Anaesthesia-related maternal deaths in South Africa
Chapter Seven of the 5th *Saving Mothers Report 2008-2010*

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Abstract

The number of reported deaths due to anaesthesia continues to increase. There were 121 reported this triennium. This represents 2.5% of all maternal deaths and 5.4% of deaths directly related to complications of pregnancy. One hundred and eighteen of these were available for review and 92 were assessed as being directly due to anaesthesia. Spinal anaesthesia accounted for 73 (79%) of the deaths and general anaesthesia 16 (17%). Two deaths were associated with sedation and one with epidural anaesthesia. The percentage of deaths caused by spinal anaesthesia increased in this triennium to 79%. Again, two thirds of these deaths resulted from poor treatment of well-recognised complications of spinal anaesthesia (hypotension and high motor block). The most common cause of death following general anaesthesia was difficult or failed intubation, which occurred in 50% of cases. Lack of basic skills in anaesthesia, including assessment and resuscitation, were identified. As in previous triennia, most anaesthesia-related deaths occurred at level 1 hospitals (70%). This reflects the need for skilled qualified anaesthetic care at these hospitals.

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Key recommendations

1. Internship training in anaesthesia should be increased to four months.
2. The hospitals that are allocated interns should be audited to ensure that appropriate training by qualified anaesthetists is being provided and that duties are being allocated solely to anaesthesia during the anaesthetic training period.
3. Where hospitals are identified as being unable to provide adequate intern training in anaesthesia, interns should be moved to another facility for the full duration of the anaesthesia training period.
4. Externally monitored audit and quality assurance programmes should be introduced to hospitals to ensure that clinical responsibilities, such as appropriate documentation and equipment checks, and administrative responsibilities, such as equipment repair and replacement, are being performed.
5. Nationally, improving governance of the perioperative process needs to become a priority. In addition to improvement of the National Committee on Confidential Enquiries into Maternal Deaths (NCCEMD) review process, evidence of widespread substandard care indicates the need for perioperative care to be examined. This should take the form of an additional reporting process.

Introduction

Of the 121 cases reported as being due to anaesthesia, the national reviewers had access to mortality reports and clinical charts from 119 cases. Of these, one case was not reviewed as the patient had not received an anaesthetic.

Of the 118 remaining, 92 were deemed to directly relate to anaesthesia. Provincial assessors for anaesthesia (PAA) reviewed 86 (71%) of the 121 reported cases. Some provinces achieved a 100% review rate (Figure 1). All provinces except one now have a PAA.
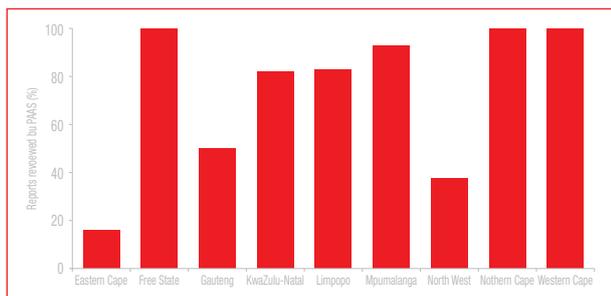
PAAs: provincial assessors for anaesthesia

Figure 1: Cases (%) seen by provincial assessors for anaesthesia and reported to be due to anaesthesia

Deaths that were not directly caused by anaesthesia, but where an anaesthetic had been administered, were reviewed to assess the contributory role that anaesthesia might have played in the patient's death. This process, in which PAAs examined the files of all patients who died who had received anaesthesia, still requires improvement as PAA reports are either not being requested provincially, or are not being sent to the national assessors for anaesthesia.

Table I demonstrates the improvement in the reporting process of the current triennium, compared to 2005-2007. Data were available from all provinces and ultimately 90 (98%) of the reports had been through the assessment process at either provincial or national level, or both. The next challenge is to improve the quality of the reports, the most important aspect of which is provision of a complete anaesthetic record in each case. The 2005-2007 report highlighted the absence of an anaesthetic form in 59% of assessed cases. The 2008-2010 report shows that a complete copy of the anaesthetic chart was included in 69 (58%) reports and was absent or only partially complete in 49 (42%) (Table II).

Absence of a copy of the chart in a report could be because of an omission on the part of the person copying the notes or failure to transfer the notes with the patient to a higher level of hospital care, where the death subsequently occurred. However, the majority of reports were accompanied by patients' notes that were so diligently copied that they frequently included copies of blank pages or hospital

Table I: Reported deaths due to anaesthesia: 2005-2007 and 2008-2010

Province	Deaths reported due to anaesthesia		Available PAA report		Judged by PAA as death due to anaesthesia		Additional deaths due to anaesthesia (seen by NAA)		Total number of deaths due to anaesthesia	
	2005-2007	2008-2010	2005-2007	2008-2010	2005-2007	2008-2010	2005-2007	2008-2010	2005-2007	2008-2010
Eastern Cape	12	13	0	2	0	2	10	6	10	8
Free State	22	3	17	3	13	3	4	0	17	3
Gauteng	10	14	4	7	3	4	3	4	6	8
KwaZulu-Natal	21	28	19	23	18	18	0	2	18	20
Limpopo	27	35	8	29	8	22	5	9	13	31
Mpumalanga	5	15	0	14	0	11	4	1	4	12
NorthWest	5	8	0	3	0	3	3	3	3	6
Northern Cape	2	2	No data	2	No data	2	N/A	0	No data	2
Western Cape	3	3	1	3	1	2	2	0	3	2
Total	107	121	46	86	40	69	31	25	74	92

NAA: national assessors for anaesthesia, PAAs: provincial assessors for anaesthesia

Table II: Assessed cases and inclusion of anaesthetic chart: 2008-2010

Province	n	Included, n (%)	Not included, n (%)	Partial, n (%)
Eastern Cape	13	8 (62)	5 (38)	0
Free State	3	3 (100)	0	0
Gauteng	12	8 (67)	4 (33)	0
KwaZulu-Natal	26	21 (81)	3 (12)	2 (8)
Limpopo	39	17 (44)	19 (49)	1 (3)
Mpumalanga	15	5 (33)	10 (67)	0
Northern Cape	2	2 (100)	0	0
North West	6	2 (33)	4 (67)	0
Western Province	4	3 (75)	1 (25)	0
Total	118	69 (58)	46 (39)	3 (3)

charts that had no entries. It is likely that the absence of an anaesthetic record represents a failure to complete an anaesthetic record by the "anaesthetist" at the time of surgery.

Demographic data

Table III shows the distribution of deaths by age over the last three triennial reports. There is little of note in these figures. Any differences in the distribution of ages in anaesthetic deaths to those within maternal deaths due to all other causes may be due to the differences within the subset of patients who presented for Caesarean section, who dominate the anaesthetic deaths.

Level of hospital care and province

As with previous reports, the largest percentage of deaths occurred in level 1 hospitals (Table IV). The only exception was Gauteng. This difference is assumed to be driven by the very different nature of the hospital system in Gauteng, e.g. urban with multiple regional hospitals. Nationwide, 72% of deaths due to anaesthesia occurred at level 1 hospitals.

There is a variation in the pattern of obstetric referral between the provinces. Northern Cape and North West provinces have no level 3 hospitals. Gauteng has a preponderance of deliveries in level 2 hospitals, in contrast to the Eastern Cape which has relatively few, while KwaZulu-Natal reports similar numbers in level 1 and 2 hospitals. The other

provinces reflect most deliveries in level 1, followed by level 2, then 3, hospitals. Gauteng and the Eastern Cape showed relatively larger numbers of deliveries in level 3 hospitals, compared to the other provinces (Figure 2). It is possible that the availability, level of training, skills and experience of anaesthesia personnel at each level of care could vary between the provinces.

The most distinct areas of concern are the high number of deaths occurring in district hospitals and the high anaesthesia-related maternal mortality figures in Limpopo, Mpumalanga and Northwest provinces, which are above the national average (Figure 3).

Caesarean section rates

The seemingly inexorable rise in the Caesarean deliveries continues (Figure 4). Nationally, there has been no significant increase in the anaesthetic-related case fatalities associated with Caesarean section which suggests that the increase in the number of anaesthetic deaths in this triennium relates entirely to the increase in the numbers of Caesarean sections (Figure 7.6). However, the documented anaesthesia case fatality rate for Caesarean sections in Limpopo, Mpumalanga, and North West has doubled between 2007 and 2010.

Primary, final and contributory causes of death

Table V shows the anaesthetic cause of death with respect to the type of anaesthesia.

Table III: Demographic data: age (reported deaths)

Age (years)	2008-2010	2005-2007	2002-2004
< 20	22 (18%)	48 (45%)	13 (36%)
20-24	32 (26%)		
25-29	18 (15%)	20 (19%)	22 (27%)
30-34	27 (22%)	24 (22%)	21 (24%)
35-39	16 (13%)	9 (8%)	15 (18%)
> 40	6 (5%)	6 (6%)	12 (14%)
Total	121	107	83

Table IV: Deaths due to anaesthesia according to level of hospital care in each province, 2008-2010

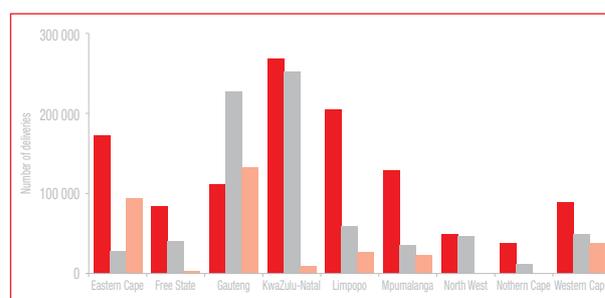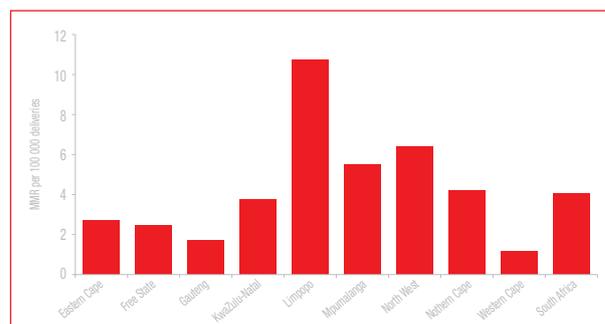|	Level 1	Level 2	Level 3
Eastern Cape	5	1	2
Free State	2	1	0
Gauteng	2	3	3
KwaZulu-Natal	15	3	2
Limpopo	25	2	4
Mpumalanga	9	3	0
North West	5	1	0
Northern Cape	2	0	0
Western Cape	1	1	0
Total by level (%)	66 (72.2%)	15 (15.6%)	11 (12.2%)

Figure 2: Deliveries according to level of provincial hospital care in each province, 2008-2010

MMR: maternal mortality ratio

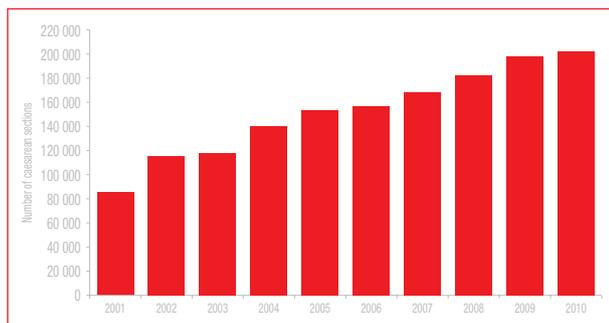**Figure 3:** Maternal deaths due to anaesthesia according to province

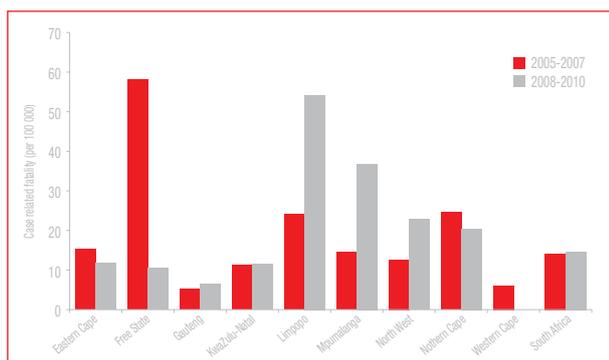**Figure 4:** Caesarean sections in provincial hospitals (2001-2010)

Figure 5: Anaesthetic case-related mortality for Caesarean section, according to province 2005-2007 and 2008-2010 (assessed deaths per 100 000 Caesarean sections performed).
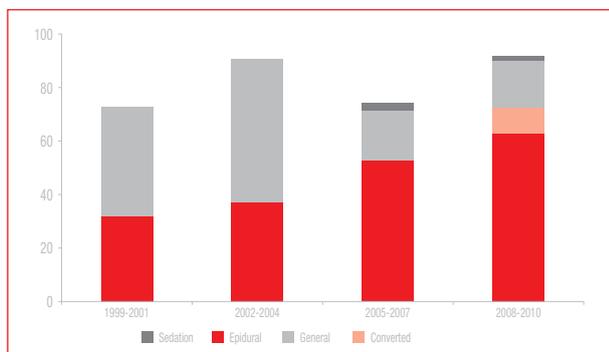

Figure 6: Maternal deaths assessed to be directly due to anaesthesia, 1998-2007

As in previous reports, no conclusion can be drawn on the safety of spinal, compared with general anaesthesia, as denominator data are not available.

Deaths associated with spinal anaesthesia continue to predominate. Seventy-nine per cent of deaths resulted from complications of spinal anaesthesia, 17% from general anaesthesia, with a small contribution from epidural anaesthesia and inappropriate sedation (Figure 6).

The apparent reduction in deaths between 2002-2004 and 2005-2007 reflects the change from use of reported deaths to use of assessed (and confirmed) deaths.

Table V: Cause of anaesthetic-related death (assessed cases)

	2002-2004		2005-2007		2008 - 2010	
	n	%	n	%	n	%
General anaesthesia	54	59	18	24	16	17
Difficult or failed intubation	18	30	4	5	8	9
Pulmonary aspiration	3	5			2	2
Intraoperative collapse	4	5	10	14	1	1
Equipment failure	3	5	2	3		
Uncontrolled hypertension			1	1		
Postoperative collapse			1	1		
Residual motor block					1	1
Inappropriate technique					2	2
Malignant hyperthermia					1	1
Unknown					1	1
Spinal anaesthesia	37	41	53	72	73[*]	79
High motor block	5	8	4	5	5	6
Hypotension or high motor block	15	25	30	41	16	15
Hypotension	6	10	2	3	31	35
Intraoperative collapse	1		10	14	6	
Postoperative collapse	2	2	3	4	1	1
Pulmonary aspiration					2	2
Ruptured uterus (shock)						
Difficult or failed intubation			1	1	2	2
Inappropriate technique					6	
Meningitis					1	1
Equipment failure					1	1
Unknown			3	4	2	2
Epidural anaesthesia			1	1	1	1
Sedation			2	3	2	2
Total assessed	62		74		92	

* Assessed on an intent-to-treat basis: 10 cases were converted to general anaesthesia when the spinal block proved inadequate for surgery

Type of surgery

The type of surgery associated with most deaths was lower segment Caesarean section or hysterotomy (85 cases). Laparotomy was performed in three cases (two ectopic pregnancies and one ruptured uterus following termination of pregnancy), evacuation of retained products of conception in two cases, and manual removal of placenta and wound inspection with one case each.

As part of the anaesthetic assessment process, in addition to attempting to identify the cause of death in each case, areas of substandard care are identified and listed in order of perceived relevance to subsequent outcome (invariably two or more areas of substandard care are identified).

The broad areas of considered substandard care are:
- Inadequate preoperative assessment.
- Inappropriate method of conducting the chosen technique.
- Inappropriate choice or dose of drug.
- Failure to check equipment.
- Lack of equipment or drugs.
- Substandard monitoring: not performed.
- Substandard monitoring: not recorded.
- Failure or delay in recognising a seminal event.
- Inadequate or inappropriate resuscitation.
- Failure in postoperative care.
- No physician explicitly allocated to provide anaesthesia.
- Intensive care unit (ICU) bed not available.

Each anaesthetic cause of death (Table V) is accompanied by a breakdown of the principle area of substandard anaesthesia care considered most relevant and a short case history (vignette). The two categories of substandard monitoring are combined as one. During assessment, differentiation between failure to perform monitoring and failure to record the vital signs is very difficult.

Spinal anaesthesia

The most common cause of death under spinal anaesthesia was severe uncorrected hypotension (42% of spinal anaesthetic deaths). This was followed by hypotension and high motor blockade (22% of spinal anaesthetic deaths). As in previous reports, the diagnosis of hypotension or high motor block relates to insufficient information in the death report to distinguish between the two. In five other cases (7% of spinal deaths) sufficient information was provided to allow a confident diagnosis of high motor block. Choice of an inappropriate technique was largely responsible for six deaths (8%).

Vignettes and breakdown of principal areas of substandard care

Hypotension

Of the 31 cases, 16 were primarily associated with delayed recognition, five with substandard monitoring, four with failure to allocate a physician explicitly to provide anaesthesia care, two with inadequate preoperative assessment, and four where the area of substandard care was unidentifiable because of inadequate information.

Case study 1

A 39-year-old para 1, gravida 2, with severe pre-eclampsia was transferred to a regional hospital while in labour, having received a loading dose of magnesium sulphate. "Foetal distress" was diagnosed and she was transferred to theatre, where spinal anaesthesia was administered by an unsupervised intern. Within five minutes, the blood pressure

had decreased from 160/110 to 85/60, with no action being taken. The blood pressure was then unrecordable for 10 minutes while the heart rate decreased to 50 beats per minute. The first evidence of any intervention was at 15 minutes following spinal injection when atropine was administered, followed by intubation and administration of adrenaline (unrecorded dose). The next recorded blood pressure was that of 230/155, with a heart rate of 165. Other doctors must have arrived, as surgery then commenced and an infant was delivered in very poor condition 35 minutes after spinal injection, and died a short time later. The mother died 10 days later in the ICU, having never regained consciousness.

Comment

The primary area of substandard care was that no physician was explicitly allocated to provide anaesthesia. The only aspect pertaining to the norms and standards of obstetric anaesthesia that were documented was the presence of a freely running intravenous line. No sodium citrate was administered and no lateral uterine displacement applied. There was evidence of initial failure to recognise the severity of the complication and no evidence of knowledge or application of appropriate resuscitative measures once a problem was recognised. The readiness of the intern to commence anaesthesia on his own suggests that this was not the first time that this had happened in this hospital.

There are good reasons why the Health Professions Council of South Africa (HPCSA) stipulates that interns must only practice under supervision. Even if the patient had been an elective, uncomplicated case, the intern should not have been allowed to proceed alone. To permit this to happen in an out-of-hours emergency for "foetal distress", in a patient with severe pre-eclampsia, represents very poor judgement. It was also illegal.

Hypotension or high motor block

Of the 16 cases, 11 were associated with delayed recognition primarily, two with failure to allocate a physician to explicitly provide anaesthesia care, one with an inappropriate method of conducting the chosen technique, one with inappropriate choice or dose of drug, and one with inadequate preoperative assessment.

Case study 2

A 28-year-old para 1, gravida 2, human immunodeficiency virus (HIV)- positive mother (not on antiretroviral therapy), with a history of previous Caesarean delivery, was admitted to a district hospital in the latent phase of labour. Her labour was allowed to progress to 8 cm dilatation when cephalopelvic disproportion (CPD) was diagnosed and preparations commenced for Caesarean delivery. However, she progressed to "full dilatation" at which point

her membranes were artificially ruptured. Dilatation was documented as 9 cm, "caput +, no moulding" 45 minutes later. She was then taken to theatre "in good condition" after a further 35 minutes. An inexperienced medical officer delayed the start of spinal anaesthesia, while another doctor was found to perform the surgery. After 45 minutes, the medical manager arrived and agreed to help and the junior doctor commenced spinal anaesthesia. Following spinal injection, the medical manager disappeared from the theatre suite. The patient lay supine (there was no record of uterine displacement) for approximately 30 minutes while the surgeon was sought. No monitoring values were documented for this period. The pulse oximeter probe was described as damaged and repeatedly fell off the patient. It was then noticed that the patient was unconscious. She was hypotensive with a saturation of 40-60%. No vasopressors were given. Assistance was requested and cardiopulmonary resuscitation (CPR) commenced. The medical manager returned, intubated the patient and continued resuscitation, while a third doctor performed the surgery and the "anaesthetist" took care of the baby, who subsequently died after having to be taken to the neonatal unit, because the Resuscitaire® in theatre wasn't working. No record of the resuscitation was made. The operative note documented a ruptured uterus.

Comment

Had it been planned for the patient to undergo Caesarean section when she first presented, sufficient time would have been available to organise a theatre team. The situation could have been prevented from developing into an emergency, then a crisis and finally a disaster. The disorganisation, use of faulty equipment, and poor documentation suggest serious governance issues in this hospital. However, this report is one of a few that have been received that have included a hospital mortality and morbidity review report. In it, are documented all the areas of substandard care, other than the poor documentation, and recommendations made of a number of immediate and short-term solutions (for example, institution of anaesthetic protocols and that the procedure should not be started without a full team in theatre), as well as long-term solutions. Among the latter was a suggestion to close the operating theatre until the inadequate staffing situation had been resolved. As this hospital, with just over 100 beds, had submitted four anaesthetic-related maternal mortality reports in the triennium, the national assessors agreed with this recommendation until it was noticed that this hospital was over three hours away from the nearest regional referral hospital within its province, and two hours away from a regional hospital within another province. This places a large part of the failure of governance at provincial level. For this hospital to be of value to its community, it should be fully staffed and equipped.

Case study 3

A 37-year-old para 2, gravida 3, presented in early labour to a district hospital. Twin pregnancy (both breech), that had not been detected at the clinic was diagnosed. Vaginal examination demonstrated an uneffaced mutiparous os and intact membranes. Clinical assessment was perfunctory. A medical history of asthma was not documented, nor that she had suffered an attack severe enough to warrant hospital admission during the current pregnancy. Apart from nursing records of vital signs, no general systems assessment was made before she went to theatre. Spinal anaesthesia was administered and Caesarean delivery commenced. A triplet pregnancy was discovered. Following delivery, 10 units of oxytocin were given as an intravenous bolus and 20 units placed in the intravenous bag. Shortly (one minute) thereafter, the patient was noted to be unresponsive. She was bradycardic, desaturated, and her blood pressure was unrecordable. There was no response to ephedrine 50 mg in increments and 500 ml colloid was given "after the 1-l MRL was finished". She was then intubated and CPR commenced. Her saturation improved slightly. Her face and "stomach" were noticed to be swelling. An allergic reaction was diagnosed and she was given hydrocortisone 100 mg (twice) and phenergan 25 mg intravenously. Following no response to this, the one and only dose of adrenaline (1 mg) was given, with no success. Death was recorded 19 minutes after the problem was first recognised. Extensive surgical emphysema was then noted and ascribed to a possible ruptured bulla.

Comment

The cause of the initial collapse is debatable. Spinal hypotension usually occurs more rapidly (bearing in mind the time required to commence surgery and deliver three babies), although it can be delayed. Onset of high motor block can vary. The massive bolus dose of oxytocin might also have been a cause of collapse, although the timing of events is against it (already unresponsive, desaturated and a bradycardia within a minute or so). It certainly would not have helped, nor would the additional 20 units given by rapid administration of the remaining Ringer's lactate. Discovery of an unresponsive desaturated patient always means that initial signs of a problem have been missed. Had earlier recognition occurred and appropriate action been taken, this mother would have survived.

Other areas of substandard care included inappropriate choice and dose of drugs and inadequate resuscitation, monitoring and preoperative assessment. Had the monitoring been adequate, the problem would have been detected earlier. Neither the anaesthetic nor the resuscitation was adequately documented. Initial treatment of an unresponsive, desaturated bradycardic patient with no detectable blood pressure is adrenaline in increments.

Ephedrine is appropriate for the treatment of early detection of reduced blood pressure in the conscious patient. The appropriate intravenous bolus dose of oxytocin is 2.5 units, not 10, and one of the dangers of injecting additional oxytocin into the intravenous infusion bag is that it is administered too rapidly if resuscitation is required, as occurred in this case. Even if the diagnosis of anaphylaxis had been correct, immediate resuscitative management is adrenaline 0.1 to 0.5 mg intravenously or intramuscularly, not hydrocortisone nor phenergan. The correct sequence of resuscitation in the scenario of an unresponsive patient with no detectable cardiac output would have been the immediate intravenous injection of adrenaline and institution of external cardiac massage. Bag and mask ventilation can be started, but immediate intubation wastes time. No evidence was presented that CPR conformed in any way to current advanced cardiac life support (ACLS) protocols and resuscitation was abandoned far too soon. If appropriate preoperative assessment had been performed, this patient would not have been managed at a district hospital (the nearest regional hospital is 90 minutes away by road in another province), the history of asthma documented and a ruptured bulla diagnosed, instead of anaphylaxis (but then she might never have received her only dose of adrenaline).

Failure of documentation and the delivery of multiple pregnancies in a small level 1 hospital again suggest failure of governance at both local and provincial level.

High motor block

Failure or delay in recognising the seminal event was the primary area of substandard care in all five cases.

Case study 4

A 19-year-old primigravid patient, in labour with a twin pregnancy and pre-eclampsia, required Caesarean delivery at a level 3 hospital. The leading twin was a breech presentation. A junior doctor (possibly a registrar) had to premix his or her own hyperbaric spinal solution (1.5 ml bupivacaine 0.5%, 0.3 ml dextrose 50%, fentanyl 15 µg) which was then administered and the patient placed in the supine-wedged position, with the table in the anti-Trendelenberg position (degree not stated). One minute later, the patient complained of tingling in her legs, which were already immobile. At three minutes, she complained of circumoral numbness and difficulty breathing. Haemoglobin saturation decreased rapidly, despite oxygen administration. She then became "unconscious". The anaesthetist sent for help from the main theatres (presumably this is an isolated obstetric theatre) and intubated the patient. Hand ventilation resulted in slight improvement of saturation to 87%. A bradycardia of 44 was noted. The record of events notes that the patient could not be connected to the mechanical ventilator because "there was no strapping for

the tracheal tube". The anaesthetist requested adrenaline 4 mg to be put into a bag of intravenous solution ("this took time"). Meanwhile, the electrocardiogram (ECG) showed asystole. Cardiopulmonary resuscitation was then commenced. Ten minutes had now elapsed since the spinal injection. Blood pressure had not been documented and no vasopressor had been administered. There was no evidence of the ACLS protocol being used. At + 20 minutes, the senior anaesthetist arrived, commenced the adrenaline infusion and connected the mechanical ventilator. The first blood pressure was then taken, and a reading of 122/90 documented, together with a heart rate of 49 and saturation of 90%. Atropine was administered at + 23 minutes and again at + 28 minutes, with no effect. The first bolus dose of adrenaline was given at + 30 minutes and another at + 33 minutes. Despite resuscitative efforts, the blood pressure continued to decrease and the bradycardia became worse. The defibrillator was used on four occasions for "asystole". No anaesthetic record was completed.

Comment

The management of this case was so disastrous that it is difficult to know where to begin. Nevertheless, it is clear that the first and foremost area of substandard care was a failure to recognise the problem of a patient rapidly developing symptoms and signs of a high motor block. The written account of events showed a lack of insight into complications of spinal anaesthesia and made no mention of the blood pressure during the onset of symptoms.

Use of the anti-Trendellenberg position of the table is contraindicated in obstetric spinal anaesthesia. The combination of inferior vena caval compression, even with lateral uterine displacement, with the effects of gravity, together with venous dilatation associated with sympathetic denervation, causes increased venous pooling in the legs and reduces venous return to the heart, exacerbating the effects of arterial dilatation and exacerbating hypotension. Also, it is possible that an error was made in mixing the spinal anaesthetic solution and that what was administered was a hypobaric mixture. There was no early use of vasopressors and once cardiac output had disappeared, time was wasted intubating the patient and looking for pieces of strapping, instead of initiating external cardiac massage and giving adrenaline. The time to have prepared for mask ventilation and intubation was when the patient first showed the signs and symptoms of a rapid onset of motor block.

Finally, why was an ill-trained or inexperienced doctor sent to provide obstetric anaesthesia care in an isolated theatre where he had to mix his own hyperbaric local anaesthetic solution in a level 3 hospital?

Inappropriate choice of spinal anaesthesia

There were six cases in which spinal anaesthesia was chosen inappropriately. The primary area of substandard

care was inappropriate method of conducting the technique in three cases, inappropriate choice or dose of drug in two and delayed recognition in one.

Case study 5

A 16-year-old primigravid at term presented for Caesarean section with poor progress in the first stage of labour and foetal tachycardia in a level 3 hospital. There was no full systems examination recorded by either the obstetric staff or the anaesthetist. A 3.5-hour delay had occurred between the decision to proceed to Caesarean section and arrival in theatre. The patient's heart rate was documented in the preanaesthetic nursing record as 137, and subsequently as 143 by the anaesthetist. No action was taken. Spinal (1.8 ml bupivacaine, baricity unrecorded) was administered in the sitting position and the patient then repositioned supine (no record of lateral uterine displacement). The height of sensory block was tested and surgery commenced. Blood pressures, following spinal administration, were not recorded. After delivery of a baby with low Apgar scores, the patient was noted to be "unresponsive and not breathing, central pulses absent". Immediate appropriate resuscitative measures were then taken and cardiac output was regained after approximately 10 minutes, but the patient never regained consciousness and was transferred to the ICU with a diagnosis of hypoxic ischaemic encephalopathy. Spontaneous breathing resumed, but a vegetative state persisted until she died of pneumonia 14 days later.

Comment

At the very least, tachycardia of 143 indicates a full historical enquiry and examination of the cardiovascular system and certainly contraindicates the use of spinal anaesthesia. An unresponsive apnoeic patient under spinal anaesthesia is a sign of neglected monitoring. A higher standard of care should be expected in a level 3 hospital.

Case study 6

A 22-year-old para 1, gravida 2, presented at 34 weeks at a level 3 hospital, with symptoms and signs of mitral stenosis, clearly documented in the preoperative clinical notes. Cardiotocography (CTG) demonstrated a "nonreactive" trace and she was immediately booked for an emergency Caesarean delivery. The anaesthetist documented the patient's breathlessness, yet still proceeded with spinal anaesthesia. Shortly after delivery and "with a well contracted uterus", the patient started "gasping" and became hypotensive, unresponsive to vasopressors and subsequently arrested. Resuscitation failed.

Comment

The reason why a pregnant mitral stenotic presents with dyspnoea at 30-34 weeks is invariably because she has exhausted her ability to increase cardiac output to match the demands of pregnancy and is in pulmonary oedema. Rather than performing a routine CTG, she should have been worked up in collaboration with the medical team and her cardiovascular status optimised. Irrespective of obstetric management, the choice of spinal anaesthesia by the anaesthetist was the cause of subsequent death. Any patient who is breathless at rest, which the anaesthetist documented, should receive general anaesthesia. The patient managed for the few minutes it took to deliver the baby, but then decompensated following delivery. Not having recognised the problem of mitral stenosis, in all likelihood, the anaesthetist administered a bolus dose of oxytocin (not documented), which proved to be the *coup de grâce*. There was no communication between the obstetric team and the anaesthetist. If the World Health Organization recommended preoperative procedures had been followed, this disaster would have been averted.

Intraoperative collapse

There were six cases, two associated primarily with substandard monitoring, one with an inappropriate choice or dose of drug, one with delayed recognition, one with inadequate resuscitation, and one with substandard preoperative assessment. Three of the cases also included excessive doses of oxytocin, although other drugs were also implicated.

Case study 7

An 18-year-old primigravid with pre-eclampsia presented at 34 weeks to a district hospital. She was kept on the antenatal ward for eight days and then booked for elective Caesarean delivery. Two attempts at spinal anaesthesia failed, so general anaesthesia was administered. The timing of events is not clear, but three things happened in close proximity. The baby was delivered in good condition, a second full dose of suxamethonium was given (no atropine) because of patient movement and two intravenous boluses of oxytocin 10 i.u. were administered. Although the report was of the ECG "suddenly going flat", the anaesthetic chart clearly documented a heart rate of 30 and an immediately subsequent haemoglobin saturation of 99%. Eventually, an output returned, but only after 30 minutes of resuscitation. She was then transferred to a regional hospital for ICU care, but convulsions commenced, hypoxic ischaemic encephalopathy was diagnosed and she died on day eight post-delivery.

Comment

The documented bradycardia with good haemoglobin saturation suggests reduction of cardiac output as a primary event, not subsequent to hypoxia. The likeliest cause of this collapse was a primary bradycardia caused by the second dose of suxamethonium, without prior administration of an anticholinergic such as glycopyrrolate or atropine. The

vasodilation caused by the large repeated doses of oxytocin would have contributed to the circulatory failure. Two opportunities to transfer her to a higher level of care were missed: first when she was admitted, and second, following the failure of spinal anaesthesia. District hospitals should not manage elective delivery of patients with pre-eclampsia.

Case study 8

A 31-year-old para 1, gravida 2, with a twin pregnancy, both in the breech position, was allowed to labour to full dilatation before going for emergency Caesarean delivery. Spinal anaesthesia was administered with hyperbaric bupivacaine 2.5ml. Both babies were delivered in good condition. The patient then collapsed, had a cardiac arrest and died. There was no documentation of either the anaesthetic or the attempts at resuscitation, if any. The only clue as to what happened was the record of a stat dose of oxytocin 20 i.u. being given.

Comment

The lack of documentation suggests serious governance issues in this hospital.

Pulmonary aspiration of gastric contents

There were two cases, both associated with conversion from inadequate spinal anaesthesia. Neither received sodium citrate.

Difficult or failed tracheal intubation

There were two cases, one associated with conversion to general anaesthesia because of failure to establish spinal anaesthesia, and the other with attempts to resuscitate a patient with cardiovascular collapse. The primary area of substandard care was inadequate preoperative assessment in the first (failure to perform an airway examination), and inappropriate choice or dose of drug in the second (3.5 ml 0.5% hyperbaric bupivacaine).

Comment

The first case occurred in a regional hospital and at least one of the doctors performing the resuscitation knew enough about the failed intubation algorithm to perform a cricothyrotomy. The second case was an unmitigated disaster in a district hospital. Not only did they administer a massive dose of spinal bupivacaine, but also to this day, they have not recognised the problem. Their resuscitative efforts were based upon a diagnosis of "bupivacaine allergy". No post-mortem examination was performed in either case and both reports were marred by woefully inadequate documentation.

Meningitis

An inappropriate method was used to conduct a chosen technique.

Case study 9

A 29-year-old para 2, gravida 3, with a history of two previous Caesarean deliveries was admitted to a district hospital in active labour. Following an allegedly uneventful Caesarean delivery under spinal anaesthesia, she was admitted to the post-delivery ward at 03h40. She was discovered unconscious by the nursing staff at 19h10. She was hypoglycaemic and pyrexial. Repeated convulsions commenced the next day. A lumbar puncture confirmed bacterial meningitis. She was referred for further ICU care at a level 3 hospital, where she was intubated on arrival. She died five days post-delivery.

Comment

The absence of an anaesthetic chart and records from the level 1 hospital made it impossible to provide an adequate anaesthetic assessment, but it must be assumed that there was a breach in aseptic technique during the delivery of the spinal anaesthetic. There are several reports in the literature of meningitis following spinal anaesthesia, when the bacterium responsible has been matched with the same organism cultured from the anaesthetist's nose. Onset of symptoms at 13 hours has been well documented, and one report as early as nine hours. This reinforces the requirement for full aseptic precautions when performing neuraxial blocks.

Equipment failure

Case study 10

A 22-year-old primigravid woman with a breech presentation presented in labour at a district hospital. Two attempts at spinal anaesthesia failed. A standard general anaesthetic sequence followed preoxygenation (although cricoid pressure was not documented). Following intubation, an "oxygen failure" occurred. Initially, time was wasted in recognising the problem and then trying to get a second anaesthetic machine into theatre. Eventually, a separate oxygen cylinder was brought in, but by then hypoxic cardiac arrest had occurred. Resuscitation was substandard and no attempt was made to deliver the baby. Both the mother and the baby died. Medical staff were subsequently informed that there had been a failure in the wall oxygen supply, following a lightning strike three days earlier.

Comment

This woman died of hypoxia, not through the lack of anaesthetic machine oxygen supply, but through failure of the "anaesthetist" to attach a self-inflating bag to the tracheal tube and hand ventilate the patient. Room air would have been sufficient to prevent death. The patient could have been allowed to awaken and then been re-anaesthetised once the problem had been sorted out. The above could have been avoided by checking the machine

cylinder oxygen supply before anaesthetic induction. There clearly were serious governance issues in this hospital, as the problem was known to management.

Postoperative collapse

There was one case, in which the primary area of substandard care was inadequate preoperative assessment.

Case study 11

A 22-year-old primigravid presented for emergency Caesarean section at a level 1 hospital with poor progress in the first stage and "foetal distress". There was no evidence of a full history and examination (by anybody) being performed although bilateral leg oedema (worse on the right) was documented. Repeatedly low haemoglobin saturation readings were documented during spinal anaesthesia, but were ascribed to a technical error. Further desaturation was again documented in recovery, with no action being taken, and she was discharged to the postnatal ward. Vomiting was documented as a problem and on examination of the chest, bilateral basal crepitations and a "mild wheeze" were heard. The only action taken was to sit the patient up, reduce fluids and administer "nebulisation" (no details were given). She had a cardiac arrest shortly thereafter, was initially successfully resuscitated, but then succumbed to a second cardiac arrest while on her way to the radiology department.

Comment

The cause of her death can only be speculated. It could have been associated with congestive cardiac failure and pulmonary oedema. The persistent desaturation makes a sudden event such as pulmonary embolism unlikely. The starting point of all medical school clinical curricula is instruction on how to examine a patient. Failure to examine a patient precludes successful diagnosis. Lack of a diagnosis precludes effective management of clinical problems.

General anaesthesia

Deaths associated with general anaesthesia comprised eight difficult or failed intubations, two due to pulmonary aspiration of gastric contents, two cases of intraoperative collapse and one case each of malignant hyperthermia, residual motor block, uncontrolled hypertension and unknown cause.

Vignettes and breakdown of principal areas of substandard care

Difficult or failed tracheal intubation

Of the eight cases, the primary area of substandard care was inadequate preoperative assessment in four cases. Lack of equipment or drugs, inappropriate method of conducting the chosen technique, inadequate or inappropriate

resuscitation and failure or delay in recognising the seminal event each accounted for the other four cases.

Case study 12

A 23-year-old para 1, gravida 2, who had had a previous Caesarean delivery, presented in labour with a big baby in a regional hospital. The decision was made for operative delivery. No ephedrine was available in the hospital, so the decision was made to proceed with general anaesthesia. Anaesthesia was induced with thiopentone, followed by suxamethonium. An endotracheal tube was passed. No capnometry was available. The first sign of a problem was progressive desaturation. The endotracheal tube was removed and initially replaced with a laryngeal mask airway, but manual ventilation was ineffective. At some point, assistance arrived and the patient was reintubated, but hypoxic cardiac arrest supervened and resuscitation was unsuccessful. The baby was delivered during resuscitation, but was in a poor condition (Apgar scores of 3 and 5) and death occurred within the hour. No monitoring data were entered on the anaesthetic chart and resuscitation notes were scanty.

Comment

This was so unnecessary. In the absence of ephedrine or phenylephrine, both of which, or their equivalents should be available in all hospitals with operative delivery units, adrenaline can be used to treat spinal hypotension in doses of 20-40 μg every minute until the pressure returns to baseline. However, it is not ideal as its effects are short-lived and it is arrhythmogenic. In the absence of capnometry, it is essential that thorough clinical checks are made to ensure that the tube is in the correct position, with auscultation of both axillae and the epigastrium, while hand-ventilating the patient. But the main question to be answered here is: what was a regional hospital doing without essential drugs and equipment? The absence of either vasopressors or a functional capnograph should have resulted in immediate closure of the obstetric unit as both are essential to safe practice.

Case study 13

A 24-year-old eclamptic primigravida, "semi-comatose" (Glasgow Coma Score of 9/15), with a swollen bitten tongue and thrombocytopenia, went into theatre in a level 3 hospital, after waiting several hours in a high care area for platelets. No preoperative anaesthetic assessment was conducted, and a specialist anaesthetist administered propofol and suxamethonium before discovering that the patient was (predictably) difficult to intubate. Attempts at intubation failed. No attempt was made to use a laryngeal mask airway. Surgical airway access was not attempted. Subsequent hypoxic cardiac arrest occurred and resuscitation failed. A fresh stillbirth was delivered during resuscitation attempts.

Comment

The available hours preoperatively waiting for platelets would have been better spent obtaining a secure airway and mechanically ventilating the patient. This case represents an extremely poor standard of care at a level 3 hospital and inappropriate management by a specialist anaesthetist.

Pulmonary aspiration of gastric contents

There were two cases. One was primarily substandard due to an inappropriate method of conducting the chosen technique and the other was due to inadequate resuscitation.

Case study 14

A 23-year-old was admitted to a district hospital for termination of pregnancy in the first trimester, followed by evacuation of the uterus. She returned after three days following discharge, complaining of lower abdominal pain with signs of generalised peritonitis. An ultrasound examination showed dilated loops of bowel with fluid levels and free fluid in the abdomen. A second evacuation was performed the next day, which confirmed a perforated uterus. Despite increasing abdominal distension and advice from a general surgeon, a nasogastric tube was never inserted. She was transferred to a level 3 hospital the same evening. She was booked for emergency laparotomy. On arrival in theatre, a nasogastric tube had still not been inserted and she was retching, with pronounced abdominal distension. The anaesthetic medical officer commenced anaesthesia without discussing the details of the case with his senior (who was busy elsewhere, but who could have been available to assist). Active vomiting of approximately one litre occurred during anaesthetic induction. She was turned on her side and immediately intubated, but approximately 100 ml of gastric contents were aspirated from her trachea. A nasogastric tube was then inserted and 1.5 l of gastrointestinal fluid drained. Desaturation was observed, but improved during the laparotomy to 97%. Because no ICU bed was available, neuromuscular blockade was reversed and she was extubated in the hope that she would be able to manage in a high care bed. Persistent desaturation ("33-87 %") was observed in recovery for approximately one hour before she was reintubated and mechanically ventilated. Haemoglobin saturation remained poor and she had a hypoxic cardiac arrest and did not recover.

Comment

Several opportunities to avert the outcome were missed. The second evacuation was inappropriate. There was sufficient clinical and ultrasound evidence to support the transfer of the patient earlier in the day, having inserted a nasogastric tube. The absence of a nasogastric tube on arrival at the level 3 centre should have been corrected before transfer to theatre. The third opportunity to insert the nasogastric tube (mandatory before anaesthesia in these circumstances) in the operating theatre before induction was not taken. Finally, the unavailability of an ICU bed should not have influenced the required standard of care, which in this instance was to maintain intubation and ventilation and to keep the patient in the operating theatre until an ICU bed became available in either the same or another hospital. The principal area of substandard anaesthetic care was an inappropriate method of conducting the chosen anaesthetic technique. Other noted areas of substandard care were inadequate resuscitation, inappropriate choice of drug, inadequate monitoring records and failure of postoperative care. The absence of an ICU bed should have been a peripheral concern in the correct management of the patient. (Wylie October 1951)

Intraoperative collapse

There were two cases, one that was associated with inadequate resuscitation and the other with inadequate preoperative assessment.

Case study 15

A 24-year-old primigravida (HIV-positive on highly active antiretroviral treatment) with severe pre-eclampsia presented to a regional hospital at 28 weeks, complaining of epigastric and chest pain, palpitations, shortness of breath and generalised oedema. An ECG was not obtained. The Pritchard regimen (magnesium sulphate 4 g intravenously plus 12 g intramuscularly) was administered twice in error. She also received methyldopa. Her haemoglobin was 16.7 g/dl, platelet count 7 000, serum urate 0.51 mmol/l, and her liver enzymes were elevated. H: haemolysis (the breakdown of red blood cells), EL: elevated liver enzymes, LP: low platelet count (HELLP) syndrome was diagnosed. Platelets and blood were ordered and theatre booked for hysterotomy. No sodium citrate was administered. Following preoxygenation, anaesthesia was induced and she was intubated. Early expired CO_2 values of "8 and 7" mmHg and haemoglobin saturation of 98-100% were documented. The anaesthetic recorded "cardiac output decreased post-induction, after five minutes pulse stopped and CPR commenced". Adrenaline 1 mg was administered as a bolus and an infusion commenced, and external cardiac massage initiated. A heart rate of 43 was obtained and CPR continued, but after another 10 minutes the pulse was impalpable and pupils were fixed and dilated. Intravenous fluids were administered rapidly and included hydroxyethyl starch, blood and platelets, but bleeding was not documented as an issue. Surgery never commenced. No post-mortem was requested.

Comment

No operation was performed, so a ruptured liver could not be excluded. Resuscitation was perfunctory, with no

delivery of the baby and the bolus dose of adrenaline was not repeated. Was performance influenced by her diagnosis of HIV?

Malignant hyperthermia

Case study 16

A 20-year-old para 0, gravida 1, presented at a level 3 hospital at 38 weeks with ruptured membranes in early labour. Grade 1 meconium stained liquor was seen and "foetal distress" diagnosed. Type 1 decelerations were evident on the CTG trace supplied. She was taken to theatre for emergency Caesarean section. General anaesthesia, for which there was no indication, was induced. Early cardiovascular instability occurred with "tachyarrhythmias" [up to 190 beats per minute (bpm)], and hypotension. End-tidal CO_2 was high and recorded as "out of range". Initially, this was ignored as "a machine error". After 30 minutes, the patient "felt warm to touch" and the isoflurane was turned off, but not a single temperature was recorded then or thereafter. A diagnosis of malignant hyperthermia was made and dantrolene was requested. None was available. An arterial blood gas and acid-base analysis showed a PCO_2 value of 112 mmHg. No attempt was made to cool the patient, either peripherally or centrally. No mention was made of hyperventilation to reduce the CO_2. She was given repeated doses of ephedrine, then an adrenaline infusion, in order to maintain a blood pressure. Resuscitation continued to ICU, where she immediately suffered a cardiac arrest and died.

Comment

The indications for emergency Caesarean section were not convincing. There was certainly no indication for general anaesthesia. Why was dantrolene not available in a level 3 hospital?

Residual motor block

Case study 17

A 111-kg 29-year-old para 0, gravida 1, with pre-eclampsia superimposed on renal disease, received magnesium sulphate and nifedipine at a regional hospital. Her urea was 16 mmol/l. She was taken to theatre for an emergency Caesarean section under general anaesthesia, during which she received 60 mg of the neuromuscular blocking agent, rocuronium. Neuromuscular blockade could not be reversed at the end of the procedure, despite several doses of neostigmine. Postoperatively, she was sent to the ward still intubated and mechanically ventilated. At some point, she developed localising neurological signs and was referred to a level 3 hospital for a computed tomography (CT) scan, where she arrived breathing spontaneously, but unconscious. She then had a cardiac arrest in the CT scan room and died. No details of any resuscitation attempts were documented. No post-mortem was performed.

Comment

Lack of details leads to a very confusing picture postoperatively and a firm diagnosis was never made. She remains as an "anaesthetic death" largely through default, because of the clearly inappropriate method of conducting the chosen anaesthetic technique. The duration of action of the rocuronium would be significantly prolonged by the renal failure and the magnesium sulphate. It is not entirely clear why general anaesthesia was chosen. Some anaesthetists maintain that regional anaesthesia is contraindicated with an increased urea because of the risk of spinal and epidural haematoma that is associated with uraemic coagulopathy, but there is little evidence to support this view. Even if general anaesthesia was a reasonable choice, the use of a large dose of rocuronium for intubation was not. Suxamethonium could have been used for intubation and spontaneous ventilation established when it wore off. This patient should have been managed at a level 3 hospital.

Uncontrolled hypertension

Case study 18

An ill-looking and disorientated 22-year-old primigravid eclamptic in obstructed labour was transferred to theatre in a district hospital. Her blood pressure was 173/132 mmHg and heart rate 112 bpm. No appropriate preoperative assessment was made and general anaesthesia was commenced without functional oximetry. Preoxygenation was not recorded nor was an attempt made to lower the blood pressure preoperatively or modify the haemodynamic response to intubation. A diastolic blood pressure of 151 mmHg was recorded post-intubation. Following delivery, the systolic blood pressure decreased dramatically to 130 and then 99 mmHg and the heart rate decreased from 120 to 56, then 49 bpm. No attempt was made to correct the hypotension until the systolic pressure was less than 90. Ephedrine, and subsequently adrenaline, were used to no effect. CPR was commenced when there was no detectable output, although the ECG showed a bradycardia. Resuscitation attempts were not fully recorded. "Patient's condition deteriorated and certified dead 1 hour and 15 minutes post-induction". No post-mortem was performed.

Comment

This patient probably had an intracranial event. She should never have been managed at a district hospital and should have been transferred directly to a level 3 facility.

Avoidable factors, missed opportunities and substandard care

Data in Tables VI-VIII were obtained from the assessments of the maternal deaths attributed to anaesthesia by the initial, non-anaesthesia assessors and entered into the MAMMAS

Table VI: Distribution of avoidable factors, missed opportunities and substandard care in anaesthesia-related deaths

Category	Assessable cases (n)	% of avoidable factors in assessable cases
Patient-orientated	**118**	**13.6**
Administrative factors	**116**	**62.1**
Healthworker-related emergency management problems		
Primary level	113	61.1
Secondary level	47	40.4
Tertiary level	48	27.1
Resuscitation	**104**	**63.6**

Table VII: Distribution of administrative-related avoidable factors, missed opportunities and substandard care

Description	Number	Percentage of assessable deaths
Lack of information	5	
No avoidable factor	44	37.9
Transport problem: home to institution	1	0.9
Transport problem: institution to institution	5	4.3
Lack of accessibility: barriers to entry	1	0.9
Lack of accessibility: other	1	0.9
Delay initiating critical care (overburdened service)	2	1.7
Lack of healthcare facilities: ICU	5	4.3
Lack of healthcare facilities: blood and blood products	2	1.7
Lack of healthcare facilities: other	2	1.7
Lack of appropriately trained staff: doctors	41	35.3
Lack of appropriately trained staff: nurses	8	6.9
Communication problems: technical	1	0.9
Communication problems: interpersonal	1	0.9
Other	16	13.8

ICU: intensive care unit

programme. As in the last report (2005-2007) healthworker-oriented problems (Table VI), lack of appropriately trained staff (Table VII) and substandard management by healthcare providers (Table VIII), are highlighted as the major causes of deaths due to anaesthesia.

However, Table VIII gives the impression that substandard management in association with a correct diagnosis is the major contributing area of substandard care among deaths due to anaesthesia, whereas the above vignettes and summaries are dominated by the failure of recognition of the primary anaesthetic problem. This discrepancy arises when the obstetric assessment concentrates on the primary obstetric diagnosis, leading to a requirement for anaesthesia and surgery. The only provision for anaesthesia in the MAMMAS system is whether or not it was considered to be the direct cause of death, and whether a general or spinal anaesthetic was used.

The anaesthetic assessment process enables examination of the records in terms of anaesthetic-related events and complications. When this is carried out, the importance of failure or delay in recognising the seminal event becomes apparent. Table IX lists the primary areas of substandard care (left-hand column) and examines the associated areas of substandard care that were considered to be contributory, but of lesser importance. Not only is failure of recognition dominant, but also many associated areas of substandard care are clustered with this primary issue. Additionally, the associated areas of substandard care in these cases are largely those associated with the safe practice of anaesthesia viz. preoperative assessment, monitoring of the patient, resuscitation abilities and performance and knowledge of pharmacology. However, one weakness of the system of assessment is that it does not examine causality coherently, thus these relationships are associations only.

The role of anaesthesia in deaths due to other causes

In these cases, death was due to another cause, e.g. haemorrhage or other co-existing morbidity, but an anaesthetic was administered and subsequently assessed by the PAA

Table VIII: Distribution of healthworker-related avoidable factors, missed opportunities and substandard care

Medical management problems	1-degree level		2-degree level		3-degree level	
	n	%	n	%	n	%
Initial assessment	5	4.4	1	2.1	3	6.3
Problem with recognition and diagnosis	30	26.5	5	10.6	4	8.3
Delay in referring the patient	6	5.3	2	4.3	0	0.0
Managed at inappropriate level	8	7.1	1	2.1	0	0.0
Incorrect management (incorrect diagnosis)	1	0.9	2	4.3	1	2.1
Substandard management (correct diagnosis)	37	32.7	11	23.4	8	16.7
Not monitored or infrequently monitored	8	7.1	4	8.5	2	4.2
Prolonged abnormal monitoring with no action taken	4	3.5	0	0.0	1	2.1
Assessable cases	113		47		48	

Table IX: Relationship between primary inadequacy of care and associated areas of substandard care in anaesthesia-related deaths

Primary inadequacy	No	Preop	Equip check	Mon perf	Mon rec	Recog-nition	Resusc	Drug	Postop	Equip or drug	No anaes	ICU bed	Method
Preoperatively	12			3	3	2	7	1	1				3
Equipment check	1					1	1						
Mon perf	8	4			5	4	5	3					
Mon rec	0												
Recognition	35	16		25	23		30	15	1	4	1	1	
Resusc	5	3		3	3			2	1			2	1
Drug	7	3		5	3	4	4					1	1
Postoperatively	1	1		1	1	1	1	1					
Equipment or drug	2	1		2		2	1						
No anaes	6	1		2	2	4	4	1					
ICU bed	0												
Method	8	5	1	4	5	3	5	3	1				
Unassessable	5												
Unknown	2												
Total	92	34	1	45	45	21	58	26	4	4	1	4	5

Drug: inappropriate choice or dose of drug, Equip check: equipment check, Equip or drug: lack of equipment or drugs, ICU bed: intensive care unit bed not available, Method: inappropriate method of conducting the chosen technique, Mon perf: substandard monitoring: not performed, Mon rec: substandard monitoring: not recorded, No anaes: no physician exclusively allocated to provide anaesthesia, Postop: failure in postoperative care, Preop: preoperatively, Recognition: failure or delay in recognising seminal event, Resuc: inadequate or inappropriate resuscitation

Table X: Summary of classes of associated deaths and technique of anaesthesia

	Anaesthesia technique															
	Total		General		Spinal		Epidural		Sedation		Unknown		Nil		Spinal to GA	
	2005 to 2007	2008 to 2010	2005 to 2007	2008 to 2010	2005 to 2007	2008 to 2010	2005 to 2007	2008 to 2010	2005 to 2007	2008 to 2010	2005 to 2007	2008 to 2010	2005 to 2007	2008 to 2010	2005 to 2007	2008 to 2010
Class 1		6		4		2										
Class 2	42	93	20	44	17	41				4	1	2			4	2
Class 3	84	70	35	34	42	29			3	2	2	5			2	
Class 4	95	89	66	59	27	25	3	2	2		4	2		1	4	
Unclassified	59	24		11		5						8				
Total	280	282	111	152	86	102	3	2	5	6	7	9	0	1	10	2

GA: general anaesthetic

as to the standard of anaesthetic care provided.

The death was classified as:
- *Class 1:* Directly due to anaesthesia (discussed above).
- *Class 2*: Due to another cause, but action or inaction by the anaesthetist contributed to the death.
- *Class 3*: Due to another cause, but substandard anaesthesia care was identified which did not contribute to the death.
- *Class 4*: Due to another cause and no substandard anaesthesia care identified.

Table X summarises "associated anaesthetic deaths". In the 2005-2007 report, all deaths that had been classified as Class 1 (deaths directly due to anaesthesia) were

moved to the direct anaesthetic deaths section. However, this results in "double counting" of maternal deaths, as those cases would also have been analysed in the section under which the obstetric assessor had placed the death [primary postpartum haemorrhage (PPH) and sepsis]. In this triennium, these deaths have been left in the associated section to avoid this problem. There were six such deaths identified, four associated with general anaesthesia and two with spinal anaesthesia.

The high proportion of deaths associated with general anaesthesia in these cases was noted in the previous report and ascribed to patient morbidity contraindicating regional anaesthesia. In the current report, this proportion is increased further and is likely to be due to the preponderance

Table XI: Deaths primarily due to other causes where anaesthesia care could be assessed

Province	Anaesthesia contributory (% of all anaesthetic reports)	Anaesthesia substandard, but not contributory (% of all anaesthetic reports)	Anaesthesia satisfactory, and not contributory (% of all anaesthetic reports)	Poor data (% of all anaesthetic reports)	Anaesthetic death misclassified (% of all anaesthetic reports)	Total anaesthetics assessed (% of all maternal deaths)	Total maternal deaths
Eastern Cape	2 (40%)	1 (20%)		2 (40%)		5 (0.70%)	710
Free State	9 (42%)	5 (24%)	7 (33%)			21 (4.88%)	430
Gauteng	3 (10%)	9 (32%)	4 (14%)	12 (43%)		28 (3.18%)	880
KwaZulu-Natal	52 (40%)	38 (29%)	34 (25%)	5 (4%)	2 (2%)	131 (11.60%)	1129
Limpopo	7 (53%)	2 (15%)	3 (23%)		1 (8%)	13 (2.11%)	616
Mpumalanga	8 (21%)	10 (26%)	13 (34%)	4 (11%)	3 (8%)	38 (9.67%)	393
North West	2 (33%)	1 (17%)	3 (50%)			6 (1.53%)	392
Northern Cape	1					1 (0.61%)	164
Western Cape	9 (23%)	4 (10%)	25 (64%)	1 (9%)		39 (15.48%)	252
Total	93	70	89	24	6	282 (5.68%)	4 966

Table XII: The types of anaesthetic error in deaths due to other causes (%)

		Associated areas of substandard anaesthesia care						
		Preop	Monitoring	Delay	Postop	Equip	ICU	SOA
Class 2	93	44%	43%	49.5%	56%	6.5%	3.2%	7.5%
Class 3	71	48%	48%	7%	26.8%	5.6%	7%	0%
Class 4	88	8%	0%	0%	4%	0%	12.5%	0%
Unclassifiable	24	0%	12.5%	0%	8.3%	0%	4	0%
All classes		27.3%	32.2%	18.1%	26.2%	1.8%	4.26%	2.5%
Total	276							

The total can be more than 100% as many anaesthetics had deficiencies in more than one area
This table is dominated by primary postpartum haemorrhage deaths
ICU: intensive care unit, Preop: Preoperatively, Postop: Postoperatively, SOA

of PPH deaths in these data, where general anaesthesia was appropriately used. The number of Class 4 deaths (those where the anaesthetic was judged to have been appropriately performed and the death completely due to other causes) has remained constant, at approximately one third of assessed cases. This suggests that anaesthetic performance has not improved over the last triennium.

There has been a significant reduction (50%) in the number of unclassifiable deaths, reflecting improvement in the reporting process. Nevertheless, there remains considerable room for further improvement. This is reflected by Table XI, which summarises the reporting process according to province.

It is known that many more assessments were conducted by PAAs. These assessments did not reach the national anaesthetic assessors for inclusion in this chapter. In some provinces, the anaesthetic assessment process is not taking place satisfactorily. This is either because the cases are not seen by an assessor, or because they are sent to the assessor with anaesthetic records that are inadequate

for valid assessment. We know that some of the KwaZulu-Natal cases were missing. It is likely that the figures for the Western Cape represent the closest to the true number of associated deaths that should have been reviewed, suggesting that nationally, the PAAs should be reporting on at least 750 cases.

Table XII addresses associated areas of substandard care and how they contributed to the various classes of anaesthetic deaths. The low percentages in the unclassifiable data reflect the lack of sufficient data in these reports for assessment, rather than good performance. The high percentage of cases where failure or delay in recognising a complication in Class 2 deaths, as opposed to Class 3 (seen in Table IX of the primary anaesthesia-related deaths), suggests that the standard of anaesthetic care could be significantly improved by concentrating on educating doctors about problem recognition.

The table also highlights postoperative care as a prominent contributing factor in both Class 2 and Class 3 deaths in contrast to primary anaesthetic-related deaths (Table IX).

Table XIII: Areas assessed for anaesthesia

Province	Antacid				Intravenous injection				Wedge				Preoxygenation				Cricoid			
	Y	N	U	N/A	Y	N	U	N/A	Y	N	U	N/A	Y	N	U	N/A	Y	N	U	N/A
Eastern Cape	0	3	2	0	3	0	2	0	0	0	5	0	0	0	4	1	0	0	4	1
Free State	3	15	1	2	18	0	3	0	2	4	8	7	3	1	5	12	2	2	5	12
Gauteng	0	5	21	2	18	0	10	0	0	5	20	3	2	0	19	7	2	1	18	7
KwaZulu-Natal	38	41	17	35	102	0	29	0	17	3	73	38	36	5	24	66	36	5	24	66
Limpopo	1	4	8	0	4	1	8	0	0	2	11	0	2	0	8	3	2	0	8	3
Mpumalanga	1	23	14	0	34	0	4	0	2	4	24	8	7	1	22	8	2	1	27	8
North West	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0
Northern Cape	1	2	2	1	5	0	1	0	0	2	3	1	0	0	4	2	1	0	3	2
Western Cape	19	3	11	6	30	0	9	0	14	0	12	13	16	1	7	15	17	0	8	15
Total	63	96	77	46	215	1	66	0	35	20	158	69	66	8	95	113	62	9	99	112

U = unknown, N/A: not applicable, N: no, Y: yes

Table XIV: The relationship between primary inadequacy of anaesthetic care and associated areas of substandard care, in deaths associated with deaths due to nonanaesthetic causes

Primary inadequacy	No	Associated areas of substandard care											
		Preop	Equip check	Mon perf	Mon rec	Recog-nition	Resusc	Drug	Postop	Equip/drug	No anaes	ICU bed	Method
Preoperatively	31		1	8	4	1	5	4	4			1	3
Equipment check	2				2					1			
Mon perf	8	1				1	1						
Mon rec	15	1							1	1			
Recognition	21	6		3	1		10	2	8	1			
Resuscitation	25	7	1	5	3	7			5	15		2	
Drug	10	3			1	3	4		3				
Postoperatively	35	18		6	7	7	12	8		2		1	1
Equipment or drug	4			1		1	2						
No anaes	7	4		4	1	7	4	5	2				1
ICU bed	3	2		1	1	1	1		1				
Method	8	2			2	3	5	2	2	1		1	
TOTAL	169	44	2	27	23	30	43	28	36	6		5	5

Drug: inappropriate choice or dose of drug, Equip check: equipment check, Equip or drug: lack of equipment or drugs, ICU bed: intensive care unit bed not available, Method: inappropriate method of conducting the chosen technique, Mon perf: substandard monitoring: not performed, Mon rec: substandard monitoring: not recorded, No anaes: no physician exclusively allocated to provide anaesthesia, Postop: failure in postoperative care, Preop: preoperatively, Recognition: failure or delay in recognising seminal event, Resuc: inadequate or inappropriate resuscitation

This is not surprising as postoperative care is never an issue in somebody who has died in theatre. Monitoring also needs to be addressed.

The increasing percentage of lack of ICU beds moving from Class 2 to Class 4 suggest that as standards of anaesthesia care improve, increased pressure will be placed on existing ICU facilities and this needs to be addressed in forward healthcare planning.

The quality of anaesthetic records was consistently poor in the case of deaths due to nonanaesthetic cases. One hundred and fifty-nine (59%) cases were not directly affected by substandard anaesthetic care. Therefore, any shortcoming in anaesthetic recordkeeping reflects a general standard, not one restricted to poor practitioners. This indicates that a poor grasp of the requirements for obstetric anaesthesia is endemic in South Africa and is not just associated with cases where anaesthesia contributed to deaths.

Currently, the anaesthetic assessment process only examines a few basic aspects that are essential to safe obstetric anaesthesia:

1. Was a nonparticulate antacid given before anaesthesia?
2. Was an intravenous infusion started before anaesthesia commenced?
3. Was the uterus displaced away from the midline during anaesthesia?

4. Was the patient preoxygenated before general anaesthesia?
5. Was cricoid pressure applied during intubation?

In the majority of assessed cases, the answer to these five questions was "unknown", because of poor documentation.

Table XIII documents the distribution of the answers to these questions among the provinces. In 236 cases where a nonparticulate antacid was indicated, it was only known to have been administered in 63 cases (27%). In the majority of cases (76%), an intravenous injection was documented to have been in place. Use of an obstetric wedge was only documented in 16%, preoxygenation for general anaesthesia in 40% and cricoid pressure in 36% of cases where these were indicated.

The blocks highlighted in yellow reveal documented known appropriate care that was vastly outnumbered by cases where the standard of care was undocumented. The cases where it was clearly documented that appropriate measures had not been implemented are more disturbing. The blocks highlighted in red in the Free State, Gauteng and Mpumalanga demonstrate documented substandard care to be more common than documented appropriate care. Even when an individual situation demands an alternative other than a standard procedure, this fact should be documented, e.g. "Patient comatose and intubated, antacid not indicated".

No information is available as to the cause of these failures in care. They could be because of lack of knowledge or diligence on the part of the anaesthetist, or lack of drugs and equipment. Irrespective of the cause, these figures represent a serious indictment of clinical governance. Either equipment should have been available or training instituted and diligence audited.

Standards of preoperative assessment and resuscitation should be improved. These areas are associated with multiple other shortcomings, suggesting a systemic failure of clinical governance.

Table XIV represents an attempt to reproduce the process in the associated direct deaths section. This confirms the conclusion (Table XII) that postoperative care is the predominant area of substandard care in the associated deaths.

Vignettes

Many of the deaths associated with anaesthesia were reviewed using only the anaesthetist's control sheet that was available, so clinical details were often unavailable.

Case study 1

A patient died suddenly two hours after being received in the ward post Caesarean section under general anaesthesia. The nursing notes in recovery read: "Patient recovered from anaesthesia. No major complications encountered in the recovery room. See anaesthetic chart for postoperative vital signs". A saturation of 100% and a respiratory rate of 20 were recorded. Anaesthetic records documented deterioration over 40 minutes to a saturation of 90% and a respiratory rate of 32. The blood pressure reached 195/63 and the heart rate 144. No action seems to have been taken on these readings, and no note is made of supplemental oxygen being administered. No request for special care in the ward was made. A single blood pressure was recorded in the ward of 176/108. A doctor was called to manage hypertension and ordered pethidine 100 mg intramuscular injection, Cefoxitin 1g intravenous injection, indomethacin 100 mg PR, Coversyl 4 mg p.o. and hydrochlorothiazide 25 mg p.o. All drugs appear to have been administered simultaneously. Twenty minutes later, the patient was found to be apnoeic.

Comment

What would be regarded as a "major complication" in this unit?

Case study 2

A level 1 hospital returned detailed notes to the confidential enquiry process. However, despite the inclusion of large numbers of pages, many of them completely blank, two vital pieces of the patient record were absent: the nursing recovery room record and the first night's observation charts. Enquiries to the hospital were unsuccessful in obtaining these notes.

Comment

This could be explained by the notes having been lost. Alternatively, they might have been removed because they were never completed and the death was associated with this negligence. Or these documents were completed and reflected so badly on the care given that they were removed in an attempt to avoid the consequences. Any of these explanations represents a failure of governance within the hospital.

A number of instances of possible note-tampering were observed in records supplied with mortality reports, both with deaths directly associated with anaesthesia, and those associated with deaths due to other causes.

In the private practice arena, the main problem lies in getting any useful information at all. Four of the associated deaths and one of the anaesthetic deaths occurred within private hospitals. Detailed reams of billing information were received

from the private hospitals, but no satisfactory accounts of the care given to the patients. The clinical governance of these hospitals needs to match their financial governance.

Instances of early abandonment of resuscitation in desperately ill patients were also seen.

Case Study 3

At a level 2 hospital, a patient with acquired immune deficiency syndrome (AIDS) presented after a self-induced abortion at home. She arrived with a haemoglobin concentration of 5 g %, a platelet count of 16 000 and delirium. Very little care was provided beyond a small dose of a sedative during evacuation of the uterus. She died later in the ward.

Case Study 4

This is in contrast to a similar case, in another hospital, where a moribund patient with AIDS was taken for a pre-terminal Caesarean section to save her baby. A full anaesthetic evaluation was performed, the patient was appropriately anaesthetised and returned to the ward for palliative care, in a better condition than when she arrived in theatre.

Discussion

Firstly, these deaths occurred against the background of over 581 000 Caesarean deliveries in provincial hospitals and an undocumented number of additional surgical procedures associated with pregnancy or delivery, and incidental operations during pregnancy, plus operative deliveries in private hospitals. When drawing conclusions, it is not known whether the 121 reported deaths represent an isolated subset against a background of appropriate care, or if they are the "tip of an iceberg", representing the detectable instances of extremely substandard care on layers of progressively less severe substandard care. The worst case scenario is that there is no iceberg and that substandard care is systemic throughout the country, with the inherent safety of modern anaesthetic drugs and techniques being such that the survivors represent the product of good luck, rather than good management.

As reports are not generated by survival, but by death, the only clues we have to answer this question are from the assessment of the standard of care provided to mothers who died from nonanaesthetic causes. Thus, it is disappointing to have received so few "associated death" reports from the NCCEMD collection system. The few (282) cases received are not randomly selected. They are dominated by reports from KwaZulu-Natal (131) and deaths due to PPH (118). They cannot be taken as representative. However, it is still disturbing to find that in the latest triennium, more of these deaths were associated with substandard anaesthetic care than were not.

Secondly, with improvements in the assessment process, we have been able to establish a clearer idea of the relationship between areas of substandard care and the events leading up to the death. In anaesthesia, we are not so interested in the final cause of death in terms of organ pathology, but rather in the sequence of events that lead to the final cause and in particular, the seminal event, i.e. the first opportunity for an intervention that when missed ultimately leads to disaster.

Although inadequate or inappropriate resuscitation is the most commonly observed area of substandard care (in 57 cases), it was the primary area of substandard care in only three cases. This is not to say that resuscitation is unimportant (several cases might have survived had resuscitation been adequate), but that a more useful intervention might have been to correct the primary area of substandard care in 54 cases and obviate the need for resuscitation entirely. The most common primary cause of substandard care was failure or delay in recognising the seminal event.

This begs the question of why the seminal event went unrecognised. The answer to this must lie in either the standard of monitoring, i.e. performed inadequately or not at all, or in the failure to recognise the implications of a change in monitored variables, i.e. failure of knowledge and training.

Monitoring

The advent of automatic monitoring technology, with clear visual displays and built-in alarm systems, has generally been an advance. More physiological variables can be obtained and displayed more rapidly that can be achieved manually, and additional information such as oximetry and capnometry, which would not otherwise be obtained. However, successful application of the technology requires the ability to integrate the displayed information into recognisable patterns and to take appropriate corrective action. This is not going to happen if the displayed values are not firstly observed, and then documented on the anaesthetic chart. Long before the availability of electronic monitoring, significant reduction in anaesthesia-related mortality was achieved simply by systematic documentation of pulse rate and blood pressure.

Sufficient knowledge of the monitoring systems is required to recognise when they are not working correctly and why they are not. Common examples here would include failure of a blood pressure monitor to cycle with persistent display of the same reading and of failure of the monitor to produce readings because the patient's blood pressure has moved outside the monitor's detection range. Any difficulty experienced with electronic monitoring should immediately direct attention to the patient's clinical condition before

the monitor's failure is addressed. Electronic monitors are confined to isolated aspects of the patient's physiology, not the patient as a whole. Left to themselves, electronic monitors will faithfully monitor the patient to death. The anaesthetists' role is to integrate the information monitors provide with his or her close clinical observation of the patient and the progress of surgery. In the case of spinal anaesthesia, this would include paying close attention to the patient's state of alertness, pattern of respiration, muscular movements and any complaints of nausea, dizziness or difficulty breathing. In the case of general anaesthesia, this would include checking the patient's pulse, ensuring the chest wall is moving with ventilation and examining the colour of the patient's mucous membranes, before proceeding to check the ventilator and circuit connections and machine settings.

Contemporaneous documentation is important, but not to the detriment of patient observation. The "faithful scribe" carefully documenting every value displayed by the electronic device, without taking appropriate action, provides the human equivalent of "monitoring the patient to death".

Knowledge and training

At its most basic level, this requires teaching the ability to recognise any change in the monitored variables that indicate an abnormal pattern, and the ability to take immediate appropriate action, including notification of the theatre team and directing available resources to help address the problem. However, choice of the most appropriate action requires the ability to integrate observation of such change with the clinical condition of the patient and the progress of anaesthesia and surgery. Failure of the first step results in the lack of recognition of early warning signs, leading to intervention only at the stage of complete collapse. But it is failure of integration of observations of monitored values with clinical changes that is frequently missing in many of these cases and results in misdiagnosis and inappropriate action.

The ability to integrate all the information from monitoring systems, the patient, the operating team and the theatre environment, and then embark upon an appropriate course of action, is a complex decision-making process that depends upon pattern recognition and retrieval of information from prior learning. Mostly this information comes from memory of similar events and is highly dependent on previous experience. This experience is lacking in medical officers in district hospitals, the majority of whom are inexperienced community service officers, or foreign graduates who have no or limited experience of anaesthesia.

There has been no obvious impact of the change in internship training in anaesthesia from two weeks to two months. This

could be because of any of a number of reasons, including:

1. The internship training programmes are not being structured with the specific aim of competency.
2. The requirements for internship training are not being observed.
3. The interns are being sent to hospitals that are unsuited to training.
4. Two months represents inadequate time to achieve the goals of training.

There have been instances of allocation of interns to inappropriate clinical duties during their anaesthetic block (for example being allocated to outpatient duties on some days and performing out-of-hours duties in other specialties), and inappropriate allocation to district level hospitals, with no qualified anaesthetist to supervise them. However, there is no way of determining whether these factors are influencing anaesthetic-related mortality. Figure V shows that, with the exception of the Free State and the Western Cape, anaesthetic case-related mortality for Caesarean sections has remained the same or increased. Without data relating to the internship training of medical officers providing anaesthetic care in the different provinces, it is impossible to identify specific shortcomings.

The likeliest explanation is that two months of internship training in anaesthesia is inadequate to provide the level of knowledge and training, and the ability to apply that knowledge to independent anaesthetic practice at district level. Anaesthesia training begins at postgraduate level. Given the few weeks allocated to anaesthesia in undergraduate training, it seems inappropriate to allocate only two months to anaesthesia.

Increasing the length of internship training alone will not correct the deficiencies observed in both the deaths directly associated with anaesthesia, and those where anaesthesia played a role in deaths due to other causes. The quality of training must also improve and include measures to enhance the interns' abilities to problem-solve. Internship training must be under the direct supervision of a qualified anaesthetist, or one who has been in three years full-time anaesthetic practice, as stated in the HPCSA regulations for intern training. The regulations also state the need to develop a level of competency, yet state that the completion of the two months training does not qualify the intern for unsupervised practice. This implies that provision of anaesthesia at community service officer level should continue to be supervised, presumably until a sufficient level of competency is achieved.

Even if training were sufficient to the requirements of a district hospital staffed predominantly with inexperienced general medical officers, this will only prove effective if the cases presented are those that are appropriate to management at district level and the facilities provided are appropriate to

needs. These needs include appropriate staffing, in terms of both number of posts and an appropriate level of training, drugs and equipment, all of which lie within the purlieu of management and administration. Failure in these areas of need represents failure of governance.

Governance

One of the disturbing elements within the cases reviewed was inadequate governance. This was not initially sought and it is not part of the anaesthetic assessment process, but it was an issue that emerged before the cases underwent anaesthetic review. Table VII demonstrates that there were 86 instances of administrative-related avoidable factors, missed opportunities and substandard care in 77 cases, where such an instance could be identified in the 121 deaths entered in MAMMAS being due to anaesthesia, without data from anaesthetic assessment. Forty-one (57%) of these instances were identified as a consequence of inadequately trained staff.

Of the 92 deaths assessed by anaesthetists as being directly due to anaesthesia, 48 (52%) were associated with governance issues, ranging from failure to complete records, the practice of leaving a nurse to monitor the anaesthetic while the doctor performed or assisted with the surgery, and unavailability of drugs and functional equipment. The cases where the doctors who provided anaesthesia were clearly delivering substandard care were not included, but it could be argued that this too is a governance issue. While it is not the responsibility of management to train doctors in anaesthesia, ensuring that doctors who are expected to provide anaesthesia are adequately trained is the responsibility of management.

Similarly, for example:

1. Management might not be responsible for the failure of drug supply, but it is their responsibility to safeguard against its occurrence, provide policies for its prevention and ensure protocols are developed for the use of alternatives.
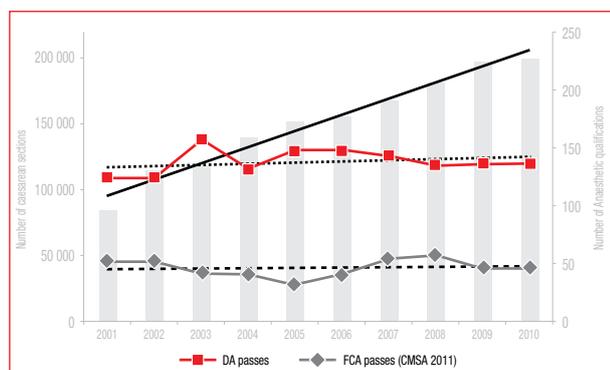2. Management is not directly responsible for equipment

failure, but is responsible for ensuring appropriate maintenance and replacement schedules.

3. Management cannot be held directly responsible for individual doctors failing to adequately document a procedure, but it is responsible for systems of audit and quality control that will detect such failure and prevent its recurrence.
4. Management cannot be responsible for storm-damage to buildings, but it is responsible for expediting inspection and repair and communicating to staff the implications of such damage. If this is not done, management should share responsibility for subsequent mishaps.
5. Occasionally, a patient will present to a hospital with a condition that is inappropriate for management at that hospital's level of care, but demands immediate treatment. It is management's responsibility to establish clear admission and referral policies to ensure that this does not become more than an isolated occurrence.

Recent years have seen the implementation of elaborate management structures in provincial hospitals. However, these structures have yet to deliver substantive improvements in the quality of governance. In the past, the traditional medical superintendent in a district hospital provided a clinical role model for inexperienced doctors and provided training in addition to his or her administrative duties. Perhaps this is a system that should be revisited in district hospitals, with the "business management" style introduced at regional level and above.

Staffing issues should perhaps be managed at regional level, where a clearer picture of referral patterns can be seen. Bold decisions, such as the temporary suspension of operative services in the face of inadequate staffing, will sometimes have to be made. This would pose less of a threat the community than the unacceptable risk of a single doctor performing both anaesthesia and surgery.

No management system would be able to overcome the current shortage of doctors in South Africa. This shortage is particularly acute in anaesthesia. Figure 7 takes the Caesarean section data from Figure 4 and plots them against the Diploma (DA) and Fellowship (FCA) passes from the College of Anaesthesiologists. Numbers of candidates passing these examinations have remained fairly constant over the past decade, which has seen Caesarean sections in provincial hospitals more than double in number. This not only limits the number of anaesthetists available to provide care in provincial hospitals at all levels, but also restricts our ability to train more anaesthetists and provide good quality, competence-directed training at internship level.

Figure 7: Showing increasing numbers of Caesarean sections in provincial hospitals in relation to the number of successful Diploma and Fellowship passes, 2001-2010

The long-term solution lies in increasing the number of medical graduates and incorporating those that we have into the provincial service. Existing medical schools are already stretched and have a limited capacity to increase

their student intakes. Consideration should be given to creating new medical schools.

In the short term, we will have to manage with current graduate output and doctors recruited from overseas. In both cases, provision for training in anaesthesia, particularly obstetric anaesthesia, will have to be made before unsupervised practice in provincial hospitals can be permitted. Currently, the compulsory two months anaesthetic internship for local graduates is insufficient, and there are no requirements for assessment or training of foreign graduates in anaesthesia.

Conclusion

1. There is no iceberg. What evidence we have suggests that substandard anaesthesia care is widespread, associated predominantly with inexperienced doctors practising in district hospitals. Unless this is addressed, anaesthetic-related obstetric mortality will continue to increase as the numbers of operative deliveries increase.

2. The problem is only vulnerable to short-term intervention via the internship training programme, the duration of which needs to be increased and its content and structure moulded to a competency-based programme. This will require collaboration between the College of Anaesthesiologists, University Departments and the HPCSA. Long-term correction will depend upon increased numbers of medical graduates and recruitment into postgraduate training programmes at the DA and FCA levels, or their equivalent.

3. The problem of anaesthetic-related mortality is being exacerbated by poor healthcare governance within the provincial administrative system, leading to the failure of the supply of essential drugs and poor maintenance and replacement of equipment, as well as inadequacies of staffing, both in numbers and competency of doctors expected to provide obstetric anaesthesia.

4. The limitations of the data obtained during the current triennial review can be reduced by further improvement of the anaesthesia assessment process. With additional funding and resources, the review process could be extended towards a Confidential Enquiry into Perioperative Deaths, along similar lines to that of the UK. This would be justified by the evidence that substandard anaesthesia care is widespread throughout South Africa. It is unlikely that this is confined to obstetric anaesthesia alone.

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