Inequities in resources and preparedness for surgical complications of caesarean section in southern Gauteng hospitals

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Background. The number of maternal deaths from bleeding during and after caesarean section (BDACS) has increased in South Africa. Health-worker training and health-system strengthening are considered important prerequisites for improving maternal health outcomes.
Objectives. To determine preparedness for, and health-system constraints to, safe caesarean section in southern Gauteng hospitals.
Methods. This was a cross-sectional study in 15 hospitals. Data were collected by questionnaire from clinical heads of department in each hospital.
Results. The 15 hospitals included 5 district hospitals, 7 regional hospitals and 3 central (university academic) hospitals. The number of deliveries per hospital ranged from 893 to 44 256 for 2013 - 2014, with a total of 201 314 births and 70 095 caesarean sections (34.8%). Despite similar numbers of births, there were 20 deaths from BDACS at regional hospitals and 6 at central hospitals (p=0.008). Service delivery constraints included an unequal staff distribution between central hospitals and lower levels of care, as well as non-availability of essential drugs and a lack of surgical capacity to arrest severe haemorrhage at district and regional hospitals.
Conclusion. The findings of this study reflect inequity in maternity services. Compared with central academic hospitals, district and regional hospitals are inadequately prepared for the management of complications from BDACS.

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The number of maternal deaths in South Africa (SA) from bleeding during and after caesarean section (BDACS) has increased in the last triennium (2011 - 2013), and over 70% of the deaths were found to be clearly avoidable.[1] A majority of maternal deaths in SA occur in regional and district hospitals.[2] The National Committee on Confidential Enquiries into Maternal Deaths has recommended improvements in healthcare systems and healthcare workers' skills to improve the safety of maternity units and the ability to manage obstetric emergencies.[2] For improving caesarean safety, a stepwise approach is suggested for the management of BDACS in the SA *Saving Mothers: Caesarean Section Monograph*,[3] which includes the use of uterotonics, and surgical techniques to arrest haemorrhage.

Clinical audit is used for monitoring and reporting on health outcomes and process of care. Audit permits the review of adverse events, such as near-misses (women who survived life-threatening complications of pregnancy and childbirth) and maternal mortality, to review and improve quality of care. Clinical audits are based on a commitment to improve the healthcare system.[4]

A health system is made up of staff, funding, supplies, transport, communications, and leadership.[5] There are various models for health-system frameworks. The World Health Organization (WHO)'s health-system framework has six key components which include governance, financing, medical technologies, health workforce, information and research, and service delivery.[6] Oliviera-Cruz *et al.*[7] described health-system constraints to improving access to priority healthcare. The service delivery constraints include shortage and distribution of appropriately qualified staff, weak management and supervision, inadequate drugs and medical supplies, and lack of equipment and infrastructure.

Health-system strengthening is a prerequisite to achieving any improvement in health outcomes. It has been shown that focusing on disease priorities without improving health systems does not improve overall outcomes,[8] hence the prioritisation of healthcare system improvements, as well as health-worker training, by the National Committee on Confidential Enquiries into Maternal Deaths.[2]

The aim of this study was to evaluate preparedness for, and health system constraints to, provision of safe caesarean section in hospitals in southern Gauteng, and to link these to hospital levels of care.

Methods

A prospective cross-sectional multicentre study was conducted in southern Gauteng, in 15 public hospitals from July 2014 to May 2015. Gauteng Province consists of Johannesburg, Pretoria and numerous surrounding towns and cities, and has the highest number of deliveries in SA per year (annual facility live births in 2013, n=208 710).[1] Southern Gauteng is a metropolis with four districts, Ekurhuleni, Johannesburg, Sedibeng and West Rand. The districts are served by 18 government hospitals with maternity units, and with the exception of one of these (Tembisa Hospital) form part of the University of the Witwatersrand cluster of hospitals, including 3 central hospitals (all teaching hospitals in Johannesburg itself), 7 regional hospitals, and 7 district hospitals. All but 2 of the district hospitals, and all the regional hospitals, serve towns and adjacent high-density settlements to the east, west and south of Johannesburg. All hospitals receive high-risk patients who cannot be managed by clinics and midwife obstetric units. District hospital maternity units are staffed by midwives and medical officers, and may employ part-time specialists. They conduct normal and assisted deliveries, and caesarean sections, and refer patients they cannot manage to higher-level hospitals. Regional hospitals offer specialist maternity care and referral services for district hospitals. They employ specialists,

medical officers and interns, and generally have intensive care and high-care units on site. Certain patients, when a difficult birth is expected, may be referred to central hospitals. Central hospitals provide specialist obstetric care and subspecialty care. Their staffing is made up of interns, medical officers, registrars, specialists and subspecialists. Academic programmes for medical students, registrars and subspecialist trainees take place in the central hospitals. One of the central hospitals, officially considered to be a regional hospital by the Department of Health, is defined as a central hospital in this study, as it is an academic tertiary referral hospital with a large complement of specialists, and part of the University of the Witwatersrand's training platform for medical students and registrars.

Ethical approval

Ethical and institutional approval for the study was obtained from the University of the Witwatersrand's Human Research Ethics Committee, and from the Gauteng Department of Health. Individual hospital permission was received from the chief executive officers of the 17 University of the Witwatersrand cluster hospitals.

Interviews – data collection

In July and August 2014, the researcher conducted interviews with the clinical head of obstetrics in each hospital, using a structured questionnaire. The interviews set out to determine staffing, supervision and preparedness for surgical complications at caesarean section in southern Gauteng. The researcher asked questions about whether the hospitals were appropriately staffed for the number of deliveries conducted. The number of staff members was calculated according to the number of full-time staff members on the monthly current obstetric department timetable. Supervision was divided into teaching and monitoring. Teaching was assessed by determining the teaching methods in each hospital, and the number of caesarean sections done under supervision.

Monitoring was assessed according to whether maternal deaths, adverse events and maternal near-misses were discussed routinely in each hospital. Preparedness was assessed by the availability of drugs, facilities and surgical skills. Drugs were evaluated by availability in the hospital, and whether the drugs were being used according to the clinical head's knowledge. Facilities were evaluated by the availability of a blood bank, postoperative recovery area, obstetric high-care unit, and an intensive care unit (ICU) on site.

Skills were evaluated according to the competence of the doctors in surgical procedures at each hospital. The clinical heads were familiar with their doctors' skills levels and which surgical procedures were performed in each hospital. The interview inquired about the availability of staff that could perform life-saving procedures related to BDACS, such as obstetric hysterectomy and B-Lynch compression suture 24 hours a day on 7 days per week.

Data analysis employed quantitative techniques. Maternal mortality ratio was calculated per hospital as the institutional maternal mortality ratio (iMMR). In the absence of live birth data, the denominator used for the iMMR was a live birth approximation of 0.98 times the total births, assuming a general SA stillbirth rate of 2%. Descriptive data were analysed using medians and ranges for continuous variables, and proportions with percentages or rates for categorical variables. Comparisons of categorical data were made using the χ^2 test, and pairwise correlation was done using scatter plots with Spearman's rank correlation for non-parametric data. Statistical significance was indicated by $p<0.05$.

Results

The study was conducted in 15 hospitals: 5 district hospitals, 7 regional hospitals and 3 central hospitals. Permission was sought from 17 hospitals, but 2 district hospital managers declined participation. In 2 hospitals the interviews were conducted with a specialist appointed by the clinical head. Four clinical heads asked to complete the questionnaire themselves, and return it to the researcher. In 11 of the hospitals the researcher was referred to the midwife in charge of the labour ward for questions about the nursing staff. The questionnaires were completed on the day of the interview. The researcher collected maternity statistics for 2013 and 2014 from the midwife in charge of the labour ward in 7 hospitals, from data capturers in 5 hospitals, and from the clinical heads in 3 hospitals. The statistics for 2014 were collected from February to April 2015.

In the 15 hospitals there were 201 314 births in 2013 and 2014, with 70 095 caesarean sections (34.8%). The total number of births at each of the hospitals

Table 1. Full-time staffing and obstetric outcomes in 15 hospitals in southern Gauteng, 2013 - 2014, by levels of care

	District (*N*=5)	Regional (*N*=7)	Central (*N*=3)
Aggregated data per level of care			
Total births, *n*	25 254	89 243	86 678
Maternal deaths, *n*	10	186	114
iMMR per 100 000 live births	40	213	134
Caesarean sections, *n*	5 919	30 833	33 343
Hospital caesarean section rate, %	23.4	34.5	38.5
Maternal deaths from BDACS, *n*	0	20	6
Obstetric specialists, *n*	1	12	51
All doctors, *n**	16	105	188
Doctors, *n*/10 000 births per annum	9.9†	23.5	43.4
Specialists, *n*/10 000 births per annum	0.0†	2.7	11.8
Hospital data, median (range)			
Midwives	18 (12 - 29)	28 (12 - 39)	55 (44 - 204)
Medical interns	0 (0 - 0)	5 (2 - 7)	21 (17 - 25)
Medical officers	3 (2 - 4)	10 (3 - 10)	5 (2 - 10)
Registrars	0 (0 - 0)	0 (0 - 2)	17 (13 - 27)
Obstetric specialists	0 (0 - 1)	1 (1 - 4)	12 (11 - 28)
All doctors	3 (2 - 5)	16 (8 - 20)	52 (46 - 90)
Hospital caesarean section rate	25.6 (16.2 - 36.2)	36.6 (25.3 - 42.4)	37.0 (33.3 - 48.5)
iMMR per 100 000 live births	43 (0 - 62)	204 (77 - 350)	136 (47 - 240)

* Doctors listed are those allocated to obstetrics and gynaecology sections or departments in their hospitals.

† *N*=4, excludes data for one district hospital that opened in April 2014.

ranged from 893 to 44 256, with a median of 9 063. Caesarean section rates ranged from 16.2% at a district hospital to 48.5% at a central hospital (Table 1). The overall maternal mortality ratio was highest at regional hospitals (213 per 100 000 live births) (Table 1). While the number of total births at regional and central hospitals was similar, BDACS accounted for 20 maternal deaths at regional hospitals and 6 at central hospitals (p=0.008). The number of obstetric doctors per 10 000 births was 9.9 at district hospitals, 23.7 at regional hospitals and 43.4 at central hospitals. The corresponding numbers for obstetric specialists were 2.7 and 11.8 for regional and central hospitals, respectively. However, the proportion of obstetric doctors per 10 000 births at the 15 hospitals did not correlate significantly with the hospital maternal mortality ratios (p=0.68) (Fig. 1).

Ten hospitals (66.7%) trained interns, and 4 hospitals (26.7%) trained registrars. Eleven hospitals (73.3%) had at least one full-time specialist (range 1 - 28). The total number of doctors ranged from 2 in a district hospital with 4 654 births to 97 in the tertiary hospital that had 44 256 deliveries in 2013 and 2014.

The skill of teaching caesarean section technique was reserved for the most senior doctors in each hospital. All hospitals taught by observation and supervision, 6 hospitals (40.0%) also used videos, and none used models. Three hospitals (20.0%) stipulated a minimum number of caesarean sections that a new doctor had to perform under supervision prior to operating independently. All the hospitals held regular perinatal review meetings, at which maternal deaths were discussed. The 3 central hospitals, as well as 2 regional hospitals, held weekly meetings, and the remaining hospitals held monthly meetings. Nine hospitals (60.0%) reported that they also presented maternal adverse events in their meetings. Three hospitals (20.0%) discussed all maternal near-miss cases from BDACS at the meetings. Collaboration between hospitals, beyond referral, was limited to occasional attendance by regional and district hospital specialists at central hospital perinatal review meetings. There were no outreach programmes (e.g. specialist support visits) in place from higher levels to lower levels of care.

Oxytocin and misoprostol were available in all 15 hospitals. Ergometrine was only available in 10 hospitals (66.7%) and prostagladin F2-alpha was available in 5 hospitals (33.3%). Tranexamic acid injection was available in 13 hospitals (86.7%); however, only 2 of these hospitals (15.4%) reported ever using it for obstetric patients. The central hospitals had all the uterotonic drugs available. Prostaglandin F2-alpha was only available in 1 district hospital, and 1 regional hospital. Only 4 of the 7 regional hospitals (57.1%) had ergometrine in stock (Table 2).

All the hospitals performed caesarean sections; however, 2 (13.3%) did not operate on all days of the week because of staffing shortages. On-site blood banks functioned in 9 hospitals (60.0%), and the rest, including all the district hospitals, relied on emergency blood kept in refrigerators on site. One district hospital had an obstetric high-care unit. One central hospital did not have an ICU on site (Table 2).

Emergency skills to arrest obstetric haemorrhage were evaluated according to whether the staff were available on a 24-hour basis to perform these procedures in each hospital. Uterine balloon tamponade (Bakri balloon or condom balloons) had never been done in 12 hospitals (80.0%), and B-Lynch compression sutures had never been done in 6 hospitals (40.0%). None of the informants could recall ever performing a uterine tourniquet procedure using a Foley catheter at their hospitals. In two of the hospitals (13.3%), the informants stated that

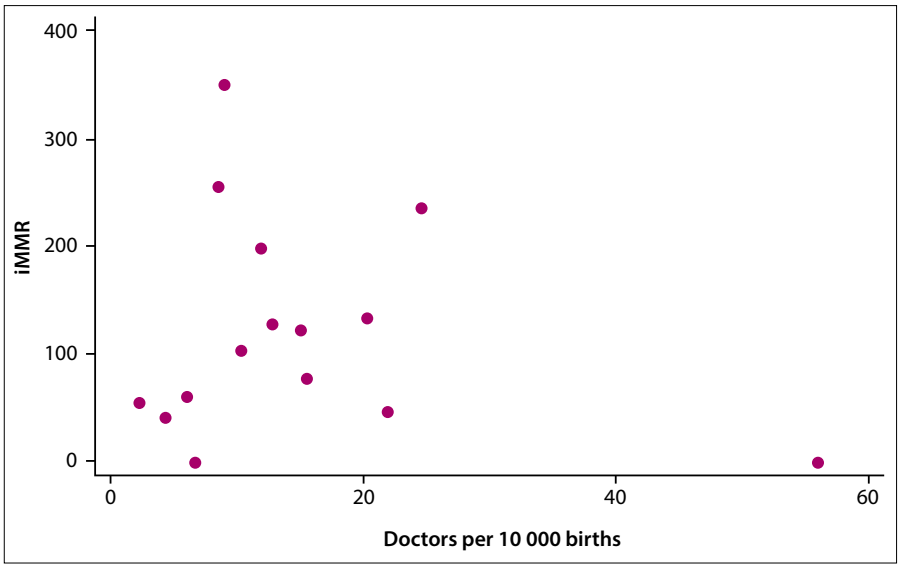

Fig. 1. Scatter plot showing institutional maternal mortality ratio per 100 000 live births (iMMR) for 15 southern Gauteng hospitals correlated to numbers of doctors as a proportion of births at each hospital (Spearman's correlation coefficient r=*0.12,* p=*0.68).*

Table 2. Preparedness for life-threatening surgical complications of caesarean section in hospitals in southern Gauteng

	District (*N*=5), *n* (%)	Regional (*N*=7), *n* (%)	Central (*N*=3), *n* (%)
Available drugs			
Oxytocin and misoprostol	5 (100)	7 (100)	3 (100)
Ergometrine	4 (80)	4 (57.1)	3 (100)
Tranexamic acid injection	3 (60)	7 (100)	3 (100)
Prostaglandin F2-alpha	1 (20)	1 (14.3)	3 (100)
Ability to perform procedures			
B-Lynch compression suture	3 (60)	3 (42.8)	3 (100)
Obstetric hysterectomy	3 (60)	7 (100)	3 (100)
On-site facilities			
Blood bank	0	6 (85.7)	3 (100)
High-care unit	1 (20)	7 (100)	3 (100)
24-hour recovery	2 (40)	5 (71.4)	3 (100)
24-hour theatre	4 (80)	6 (85.7)	3 (100)

none of the doctors was skilled to perform emergency hysterectomy during and after caesarean section (Table 2).

Discussion

A clear message has emerged of inequities in Gauteng maternity services. These inequities, mostly between regional hospitals and teaching centres, are unfortunate, given the relative sophistication of Gauteng Province in SA, with its medical schools and high-level central hospitals. As in the remainder of the country, the majority of maternal deaths occurred in district and regional hospitals, where medical staffing and facilities are most lacking. The relationship between overall maternal mortality and staffing levels per hospital is complex, and did not show any correlation, but there was a significant difference in numbers of maternal deaths related to BDACS between regional and central hospitals, with similar caesarean section rates. Observing overall maternal mortality ratios alone may therefore mask preventable maternal mortality, as is the case with BDACS. While the ideal is that there should be no deaths at all from BDACS, one would expect more deaths, not fewer, in central hospitals, given that high-risk obstetric patients, both preoperatively and postoperatively, should be cared for at high-level hospitals. The high maternal mortality in regional hospitals is therefore of concern. The inequities were greatest in medical staffing, and most obvious with specialist obstetricians. The central hospitals had twice as many doctors and more than four times more specialists per delivery than regional hospitals. It should of course be accepted that central teaching hospitals need more specialists than regional hospitals, but the difference here still amounts to a serious maldistribution of skilled human resources. In that context, the absence of any formal outreach activities from the central hospitals seems regrettable.

The inequities are further reflected in the relative lack of preparedness of regional and district hospitals for dealing with severe BDACS. Essential second-line drugs, such as tranexamic acid and prostaglandin F2-alpha, and especially ergometrine, were not available in several institutions, remarkably in three of the regional hospitals where difficult caesarean sections might be done. The inability to perform B-Lynch compression sutures at several regional hospitals was also notable. These deficiencies were not investigated in this study, but root cause analysis might find management failures, overburdened specialists and the lack of central hospital outreach activities to be significant culprits.

What was somewhat encouraging was the ability of all hospitals to provide emergency blood for transfusion. Also, all hospitals held perinatal review meetings, where maternal deaths were also discussed. Both of these successes may have resulted from implementing guidelines suggested in the Saving Mothers reports of the National Committee for Confidential Enquiries into Maternal Deaths.[2]

Inequities in emergency obstetric care are a fact across the world, most notably between rich and poor countries,[9] but also within countries. Differences between rural and urban obstetric services[10,11] are well described, as are the extreme differences between private and public healthcare overall in SA.[12] However, there appear to be no reports of inequities in public obstetric services within a city region, such as southern Gauteng. Possible drivers of the inequity include university advocacy for optimal care in its training hospitals, unattractiveness to doctors of regional hospitals in economically depressed towns away from Johannesburg, budgetary constraints in the provincial health service, poor co-ordination of hospital referral systems, and management weakness at lower levels of care. Further research should investigate these and other possibilities relating to caesarean section preparedness, as well as emergency obstetric care as a whole. This study was limited by its focus on caesarean section safety in terms of resource limitations and outcomes, without consideration of upstream determinants of these deficiencies. Another limitation relates to the once-off cross-sectional nature of the evaluation, which cannot assess trends in resource capacity at the hospitals. However, the data stand as facts that suggest inequitable resource allocation for emergency obstetrics, which may be a problem in other SA metropolitan areas that have medical schools.

Several immediate interventions should be considered to improve caesarean section safety at the hospitals in southern Gauteng. Most of these relate to recommendations in the national Confidential Enquiries into Maternal Deaths report from 2008 to 2010:[2] (*i*) human resources needs and norms must be investigated, perhaps using the Workforce Indicators of Staffing Need (WISN) approach introduced to SA in 2012,[13] to create and fill obstetric specialist and medical officer posts in the regional and district hospitals; (*ii*) all maternal deaths and cases of near-miss related to caesarean section bleeding should be audited and discussed at regular perinatal review meetings; (*iii*) training in caesarean section technique needs to be formalised at district and regional hospitals, including using training videos, with a minimum of 10 caesarean sections done under supervision before 'solo' caesarean sections can be attempted;[14] (*iv*) all midwives and obstetric doctors in the hospitals must be exposed to ESMOE (**E**ssential **S**teps in **M**anaging **O**bstetric **E**mergencies) training, which includes modules on surgical skills and obstetric haemorrhage;[15] and (*v*) sustainable emergency obstetrics outreach programmes from the central to the regional and district hospitals must be implemented and sustained, with university and provincial government support.

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