAGERSFONTEIN	Diamond	0	1	1	1	1	1	0	0	1	0	1	0	4	3
KROONSTAD	Boitumelo	0	1	1	1	1	1	1	1	1	1	1	1	5	6
LADYBRAND	Mantsopa	0	1	1	1	1	1	1	1	1	1	0	1	4	6
MANAPO	MMM	0	0	1	1	1	1	1	1	1	1	1	1	5	5
MOROKA	Dr. JS Moroka	0	0	1	1	0	1	1	1	1	1	1	1	4	5
ODENAALSRUS	Thusanong	1	1	1	1	1	1	1	1	1	1	1	1	6	6
PARYS	Parys		1		1		1		1		1		1	0	6
PHEKOLONG	Phekolong	0	0	1	1	1	1	0	0	1	1	1	1	4	4
REITZ	Nketoana	0	0	1	1	1	1	0	0	1	1	1	1	4	4
SASOLBURG	Metsimaholo	1	1	1	1	1	1	0	0	1	1	1	1	5	5
SENEKAL	Itemoheng	0	0	1	1	1	1	0	1	1	1	1	1	4	5
SMITHFIELD	Stoffel Coetzee	0	0	1	1	1	1	1	0	1	1		1	4	4
VIRGINIA	Katleho	0	1	1	1	1	1	1	1	1	1	1	0	5	5
WELKOM	Bongani	1	1	1	1	1	1	1	1	1	1	1	1	6	6
WINBURG	Winburg	0	1	1	1	0	0	0	1	1	1	1	1	3	5
ZASTRON	Embekweni	1	1	1	1	1	1	1	0	1	1	1	1	**6**	**5**
TOTAL		6	13	25	26	22	25	18	19	25	25	20	24	116	132

Appendix H. Anaesthetic Drugs and Equipment Results (continued)

(b) Haemorrhage:

i. Blood

HOSPITAL	Units of blood present in Phase 1				Units of blood present in Phase 2			
	None	1 unit	2 units	Total with blood	None	1 unit	2 units	Total with blood
Dihlabeng			1	1			1	1
National	1			0	1			0
Pelonomi			1	1			1	1
Nala		1		1		1		1
Botshabelo		1		1			1	1
John Daniel Newsberry	1			0		1		1
Phuthuloha	1			0		1		1
Mafube		1		1		1		1
Thebe			1	1			1	1
Tokollo		1		1		1		1
Diamond	1			0	1			0
Boitumelo			1	1			1	1
Mantsopa	1			0	1			0
MMM			1	1			1	1
Dr. JS Moroka			1	1			1	1
Thusanong		1		1			1	1
Parys			1	1			1	1
Phekolong	1			0	1			0
Nketoana	1			0		1		1
Metsimaholo			1	1		1		1
Itemoheng	1			0		1		1
Stoffel Coetzee	1			0	1			0
Katleho			1	1	1			0
Bongani			1	1	1			0
Winburg			1	1			1	1
Embekweni	1			0	1			0
Total	10	5	11	16	8	8	10	18
%	38	19	42	62	31	31	38	69

Appendix H. Anaesthetic Drugs and Equipment Results: (b) Haemorrhage (continued)

ii. Colloids, plasma and misoprostol

HOSPITAL	Phase 1			Phase 2		
	IV colloid	IV plasma	Misoprostol	IV colloid	IV plasma	**Misoprostol**
Dihlabeng	**1**	**1**	**1**	**1**	**1**	**1**
National	**1**	**0**	**1**	**0**	**0**	**1**
Pelonomi	**1**	**1**	**1**	**1**	**1**	**1**
Nala	**1**	**0**	**0**	**1**	**0**	**1**
Botshabelo	**1**	**0**	**1**	**1**	**0**	**1**
John Daniel Newsberry	**1**	**0**	**0**	**1**	**0**	**0**
Phuthuloha	**1**	**0**	**0**	**1**	**0**	**0**
Mafube	**1**	**0**	**1**	**1**	**0**	**0**
Thebe	**1**	**1**	**1**	**1**	**0**	**0**
Tokollo	**1**	**0**	**1**	**1**	**0**	**1**
Diamond	**1**	**0**	**0**	**0**	**0**	**1**
Boitumelo	**1**	**1**	**1**	**1**	**1**	**1**
Mantsopa	**0**	**0**	**0**	**1**	**0**	**1**
MMM	**1**	**0**	**1**	**1**	**1**	**1**
Dr. JS Moroka	**1**	**0**	**1**	**1**	**0**	**1**
Thusanong	**1**	**1**	**0**	**1**	**1**	**1**
Parys	**1**	**0**	**1**	**1**	**0**	**1**
Phekolong	**1**	**0**	**1**	**1**	**0**	**1**
Nketoana	**1**	**1**	**0**	**1**	**0**	**0**
Metsimaholo	**1**	**0**	**1**	**1**	**0**	**1**
Itemoheng	**1**	**0**	**0**	**1**	**0**	**0**
Stoffel Coetzee	**1**	**1**	**1**	**0**	**0**	**0**
Katleho	**1**	**0**	**1**	**1**	**0**	**1**
Bongani	**1**	**1**	**1**	**1**	**0**	**1**
Winburg	**1**	**0**	**0**	**0**	**0**	**1**
Embekweni	**1**	**0**	**0**	**0**	**0**	**0**
Total	**25**	**8**	**16**	**21**	**5**	**18**
%	**96**	**31**	**62**	**81**	**19**	**69**

Appendix H. Anaesthetic Drugs and Equipment Results (continued)

(c) Equipment 1

HOSPITAL	Theatre used for CS 023	Theatre used for CS 05	Op Table 02	Op Table 05	Op light 02	Op light 05	Arm support 02	Arm support 05	PNS 02	PNS 05	Oxygen 02	Oxygen 05	N2O 02	N2O 05	Vapouriser 02	Vapouriser 05	Total 02	Total 05
Dihlabeng		1		1		1		1		0		1		1		1	0	6
Dihlabeng	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	7	6
Dihlabeng	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	7
National	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	0	6	4
Pelonomi	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Nala	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	6	7
Botshabelo	1	1	1	1	1	1	1	1	0	0	1	0	1	0	1	1	6	4
J D Newsberry	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	1	6	5
Phuthuloha	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Mafube	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	1	6	5
Thebe	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	5	6
Tokollo	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Diamond	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Boitumelo	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Boitumelo	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Boitumelo	1		1		1		1		0		1		1		1		6	0
Boitumelo	1		1		1		1		0		1		1		1		6	0
Mantsopa	1	1	0	0	1	1	1	1	0	0	1	0	1	0	1	1	5	3
MMM	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	6	5
Dr. JS Moroka	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Dr. JS Moroka	1	1	1		1		1		0		1		1		1		6	0
Thusanong	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1	1	4	7
Parys	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	6	7
Phekolong	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	6	7
Nketoana	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	5	6
Metsimaholo	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Itemoheng	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Stoffel Coetzee	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Katleho	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	5	7
Bongani		1		1		1		1		1		1		0		1	0	6
Bongani	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1		7	5
Winburg	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	6	6
Embekweni	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	6	6
Total	31	31	28	29	31	30	31	30	3	9	28	24	31	25	31	28	183	175
%	100	100	90	94	100	97	100	97	10	29	90	77	100	81	100	90	84	81

Appendix H. Anaesthetic Drugs and Equipment Results (continued): (c) Equipment 2

HOSPITAL	Theatre for CS 023	Theatre for CS 05	Suction 02	Suction 05	Breathing circuit 02	Breathing circuit 05	Spare bag 02	Spare re bag 05	Catheter mount 02	Catheter mount 05	Breathing filter 02	Breathing filter 05	Face masks 02	Face masks 05	ET tubes 02	Et tubes 05	Total 02	Total 05
Dihlabeng		1				1		1		1		1		1		1	0	6
Dihlabeng	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	7
Dihlabeng	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	7
National	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	4	6
Pelonomi	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	5	6
Nala	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	5	6
Botshabelo	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	6	5
John Daniel Newsberry	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	6	5
Phuthuloha	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	6	5
Mafube	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	5	5
Thebe	1	1	1	1	1	1	1	1	1	0	0	0	1	1	0	1	5	5
Tokollo	1	1	1	0	1	1	1	1	1	1	0	0	1	1	1	0	6	4
Diamond	1	1	1	1	1	1	1	0	1	0	0	0	1	1	0	0	5	3
Boitumelo	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	5	6
Boitumelo	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	6	6
Boitumelo	1		1		1		1		1		1		1		1		7	0
Boitumelo	1		1		1		1		1		1		1		1		7	0
Mantsopa	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	6	4
MMM	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	3	7
Dr. JS Moroka	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	5	6
Dr. JS Moroka	1	1	1		1		1		1		1		1		1		7	0
Thusanong	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	6	7
Parys	1	1	1	1	0	1	1	0	1	1	0	0	1	1	1	1	5	5
Phekolong	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0	5	6
Nketoana	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	6	5
Metsimaholo	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	7	4
Itemoheng	1	1	1	1	0	0	1	1	1	1	0	0	0	0	1	1	4	4
Stoffel Coetzee	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	6	5
Katleho	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	5	7
Bongani		1		1		1		1		1		1		1		1	0	7
Bongani	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	6	7
Winburg	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	6	7
Embekweni	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	0	5	5
Total	31	31	28	28	29	29	29	28	27	23	12	17	28	27	21	16	174	168
%	100	100	90	90	94	94	94	90	87	74	39	55	90	87	68	52	80	77

Appendix H. Anaesthetic Drugs and Equipment Results (continued): (c) Equipment 3

HOSPITAL	Theatre used for CS 023	Theatre used for CS 05	02: O2 enrichment	05: O2 enrichment	02: Guedel airways	05: Guedel airways	02: Laryngoscopes	05: Laryngoscopes	02 intubation stylet	05: intubation stylet	02: Long bougie	05: Long bougie	02:LMA	05: LMA	02: crico set	05: crico set	02: spinal needles and prep	05: spinal needles and prep	Total 02	Total 05
Dihlabeng	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0	1	1	6	6
Dihlabeng	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0		1	5	6
Dihlabeng		1		1		0		1		1		0		1		0		1	0	5
National	1	1	1	1	0	1	0	1	1	1	0	1	1	1	0	1	1	1	4	8
Pelonomi	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0	1	1	1	5	7
Nala	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0	1	1	1	5	7
Botshabelo	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	5	5
J D Newsberry	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	1	4	3
Phuthuloha	1	1	1	1	1	0	1	0	0	0	0	0	0	1	0	0	1	1	4	3
Mafube	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	4	6
Thebe	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	6	7
Tokollo	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1		5	4
Diamond	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	3	2
Boitumelo	1	1	1	1	1	0	1	0	1	1	0	0	1	1	0	0	1	1	6	4
Boitumelo	1	1	1	1	1	0	1	0	1	1	0	0	1	1	0	0	1	1	6	4
Boitumelo	1		1		1		1		1		0		1		0		1		6	0
Boitumelo	1		1		1		0		1		0		1		0		1		5	0
Mantsopa	1	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	1	1	5	3
MMM	1	1	1	1	0	1	0	1	0	1	0	0	0	1	0	0	1	1	2	6
Dr. JS Moroka	1	1	0	1	1	1	0	1	1	1	0	0	0	1	0	0	1	1	3	6
Dr. JS Moroka	1	1	0	1	1	1	1	1	1	1	0	0	0	1	0	0	1	1	4	6
Thusanong	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	5	8
Parys	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	6	7
Phekolong	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	6	7
Nketoana	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	5	6
Metsimaholo	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0	1	1	5	6
Itemoheng	1	1	1	1	1	0	1	1	1	1	0	0	0	0	0	1	1	1	5	5
Stoffel Coetzee	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	5	5
Katleho	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	5	5
Bongani	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	6	7
Bongani		1		1		0		0		1		0		1		0		1	0	4
Winburg	1	1	0	1	1	1	1	1	1	1	0	0	0	1	0	1	0	1	3	7
Embekweni	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0	1	1	1	5	7
Total	31	31	27	30	28	23	26	25	28	28	0	2	14	21	0	13	25	30	148	172
%	100	100	87	97	90	74	84	81	90	90	0	6	45	68	0	42	87	97	60	69

Appendix H. Anaesthetic Drugs and Equipment Results (continued): (c) Equipment 4

HOSPITAL	Theatre used for CS 023	Theatre used for CS 05	02: IV cannulas	05: IV cannulas	02: chair	05 chair	02 drug trolley	05 drug trolley	02 iv pole	05 iv pole	02 tape	05 tape	02 iv giving sets	05 iv giving sets	02 blood sets	05 blood sets	02 blood warmer	05 blood warmer	Total 02	Total 05
Dihlabeng		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	8	7
Dihlabeng	1	1	1		1		1		1		1		1		1		1		8	0
Dihlabeng	1	1																	0	0
National	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	7	7
Pelonomi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	8	7
Nala	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	7	7
Botshabelo	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	7	6
J D Newsberry	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	7	5
Phuthuloha	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	7	7
Mafube	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	7	6
Thebe	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	6	6
Tokollo	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	6	7
Diamond	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	6	6
Boitumelo	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	6	6
Boitumelo	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	6	6
Boitumelo	1		1		0		1		1		1		1		1		0		6	0
Boitumelo	1		1		1		1		1		1		1		1		0		7	0
Mantsopa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	7	7
MMM	1	1	0	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	5	6
Dr. JS Moroka	1	1	0	0	0	1	1	1	1	1	0	1	1	1	0	1	0	1	3	7
Dr. JS Moroka	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	7	7
Thusanong	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	8
Parys	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	7	6
Phekolong	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	8
Nketoana	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	7	7
Metsimaholo	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	7	7
Itemoheng	1	1	0	0	1	1	1	1	1	1	1	0	1	1	0	1	0	0	5	5
Stoffel Coetzee	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	6	5
Katleho	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	6	6
Bongani		1		1		1		1		1		1		1		1		0	0	7
Bongani	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	8	7
Winburg	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0	6	6
Embekweni	1	1	0	0	1	0	1	1	1	1	1	1	1	1	0	1	0	0	5	5
Total	31	31	18	14	27	28	31	27	31	29	30	28	30	27	27	28	8	6	202	187
%	100	100	58	45	87	90	100	87	100	94	97	90	97	87	87	90	26	19	81	75

Appendix H. Anaesthetic Drugs and Equipment Results (continued): (c) Equipment 5

HOSPITAL	Theatre used for CS 023	Theatre used for CS 05	02 Masks	05 Masks	02 Gloves	05 Gloves	02 Syringes	05 Syringes	02 Needles	05 Needles	02 Trolley	05 Trolley	Total 02	Total 05
Dihlabeng		1	1	1	1	1	1	1	1	1	1	1	5	5
Dihlabeng	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Dihlabeng	1	1		1		1		1		1		1	0	5
National	1	1	1	1	1	1	1	0	1	1	1	1	5	4
Pelonomi	1	1	1	1	1	1	1	0	1	1	1	1	5	4
Nala	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Botshabelo	1	1	1	1	1	1	1	1	1	1	1	1	5	5
JD Newsberry	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Phuthuloha	1	1	1	1	1	1	1	1	1	1	0	0	4	4
Mafube	1	1	1	1	1	0	1	0	1	1	0	1	4	3
Thebe	1	1	1	1	1	1	1	1	1	1	0	1	4	5
Tokollo	1	1	1	1	1	1	1	1	1	1	1	0	5	4
Diamond	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Boitumelo	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Boitumelo	1	1	1		1		1		1		1		5	0
Boitumelo	1		1		1		1		1		1		5	0
Boitumelo	1		1		1		1		1		1		5	0
Mantsopa	1	1	1	1	1	1	1	1	1	1	0	1	4	5
MMM	1	1	1	1	0	1	1	0	1	1	1	1	4	4
Dr. JS Moroka	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Dr. JS Moroka	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Thusanong	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Parys	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Phekolong	1	1	1	1	1	1	1	0	1	1	0	1	4	4
Nketoana	1	1	1	1	1	1	1	1	1	1	1	1	5	5
Metsimaholo	1	1	1	1	1	1	1	1	1	1	1	0	5	4
Itemoheng	1	1	1	1	0	1	1	1	1	1	1	1	4	5
Stoffel Coetzee	1	1	1	1	1	1	0	1	1	1	1	0	4	4
Katleho	1	1	1	1	1	0	1	1	1	1	1	1	5	4
Bongani		1	1	1	1	1	1	1	1	1	1	1	5	5
Bongani	1	1		1		1		1		1		1	0	5
Winburg	1	1	1	1	1	1	1	1	1	1	0	0	4	4
Embekweni	1	1	1	1	1	0	1	1	1	1	1	1	5	4
Total	31	31	31	30	29	27	30	25	31	30	25	25	146	137
%	100	100	100	97	94	87	97	81	100	97	81	81	94	88

Appendix H. Anaesthetic Drugs and Equipment Results (continued)

(d) General Anaesthesia Drugs

HOSPITAL	Thio/Pro 023	Thio/Prop 05	Suxamethonium 023	Suxamethonium 05	Hal/Iso 023	Hal/Iso 05	INDMR 023	INDR 05	Opiate 023	Opiate 05	Naloxone 023	Naloxone 05	Neostigmine 023	Neostigmine 05	Total 023	Total 05
Dihlabeng	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
National	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Pelonomi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Nala	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Botshabelo	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
J D Newsberry	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Phuthuloha	1	1	1	1	1	1	1	0	1	1	1	1	1	1	8	6
Mafube	1	1	1	1	1	1	1	0	1	1	1	1	1	1	8	6
Thebe	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Tokollo	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Diamond	1	1	0	0	1	1	0	0	1	0	1	0	0	0	4	2
Boitumelo	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Mantsopa	1	1	1	1	1	1	1	0	1	1	1	1	1	1	8	6
MMM	1	1	1	1	1	1	1	1	1	1	0	1	1	1	6	7
Dr. JS Moroka	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Thusanong	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Parys	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Phekolong	0	1	0	1	1	1	0	1	1	1	0	1	1	1	4	7
Nketoana	1	1	1	1	1	1	0	0	1	1	1	1	0	0	6	5
Metsimaholo	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Itemoheng	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Stoffel Coetzee	0	1	0	1	1	1	0	0	1	0	1	1	1	0	4	4
Katleho	1	1	1	1	1	1	1	0	1	1	1	1	1	1	8	6
Bongani	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7
Winburg	1	1	1	1	1	1	0	0	1	1	1	1	1	0	7	5
Embekweni	1	1	0	0	1	1	0	0	1	1	1	1	1	0	6	4
Total	24	26	22	24	26	26	20	17	26	24	24	25	24	21	189	163
%	92	100	85	92	100	100	77	65	100	92	92	96	92	81	91	78

Appendix H. Anaesthetic Drugs and Equipment Results (continued):

(e) Drugs for Medical Emergencies

(i) Dantrolene - Insulin

HOSPITAL	Dantrolene 023	Dantrolene 05	Diazepam 023	Diazepam 05	Frusemide 023	Frusemide 05	GTN 023	GTN 05	Hydrocort 023	Hydrocort 05	Insulin 023	Insulin 05	Total 023	Total 05
Dihlabeng*	0	1	1	1	1	1	1	1	1	1	1	1	5	6
National	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Pelonomi*	1	1	1	1	1	1	1	1	1	1	1	1	6	6
Nala	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Botshabelo	0	0	1	1	1	1	0	1	1	1	0	1	3	5
John Daniel Newsberry	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Phuthuloha	0	0	1	1	1	1	1	1	1	1	1	0	5	4
Mafube	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Thebe	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Tokollo	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Diamond	0	0	1	1	1	1	1	1	1	1	1	0	5	4
Boitumelo*	0	1	1	1	1	1	1	1	1	1	1	1	5	6
Mantsopa	0	0	1	1	1	1	1	1	1	1	1	0	5	4
Mofumahadi Manapo Mopeli*	0	0	1	1	1	1	1	1	1	1	1	0	5	4
Dr. JS Moroka	0	0	1	1	1	1	0	1	1	1	0	1	3	5
Thusanong	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Parys	0	0	1	1	1	1	0	1	1	1	1	1	4	5
Phekolong	0	0	0	1	1	1	1	1	1	1	1	1	4	5
Nketoana	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Metsimaholo	0	0	1	1	1	1	0	1	1	1	1	1	4	5
Itemoheng	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Stoffel Coetzee	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Katleho	0	0	1	1	1	1	1	1	1	1	1	0	5	4
Bongani*	1	1	1	1	1	1	1	1	1	1	1	1	6	6
Winburg	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Embekweni	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Total	2	4	25	26	26	26	22	26	26	26	24	21	125	129
%	8	15	96	100	100	100	85	100	100	100	92	81	80	83

Appendix H. Anaesthetic Drugs and Equipment Results (e) Drugs for Medical Emergencies (continued):

(ii) Ketamine – 50% Glucose

HOSPITAL	Ketamine 02	Ketamine 05	Labetalol 02	Labetalol 05	Magnesium 02	Magnesium 05	Phenytoin 02	Phenytoin 05	Promethazine 02	Promethazine 05	Salbutamol 02	Salbutamol 05	Glucose 50% 02	Glucose 50% 05	Total 02	Total 05
Dihlabeng	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7	7
National	1	0	1	0	1	1	1	1	1	1	1	1	1	1	7	5
Pelonomi	1	1	1	1	1	1	1	1	1	1	0	1	1	1	6	7
Nala	1	0	0	0	1	1	1	1	0	1	1	1	1	1	5	5
Botshabelo	1	1	0	0	1	1	0	1	1	1	0	1	1	1	4	6
John Daniel Newsberry	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Phuthuloha	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Mafube	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Thebe	1	1	0	0	1	1	1	1	1	0	1	1	1	1	6	5
Tokollo	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Diamond	0	0	0	0	1	1	1	1	1	1	1	1	1	1	5	5
Boitumelo	1	1	0	1	1	1	1	1	1	1	1	1	1	1	6	7
Mantsopa	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
MMM	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Dr. JS Moroka	1	1	0	0	1	1	1	1	1	1	0	1	1	1	5	6
Thusanong	0	1	0	1	1	1	1	1	1	1	1	1	1	1	5	7
Parys	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Phekolong	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Nketoana	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Metsimaholo	1	1	0	0	1	1	1	1	0	1	1	1	1	1	5	6
Itemoheng	1	1	0	0	1	1	0	1	1	1	1	1	1	1	5	6
Stoffel Coetzee	1	1	0	0	1	1	1	1	1	0	1	1	1	1	6	5
Katleho	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Bongani	0	1	1	1	1	1	1	1	1	1	1	1	1	1	6	7
Winburg	1	1	0	0	1	1	1	1	1	1	1	1	1	1	6	6
Embekweni	0	1	0	0	1	1	1	1	1	1	1	1	1	1	5	6
Total	22	23	4	5	26	26	24	26	24	24	23	26	26	26	149	156
%	85	88	15	19	100	100	92	100	92	92	88	100	100	100	82	86

Appendix H. Anaesthetic Drugs and Equipment Results (continued):

(f) Post-spinal Hypotension

HOSPITAL	**Etilefrine 023**	**Etilefrine 05**	**Phenylephrine 023**	**Phenylephrine 05**	Total 023	Total 05
Dihlabeng	**1**	**1**	**0**	**0**	1	1
National	**1**	**1**	**0**	**0**	1	1
Pelonomi	**1**	**1**	**1**	**0**	2	1
Nala	**1**	**1**	**0**	**1**	1	2
Botshabelo	**1**	**1**	**0**	**0**	1	1
John Daniel Newsberry	**1**	**1**	**0**	**0**	1	1
Phuthuloha	**1**	**1**	**0**	**0**	1	1
Mafube	**1**	**1**	**0**	**0**	1	1
Thebe	**1**	**1**	**0**	**0**	1	1
Tokollo	**0**	**1**	**0**	**0**	0	1
Diamond	**0**	**1**	**0**	**0**	0	1
Boitumelo	**1**	**1**	**0**	**1**	1	2
Mantsopa	**0**	**1**	**0**	**0**	0	1
MMM	**1**	**1**	**0**	**0**	1	1
Dr. JS Moroka	**1**	**1**	**0**	**0**	1	1
Thusanong	**1**	**1**	**0**	**1**	1	2
Parys	**1**	**1**	**0**	**0**	1	1
Phekolong	**1**	**1**	**0**	**0**	1	1
Nketoana	**1**	**1**	**0**	**0**	1	1
Metsimaholo	**1**	**1**	**0**	**0**	1	1
Itemoheng	**1**	**1**	**0**	**0**	1	1
Stoffel Coetzee	**0**	**1**	**0**	**0**	0	1
Katleho	**1**	**1**	**0**	**0**	1	1
Bongani	**1**	**1**	**1**	**1**	2	2
Winburg	**0**	**0**	**0**	**0**	0	0
Embekweni	**0**	**1**	**0**	**0**	0	1
Total	20	25	2	4	22	29
%	76.9	96.1	7.7	15.4	42.3	55.8

Appendix H. Anaesthetic Drugs and Equipment Results (continued):

(g) Acid Aspiration Prophylaxis

HOSPITAL	Oral Cimetidine 023	Oral Cimetidine 05	IV Cimetidine 023	IV Cimetidine 05	Na Citrate 023	Na Citrate 05	Total 023	Total 05
Dihlabeng*	1	1	1	1	0	0	2	2
National	1	1	1	1	1	0	3	2
Pelonomi*	0	1	1	1	1	1	2	3
Nala	1	1	1	1	0	0	2	2
Botshabelo	1	1	1	1	0	0	2	2
John Daniel Newsberry	1	0	1	0	0	0	2	0
Phuthuloha	1	0	1	0	0	0	2	0
Mafube	1	1	1	1	1	0	3	2
Thebe	1	1	1	1	1	0	3	2
Tokollo	0	1	1	1	1	0	2	2
Diamond	0	0	1	1	0	0	1	1
Boitumelo*	1	1	1	1	0	0	2	2
Mantsopa	1	0	1	0	0	0	2	0
Mofumahadi Manapo Mopeli*	1	1	1	1	0	0	2	2
Dr. JS Moroka	0	1	0	0	0	0	0	1
Thusanong	0	1	1	1	0	1	1	3
Parys	1	1	1	1	0	0	2	2
Phekolong	0	0	0	0	0	0	0	0
Nketoana	1	0	1	0	0	0	2	0
Metsimaholo	1	1	1	1	0	0	2	2
Itemoheng	1	1	1	1	0	1	2	3
Stoffel Coetzee	1	1	1	1	0	1	2	3
Katleho	1	1	1	1	0	0	2	2
Bongani*	1	1	1	1	0	1	2	3
Winburg	1	1	1	1	0	0	2	2
Embekweni	1	1	1	1	1	0	3	2
Total	20	20	24	20	6	5	50	45
%	77	77	92	77	23	19	64.1	58

Appendix H. Anaesthetic Drugs and Equipment Results (continued):

(h) Monitors in operating theatres

HOSPITAL	Theatre used for CS 023	Theatre used for CS 05	ECG 023	ECG 05	AutNIBP 023	AutNIBP 05	Capnog 023	Capnog 05	Total 023	Total 05
Dihlabeng		1		1		1		1		3
Dihlabeng	1	1	1	1	1	1	1	1	3	3
Dihlabeng	1	1	1	1	1	1	1	1	3	3
National	1	1	1	1	1	1	1	1	3	3
Pelonomi	1	1	1	1	1	1	1	1	3	3
Nala	1	1	0	1	0	1	0	1	0	3
Botshabelo	1	1	1	1	1	1	0	1	2	3
J D Newsberry	1	1	1	0	0	1	0	1	1	2
Phuthuloha	1	1	1	1	1	1	0	1	2	3
Mafube	1	1	0	0	0	1	0	0	0	1
Thebe	1	1	1	1	1	1	0	0	2	2
Tokollo	1	1	1	1	1	1	0	0	2	2
Diamond	1	1	1	0	0	1	1	1	2	2
Boitumelo	1		1		1		1		3	
Boitumelo	1		1		1		1		3	
Boitumelo	1	1	1	1	1	1	1	1	3	
Boitumelo	1	1	1	1	1	1	1	1	3	3
Mantsopa	1	1	1	1	1	1	0	0	2	2
MMM	1	1	1	1	1	1	1	1	3	3
Dr. JS Moroka	1	1	1	1	0	1	0	0	1	2
Dr. JS Moroka	1	1	1	1	1	1	0	1	2	3
Thusanong	1	1	1	1	1	1	0	1	2	3
Parys	1	1	1	1	1	1	0	0	2	2
Phekolong	1	1	0	1	1	1	0	0	1	2
Nketoana	1	1	1	1	1	1	0	0	2	2
Metsimaholo	1	1	1	1	1	1	0	1	2	3
Itemoheng	1	1	0	1	1	1	0	1	1	3
Stoffel Coetzee	1	1	1	1	1	1	0	0	2	2
Katleho	1	1	1	1	1	1	0	1	2	3
Bongani		1		1		1		1		3
Bongani	1	1	1	1	1	1	1	1	3	3
Winburg	1	1	0	1	1	1	0	1	1	3
Embekweni	1	1	1	1	1	1	0	0	2	2
Total	31	31	26.0	28	26.0	31	11	21	63	77
%	100	100	84	93	84	100	35	70	68	86

Appendix H. Anaesthetic Drugs and Equipment Results (continued)

(i) Anaesthetic Machines

HOSPITAL	Type 023	Type 05	Working 023	Working 05	6 monthly service 023	6 monthly service 05	FiO2 023	FiO2 05	Scavenging 023	Scavenging 05	Total 023
Dihlabeng		S 900		1		1		0		1	0
Dihlabeng	S 900	S 900	1	1	1	1	0	0	1	1	3
Dihlabeng	S 900	S 900	1	1	1	1	0	0	1	1	3
National	Datex Ohmeda	Datex Ohmeda	1	1	1	1	1	0	1	1	4
Pelonomi	Blease 690	Blease 690	1	0	1	1	1	0	1	1	4
Nala	S 900	S 900	1	1	1	1	0	1	1	1	3
Botshabelo	S 900	S 900	1	1	0	0	0	0	1	0	2
J D Newsberry	S 900	S 900	1	1	0	1	0	0	0	0	1
Phuthuloha	S 900	S 900	1	1	1	1	0	0	1	1	3
Mafube	S 900	S 900	1	1	1	1	0	1	0	1	2
Thebe	S 900	S 900	1	1	1	1	0	0	1	1	3
Tokollo	S 900	S 900	1	1	0	1	0	0	0	1	1
Diamond	S 900	S 900	1	0	1	0	0	0	0	0	2
Boitumelo	S 900		1		1		1		0		3
Boitumelo	S 900		1		1		1		1		4
Boitumelo	S 900		1		1		1		1		4
Boitumelo	Datex Ohmeda	Datex Ohmeda	1	1	1	1	1	1	1	1	4
Mantsopa	S 900	S 900	1	1	0	0	0	0	0	1	1
MMM	S 900	S 900	1	0	0	1	0	0	1	0	2
Dr. JS Moroka	Medcare	S 900	1	1	1	0	0	1	1	1	3
Dr. JS Moroka	Medcare	S 900	1	1	1	0	0	0	1	1	3
Thusanong	S 900	Blease Focus	1	1	1	1	0	1	0	1	2
Parys	S 900	Blease Focus	0	1	1	1	0	1	1	1	2
Phekolong	S 900	S 900	1	1	1	1	0	1	1	0	3
Nketoana	S 900	S 900	1	1	1	1	0	0	0	1	2
Metsimaholo	Procare	S 900	1	1	1	1	0	0	1	1	3
Itemoheng	S 900	Drager Fabius	0	1	1	1	0	1	0	1	1
Stoffel Coetzee	S 900	S 900	1	1	0	1	0	0	0	0	1
Katleho	S 900	Blease Focus	1	1	1	1	0	1	1	1	3
Bongani	Datex Ohmeda	Datex Ohmeda	1	1	1	0	1	1	0	1	3
Bongani		Datex Ohmeda		1		0		1		1	0
Winburg	S 900	Blease	1	1	1	1	0	1	1	1	3
Embekweni	S 900	Datex Ohmeda	1	1	0	1	0	0	0	0	1
Total	31	30	29	27	24	23	7	12	19	23	79
%			94	90	77	77	23	40	61	77	64

Appendix H. Anaesthetic Drugs and Equipment Results (continued):

(j) Emergency Equipment

HOSPITAL	Defibrillator 023	Defibrillator 05	Ambu Bag 023	Ambu Bag 05	Mobile 0xygen 023	Mobile Oxygen 05	Total 023	Total 05
Dihlabeng	1	1	1	1	1	1	2	2
National	1	1	1	1	1	1	2	2
Pelonomi	1	1	1	1	1	0	2	1
Nala	1	1	0	1	1	1	1	2
Botshabelo	1	1	1	1	1	1	2	2
JDNewsberry	1	1	1	1	1	1	2	2
Phuthuloha	1	1	1	1	1	1	2	2
Mafube	1	1	1	1	1	1	2	2
Thebe	1	1	1	1	0	1	1	2
Tokollo	1	1	1	1	1	0	2	1
Diamond	1	1	0	1	1	1	1	2
Boitumelo	1	1	1	1	1	1	2	2
Mantsopa	1	1	1	0	1	1	2	1
MMM	1	1	1	0	0	1	1	1
Dr. JS Moroka	1	1	1	1	0	1	1	2
Thusanong	1	1	1	1	0	1	1	2
Parys	1	1	1	1	0	1	1	2
Phekolong	1	1	1	1	0	1	1	2
Nketoana	1	1	1	1	0	1	1	2
Metsimaholo	1	1	1	0	0	0	1	0
Itemoheng	1	1	1	0	1	1	2	1
Stoffel Coetzee	1	0	1	0	1	0	2	0
Katleho	1	1	1	1	1	1	2	2
Bongani	1	1	1	1	1	1	2	2
Winburg	1	1	0	0	0	0	0	0
Embekweni	1	1	1	1	1	0	2	1
Total	26	25	23	20	17	20	40	40
%	100	96	88	77	65	77	77	77

Appendix H. Anaesthetic Drugs and Equipment Results (continued):

(k) Recovery Areas

HOSPITAL	02 used	05 used	02 O2	05 O2	02 suction	05 suction	02 NIBP	05 NIBP	02 SpO2	05 SpO2	02 ECG	05 ECG	02 Ambu	05 Ambu	Total 02	Total 05
Dihlabeng	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	8
National	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	8
Pelonomi	1	1	1	1	1	1	0	1	1	1	1	1	1	1	7	8
Nala	0	0													0	0
Botshabelo	1	1	1	1	1	1	1	1	1	1	0	1	1	1	7	8
John Daniel Newsberry	0	0													0	0
Phuthuloha	0	0													0	0
Mafube	0	0													0	0
Thebe	1	1	1	1	1	1	1	1	1	1	1	1	0	1	7	8
Tokollo	0	0													0	0
Diamond	1	0	1		1		1		1		1		1		8	0
Boitumelo	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	8
Mantsopa	0	0													0	0
MMM	1	1	1	1	1	0	1	1	1	1	1	1	1	1	8	7
Dr. JS Moroka	1	1	1	1	1	1	1	1	0	1	0	1	1	1	6	8
Thusanong	0	0													0	0
Parys	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	8
Phekolong	0	0													0	0
Nketoana	0	0													0	0
Metsimaholo	0	1		1		1		1		1		1		1	0	8
Itemoheng	0	0													0	0
Stoffel Coetzee	0	0													0	0
Katleho	0	0													0	0
Bongani	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	8
Winburg	1	1	1	1	1	1	1	1	0	0	1	1	0	0	6	6
Embekweni	0	0													0	0
Total	12	12	12	12	12	11	11	12	10	11	10	12	10	11	89	93
%	48	48	100	100	100	92	92	100	83	92	83	100	83	92	93	97

Appendix I. Referral System Audit Form

AUDIT OF REFERRAL SYSTEM FOR TRANSFER OF PATIENTS REQUIRING CAESAREAN SECTION TO A HIGHER LEVEL HOSPITAL

The aim of this audit is to gather information regarding problems doctors are having in referring patients to higher level hospitals, in order that these problems may be formally addressed.
Your participation in this audit will thus benefit patient care.
Please could the doctor performing the operation complete the form for EACH PATIENT having a caesarean section, whether they needed transfer or not.

Name of Hospital…….

Date…….

Using what criteria do you usually decide whether an individual patient should be transferred to a higher level hospital for C. Section?

1. Written guidelines *(describe source)*
……..

2. Clinical Experience

3. Other (please describe)
…….

Did you CONSIDER transfer patient of this patient to a higher level (2 or 3) hospital pre-operatively? Yes No

If NO:

Then do not proceed further with this questionnaire, just place it in the collecting box.

If YES:

1. Why did you consider transfer of this patient?

Tick box as appropriate and then describe the reason in your own words

Obstetric reason

……
……
……

Anaesthetic reason

……
……
……

2. Why then was this patient NOT transferred pre-operatively?

   a. No emergency transport available

   b. Patient's condition too unstable

   c. Fetal distress

   d. Patient refused

   e. Doctor at level 2 hospital refused the patient transfer
   Give reason why transfer was refused:
   ……
   ……
   …….

   f. Doctor at level 3 hospital refused the patient transfer
   Give reason why transfer was refused:
   ……
   ……
   ……

   g. Other *(please describe)*
   ……
   ……
   ……

3. What is the name of the hospital you wished to refer the patient to?

. . . . . .

Thankyou for completing this form. Now place it in the collecting box.

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