

# Auditing surgical service provision at a South African tertiary institution: Implications for the development of district services

G L Laing,<sup>1</sup> D L Skinner,<sup>2</sup> J L Bruce,<sup>1</sup> C Aldous,<sup>3</sup> V Govindasamy,<sup>1</sup> S R Thomson,<sup>4</sup> D L Clarke<sup>1</sup>

<sup>1</sup> Pietermaritzburg Metropolitan Department of Surgery, Greys Hospital, Pietermaritzburg, KZN

<sup>2</sup> Durban Department of Critical Care, King Edward VIII Hospital, KZN

<sup>3</sup> Clinical School of Medicine, University of KwaZulu Natal

<sup>4</sup> Department of Gastroenterology, Groote Schuur Hospital, Cape Town

*Corresponding author: Dr GL Laing (grantlaing@me.com)*

**Background:** The optimal management of resources within South African state hospitals has been hampered by a paucity of data due to a lack of robust auditing information systems. This study reviews the use of a Hybrid Electronic Medical Record (HEMR) system to capture and aggregate data pertaining to the inpatient service demands on a South African tertiary surgical service. This dataset was used to analyse the appropriateness of tertiary surgical resource utilisation.

**Methods:** The HEMR system was implemented at Greys Hospital, in the city of Pietermaritzburg, Kwa-Zulu Natal, South Africa on 1 January 2013. Inpatient data pertaining to surgical admissions and operative interventions were captured prospectively. Following an 18-month study period, the data were extracted, aggregated and analysed. The district referral hospitals were mapped, and district surgical procedures performed within the tertiary center were identified and quantified.

**Results:** 7314 patients were admitted and managed by the tertiary surgical service during the study period. The median patient age was 33 years (IQR 6.5–42.4 years). 59.7% were male and 40.3% were female. General, trauma and paediatric surgical admissions constituted 54.8%, 28.6% and 16.6% respectively. Emergency admissions constituted 62.4% and elective admissions 37.6%. Referral sources were captured for 6653 (91%) of the cohort. 4338 (65.2%) patients were referred from district hospitals. The district hospital (Northdale) closest to Greys Hospital was responsible for 1675 (25.2%) of surgical referrals. 4174 operative procedures were performed during the study period, 54.7% performed as an emergency, 34.1% electively and 11.2% semi-electively. The median waiting time for emergency operative intervention was 535 minutes (IQR 130–663). A total of 1272 (30.5%) operative procedures performed were assessed as district-level operations. The time intervals of 07:00–07:59 and 17:00–17:59 were identified as the time periods during which the least number of emergency procedures were performed in the operating theatres.

**Conclusion:** The HEMR system enabled the Pietermaritzburg Metropolitan Department of Surgery to quantify the burden of surgical disease and map district referral patterns. Thirty percent of operative procedures performed were assessed as district-level operations. Potentially correctable deficits identified within the tertiary center were lengthy delays to emergency surgery and non-optimal theatre utilisation periods.

S Afr J Surg 2017;55(4)

## Introduction

One of the principles integrated into the South African state healthcare system is the categorisation of hospitals into district, regional and tertiary level institutions. Resources are allocated to each facility according to its designated level of care. Similarly, the types and severity of surgical conditions which should be managed and treated at each institution, differ according to the designated level of care.<sup>1,2,3,4</sup> For the system to function optimally, each institution must manage surgical conditions appropriate to their designated level of care. There is evidence that this is not occurring and that a

number of district hospitals are not functioning efficiently. We have previously assessed the service delivery of district hospitals within our system and found that there is a paucity of general surgical procedures performed at this level.<sup>1,2,3,4</sup> If district hospitals are limited in their surgical capacity, patients with district-level surgical conditions will be transferred to the higher levels of care.

The management of resources in the South African state sector has been inhibited by a lack of health information systems. This has frustrated clinicians' abilities to capture quality indicators that measure the appropriateness of resource

allocation within these institutions. The rapid and progressive development of information technology (IT) has allowed the creation of digital hospital information systems, but these have mostly been confined to the private health-sector and are administrative rather than clinically-based systems. We have formerly described the implementation of an Electronic Surgical Registry (ESR) and developed a Hybrid Electronic Medical Record (HEMR) system in the Pietermaritzburg Metropolitan Department of Surgery.<sup>5,6</sup> The HEMR system captured data at multiple points in time and combined hand-written documents with printed medical records. The HEMR system not only captures data for research purposes, but also acts as a driver of Quality Improvement (QI) projects by facilitating workflow and record keeping. This study reviewed the use of the HEMR system to capture and aggregate data pertaining to the inpatient service demands placed on the tertiary surgical service at Greys Hospital, Pietermaritzburg, Kwa-Zulu Natal, South Africa. In addition, this study aimed to map the referrals from the district hospital services and quantify their impact on a tertiary centre.

## Methods

Ethical approval to construct and implement the HEMR system was obtained prior to any development (ethics number BCA221/13 BREC UKZN). The following terms are defined for the purpose of clarity. An information system, which combines an electronic registry (ER) with an EMR system and a traditional paper-based record system, can be referred to as a Hybrid Electronic Medical Record (HEMR) system. The HEMR system was designed to capture data at multiple points of care. Inpatient data pertaining to surgical admissions and operative interventions were captured prospectively. Following a period of 18 months, these data were extracted, aggregated and analysed. The district referral bases were identified and geographically mapped. Using an official government-based taxonomy of district care standards,<sup>8</sup> the number of district surgical procedures performed within the tertiary center were identified and quantified.

## Results

### Admissions

A total of 7314 patients were admitted and managed within the tertiary surgical service during the 18-month study period. Of these 4365 (59.7%) were male and 2949 (40.3%) were female. The racial breakdown of the patients included 6178 (84.5%) African, 536 (7.3%) Indian, 421 (5.8%) White and 179 (2.4%) Mixed race patients. The median patient age was 33 years (IQR 6.5–42.4 years). The total series consisted of 4009 (54.8%) general, 2095 (28.6%) trauma and 1210 (16.6%) paediatric surgical admissions. Within these sub-groups, general surgical admissions consisted of 2018 (50.3%) emergency and 1991 (49.7%) elective cases. Trauma surgical admissions consisted of 1962 (93.7%) emergency and 133 (6.3%) elective cases. Paediatric surgical admissions consisted of 585 (48.3%) emergency and 625 (51.7%) elective cases. In total, 4564 (62.4%) constituted emergency admissions and 2750 (37.6%) were elective. The average monthly admission rates for emergency and elective surgical cases were 253.6 and 152.8 patients respectively. The average total monthly admission rate was 406 patients. The trends of monthly surgical admissions are illustrated in Chart 1. A total of 747 (10.2%) patients required admission to the Intensive Care Unit (ICU). 354 deaths were identified equating to a mortality rate of 4.8%.

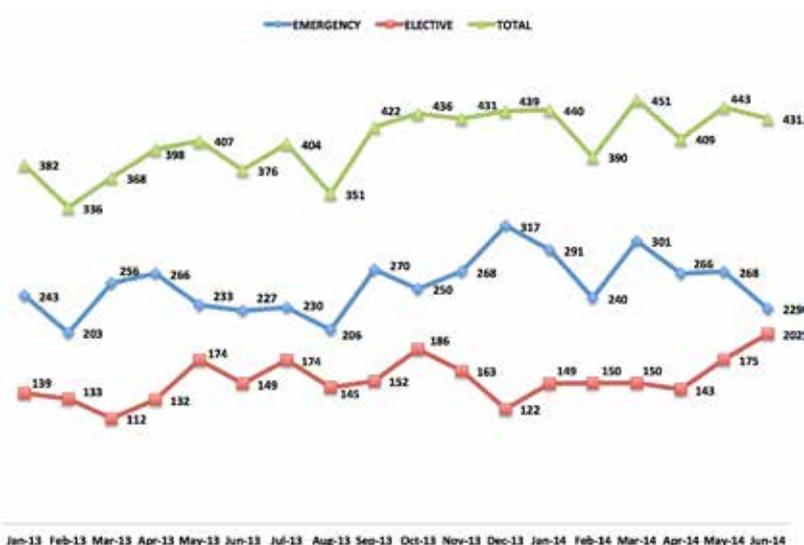


Chart 1. Comparison of monthly elective and emergency surgical admission numbers

Table 1. Classification of operative procedures by discipline and urgency

	Emergency	%	Elective	%	Semi-Elective	%	TOTAL
General surgery	1262		772		255		2289
Paediatric surgery	669		411		114		1194
Trauma surgery	310		203		82		595
Vascular surgery	42		38		16		96
	2283	54.7%	1424	34.1%	467	11.2%	4174

**Table 2. Referral centres of patients admitted to Greys Department of Surgery and their frequency of referral**

Referral Base	Level	Number	%	Referral Base	Level	Number	%
Major				Minor			
Northdale	District	1675	25.2%	Addington	Tertiary	6	
Greys (internal referral)	Tertiary	539	8.1%	Private Hospital - Durban	Private	6	
Edendale	Regional	525	7.9%	Townhill	Psychiatric	6	
Estcourt	District	524	7.9%	King Edward	Tertiary	5	
Vryheid	District	459	6.9%	Richmond	Clinic	5	
Church of Scotland	District	447	6.7%	Ekombe	District	3	
Emmaus	District	375	5.6%	Tayler Bequest (Eastern Cape)	District	2	
Greytown	District	362	5.4%	Baragwanath (Gauteng)	Tertiary	1	
None – Private transport	NA	285	4.3%	Benedictine	District	1	
Appelsbosch	District	248	3.7%	Fort Napier	Psychiatric	1	
None – Paramedics	NA	178	2.7%	King George V	District	1	
Ladysmith	Tertiary	167	2.5%	Manguzi	District	1	
Madadeni	Tertiary	153	2.3%	Ngwelezane	Tertiary	1	< 1%
Clinic - local	Clinic	146	2.2%	Niemeyer Hospital	District	1	
Inkosi Albert Luthuli	Quaternary	115	1.7%	Private Hospital - Bloemfontein	Private	1	
Montebello	District	104	1.6%	Umtata	Tertiary	1	
GP - private	Private	70	1.1%	Zithulele (Eastern cape)	District	1	
Newcastle	Regional	53					
Private Hospital - Pietermaritzburg	Private	51					
Dundee	District	38					
Charles Johnson Memorial	District	30					
EG Usher Memorial	District	28					
St. Apollinaris	District	21					
Rietvlei	District	17					

The referral sources of 6653 (91%) patients within the total series are listed (Table 2 and Figure 1). 4338 (65.2%) patients were referred from district hospitals.

### **Operating theatre utilisation**

During the study period, 4174 procedures were performed in the operating theatre, 3944 surgical operations and 230 endoscopies. Of these, 2289 (54.8%) surgeries were performed by general surgeons, 1194 (28.6%) by paediatric surgeons, 595 (14.3%) by trauma surgeons and 96 (2.3%) by vascular surgeons (Table 1). There were 2283 (54.7%) emergency, 1424 (34.1%) elective and 467 (11.2%) semi-elective procedures performed in the OT. This represents a monthly average of 127 emergency, 79 elective and 26 semi-elective procedures.

Three thousand and eighty-seven operative procedures were performed at the tertiary centre on patients referred from district hospitals. 578 (18.7%) of these cases included 228 lower extremity amputations, 140 incision and drainage of abscesses, 113 uncomplicated appendectomies (26 laparoscopic, 87 local incision) and 97 uncomplicated soft tissue debridements. These constitute emergency surgical cases, which theoretically should have been manageable at district surgical facilities.

One thousand two hundred and seventy-two (30.5%) of the operative procedures performed were classified as district-level procedures (391 elective, 881 emergency). These included 339 appendectomies, 252 amputations, 240 inguinal hernia repairs, 110 soft-tissue debridements, 81 excisional biopsies, 174 abscess incision and drainage procedures, 43 umbilical hernia repairs, 25 split-skin-grafts (SSGs) and 8 circumcisions. The district hospital Northdale, closest to Greys Hospital was responsible for 1675 (25.2%) of the surgical referrals of which 51% underwent surgery at the tertiary center. Surgery for district level surgical conditions was performed in 159 patients comprising 58 abscess drainages, 49 lower extremity amputations, 35 minor soft-tissue debridements and 17 uncomplicated appendectomies.

The time of initiation of 2261 emergency procedures performed in the OT were analysed. The time intervals of 07:00–07:59 and 17:00–17:59 were identified as the time periods during which the least number of emergency procedures were performed in the OT (Chart 3). The time in minutes between admission and initiation of emergency operation was calculated for 1483 surgical emergencies and the results are summarized in Chart 4. The median waiting time for emergency operative intervention was 535 minutes (IQR 130–663).

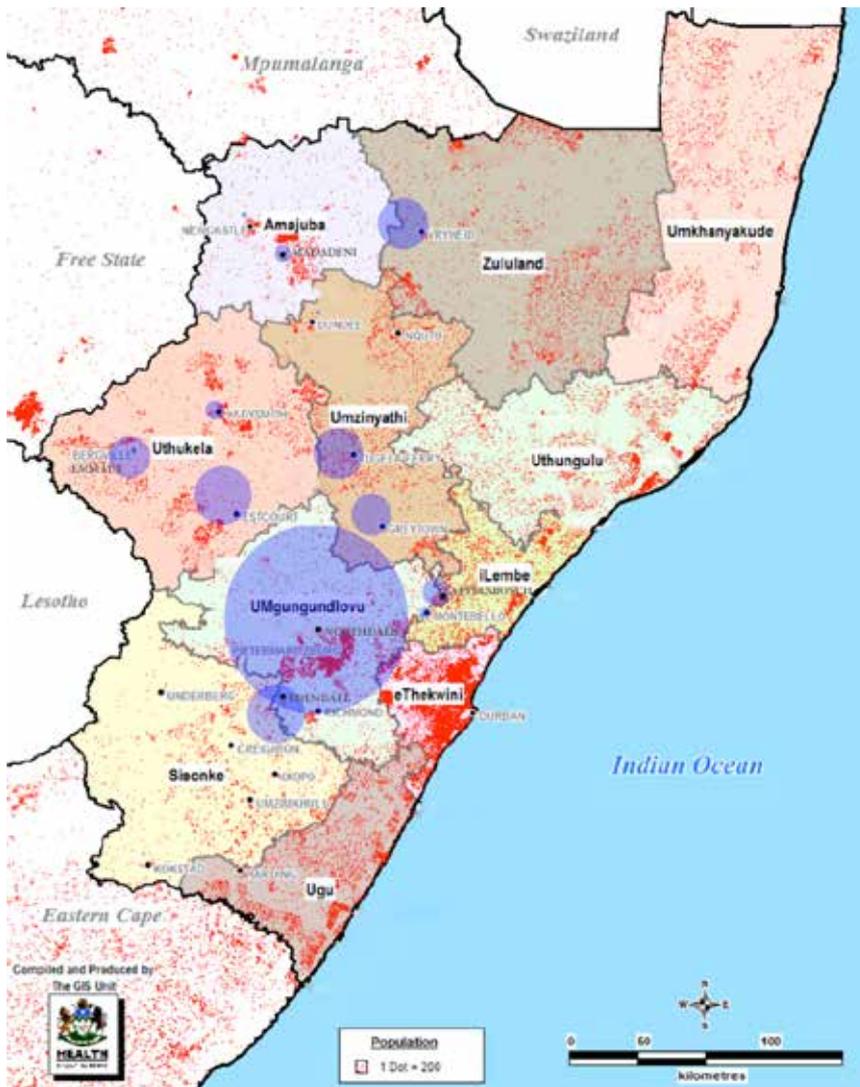


Figure 1. Map of the KZN Districts  
Purple Circles (520 patients per centimetre diameter length) represent mapped referrals of patients admitted to Greys Hospital Department of Surgery.

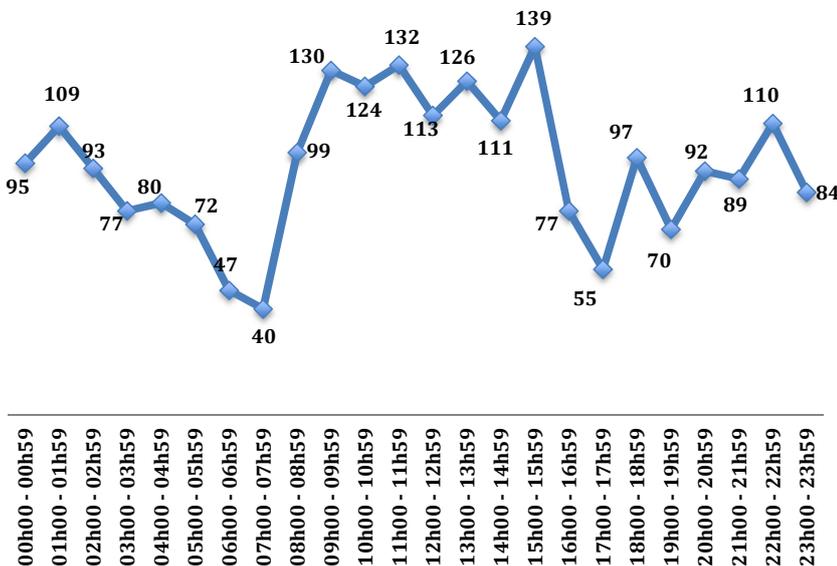


Chart 2. Trend of emergency operative procedures performed by time

## Discussion

The HEMR system has been successful in terms of its primary objective of providing a functional and user-friendly hospital information system. It has enabled us to quantify the burden of disease and hospital service-load and to measure the functionality of the system as a whole. It has furthermore enabled the geographical mapping of surgical referrals from the district healthcare facilities.

## Referrals

Analysis of the referral patterns identified the spectrum of district referring centers of care (Table 2, Chart 2). A single district hospital (Northdale) within the metropolitan complex was identified as the single largest source of referrals. 159 operative cases referred from this district hospital should theoretically have been possible to be completed at the district-level. This information can now be further analysed and fed back to the referring institutions through outreach programs with an aim to continue to develop these centers to improve the functionality of the entire healthcare system.

We have previously published on the burden of trauma within the Pietermaritzburg Metropolitan Trauma Service.<sup>7</sup> The current study supports the need for added resources to manage the large volume of trauma in Pietermaritzburg.

## Admissions

There is a glaring disproportion between emergency and elective admissions with the ratio between the two being in the order of 2:1. A functional tertiary center should be focusing largely on complex elective surgery and one would expect a lower ratio of emergency to elective surgical cases. Emergency surgery is a major consumer of resources and denies elective patients access to theatre and ICU. The development of a dedicated emergency hospital in the complex is a potential solution to this problem.

## Operating theatre utilisation

The HEMR system has enabled us to identify 1272 (30.5%) operative procedures, which according to the 'set of norms and standards' published by the Department of Health (DOH), should be managed within a district hospital service.<sup>8</sup> These included 339 appendectomies, 252 amputations, 240 inguinal hernia repairs, 110 soft-tissue

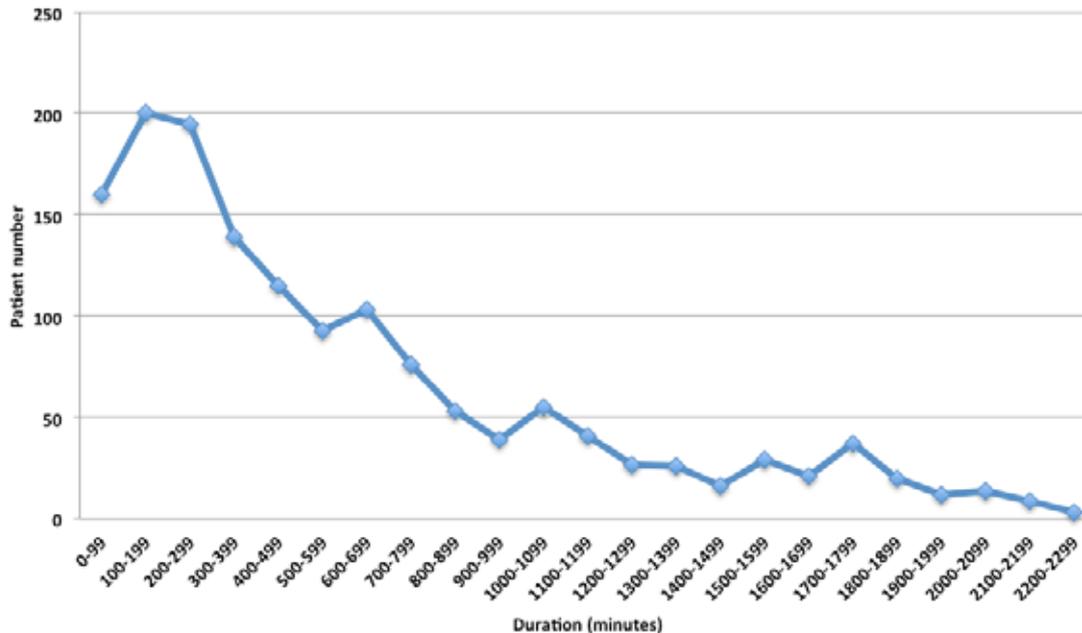


Chart 3. Duration between admission and emergency operative intervention

debridements, 81 excisional biopsies, 174 abscess incision and drainage procedures, 43 umbilical hernia repairs, 25 split-skin-grafts (SSGs) and 8 circumcisions.

The process of nursing handovers in the OT correlated with a reduction in theatre utilisation (Chart 3). This phenomenon requires closer analysis and thereafter a QI project to achieve a more consistent trend in emergency OT utilization. The duration between admission and emergency operative intervention demonstrated considerable delays (Chart 4). This inefficiency harbors the potential to impact negatively on surgical outcomes. The limitation of a single emergency OT slate, which is shared between competing surgical disciplines results in significant delays to definitive surgical intervention. An intermediate solution would involve the creation of a second emergency operative slate within the tertiary center. The long-term solution would be to develop the district centers of care to harbor the skills and capacity to manage more surgical cases.

## Conclusion

The development of the HEMR has allowed us to perform a robust and accurate audit of the service and outcomes at the tertiary level of care. This exercise has identified a number of deficiencies and inefficiencies within the system. These include delays to definitive emergency surgery as well as times when theatre resources are not being optimally utilised. The excessive burden of district-level pathology being referred and managed at the tertiary center is a concern. Closer district analysis will be required to identify the reasons for the volume of referrals. A systematic multi-faceted outreach quality improvement program is needed to address these deficits.

## REFERENCES

1. Clarke DL, Aldous C. Surgical outreach in rural South Africa: are we managing to impart surgical skills? *S Afr Med J.* 29 Jul 2013;104(1):57-60. doi: 10.7196/samj.7252
2. Kong VY, Bulajic B, Allorto NL, Handley J, Clarke DL. Acute appendicitis in a developing country. *World J Surg.* Sep 2012;36(9):2068-73
3. Kong VY, Aldous C, Clarke DL. Understanding the reasons for delay to definitive surgical care of patients with acute appendicitis in rural South Africa. *S Afr J Surg.* 2014;52(1):2-5.
4. Kong VY, van der Linde S, Handley J, Aldous C, Clarke DL. Quantifying the disparity in outcome between urban and rural patients with acute appendicitis in South Africa. *S Afr Med J.* 29 Jul 2013 [accessed on 01 Oct 2013];103(10):742-5. doi: 10.7196/samj.7109. Available from: <<http://www.samj.org.za/index.php/samj/article/view/7109>>. doi:10.7196/samj.7109
5. Laing GL, Bruce JL, Aldous C, Clarke DL. The design, construction and implementation of a computerized trauma registry in a developing South African metropolitan trauma service. *Injury.* Jan 2014;45(1):3-8. doi: 10.1016/j.injury.2013.05.013
6. Laing GL, Bruce JL, Skinner DL, Allorto NL, Clarke DL, Aldous C. Development, implementation and evaluation of a hybrid electronic medical record system specifically designed for a developing world surgical service. *World J Surg.* Jun 2014;38(6):1388-97. doi: 10.1007/s00268-013-2438-2
7. Laing GL, Skinner DL, Bruce JL, Aldous C, Oosthuizen GV, Clarke DL. Understanding the burden and outcome of trauma care drives a new trauma systems model. *World J Surg.* 22 Jan 2014. [Epub ahead of print]
8. A District Hospital Service Package for South Africa. 'A Set of Norms and Standards'. Department of Health, Pretoria, South Africa, 2002, p 33-5.