Cost of intensive care services at a central hospital in South Africa

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Background. Intensive care services are one of the largest cost drivers in a hospital. Increasing life expectancy and comorbidities have resulted in an increased need for intensive care beds.
Objectives. To conduct a cost analysis of intensive care services at a central hospital in the public sector in South Africa (SA).
Methods. A retrospective cost analysis for the 2015/16 financial year was conducted across two intensive care units (ICUs), a trauma ICU (10 beds) and a combined ICU for neurosurgery, medicine and surgery (18 beds). A mixed-methods costing approach was used based on the availability of data. The bottom-up approach was used to calculate the cost of clinical support, pharmaceuticals, consumables and human resources. The top-down approach was used to allocate the cost of equipment and goods and services.
Results. There were 544 admissions resulting in 4 987 inpatient days during the study period. The total estimated inpatient cost across the two ICUs was ZAR114 055 104, with a cost per patient day of ZAR22 870. The combined ICU cost per patient day was 58% higher than the cost per patient day in the trauma ICU (ZAR26 954 v. ZAR17 021). The mean cost per admission was ZAR157 883 in the trauma ICU and ZAR245 087 in the combined ICU. Human resources costs were the highest ICU cost driver (55%), followed by direct patient activity costs (medical consumables, pharmaceuticals, laboratory tests, radiology and blood products), which contributed 24%.
Conclusions. This is the first reported cost analysis of intensive care services in SA. Our cost per patient day was higher than that reported in other lower-income countries, but lower than that in high-income countries. These costs vary owing to the different types of ICUs, wide spectrum of disease presentation and availability of diagnostic and treatment options. This study provides useful data that could assist in the planning and provision of intensive care services.

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South Africa (SA) has a two-tiered healthcare system comprising a large public health service and a rapidly growing private for-profit sector. In 2015/16, hospital services accounted for an estimated ZAR87 billion (57%) of the total public health expenditure in SA, of which more than half was used for general regional hospitals (ZAR24 billion), central hospitals (ZAR18 billion) and tertiary hospitals (ZAR10 billion). Expenditure at these hospitals was mainly driven by personnel, laboratory tests, medicines and medical supplies.[1] In the province of KwaZulu-Natal, regional and tertiary hospitals and central hospitals accounted for 27% and 12%, respectively, of the total provincial health expenditure in the public sector in 2015/16.[2] Regional hospitals provide access to high care and short-term ventilation, while tertiary hospitals offer services that are more specialised and have intensive care units (ICUs). Central hospitals deliver highly specialised services, often in subspecialties that require skilled personnel and unique and expensive technologies, and have specialised ICUs.[3]

In 2008/09, there was a total of 4 719 ICU beds in the healthcare sector in SA, with 75% (3 533) in the private sector and 25% (1 186) in the public sector.[4] The majority of ICU beds were located in three provinces: Gauteng (49%), KwaZulu-Natal (14%) and Western Cape (15%).[4] KwaZulu-Natal had a total of 224 ICU beds in the public sector, translating to 1 bed per 45 000 population.[4] ICUs function differently in the two sectors. In public hospitals ICUs are closed units run by a specialist clinician, usually an intensivist, whereas in the private sector the ICUs are open units and any clinician can admit and manage a patient in the ICU.

Medical advances, together with increasing life expectancy, have increased the proportion of patients with multiple morbidities, thereby increasing demands for intensive care beds.[5] The need for ICU services often exceeds the availability of ICU beds. In the public sector, the development of new hospitals with ICUs has been constrained owing to the increasing focus on making primary healthcare accessible to the population. As a result, the growth in private sector ICUs has outstripped that in the public sector.

Although ICUs comprise <10% of all hospital beds, the cost of admissions in an ICU is significant.[6] In the USA, intensive care costs have increased from ~13% to nearly a third of inpatient costs over the past two decades.[6,7] In SA, intensive care services, like all other health services in the public sector, are provided at no cost to patients who are unemployed. Previously, if a patient required intensive care services and there was no available ICU bed in the public sector, the KwaZulu-Natal Department of Health would 'buy' this service from the private sector. This arrangement met the healthcare needs of the patients, but presented challenges in terms of who took responsibility for the care of the patient, and the surmounting costs associated with private healthcare. It is therefore important for both managers and clinicians to be aware of the cost of patient stays in an ICU.

Objectives

Previous research has analysed the cost of primary healthcare services, district hospital services and specific health programmes,[8-10] but there has not been an analysis of the costs incurred in ICUs in the SA public sector. The objective of this research was to conduct a

cost analysis of intensive care services in the public sector from the perspective of the health service provider.

Methods

The study was conducted at an 846-bed central hospital in the eThekwini Health District in KwaZulu-Natal. This hospital has a trauma ICU (10 beds), a combined neurosurgical, medical and surgical ICU (6 beds per discipline), a cardiothoracic ICU (8 beds), a burns ICU (4 - 7 beds) and a transplant ICU (2 beds). We included the trauma and combined neurosurgical, medical and surgical ICUs in this study. A retrospective cost analysis for the 2015/16 financial year (1 April 2015 - 31 March 2016) was conducted.

We used a mixed-methods costing approach based on the availability of data for the ICUs under consideration. The cost components utilised are outlined in Table 1. Land and building costs were excluded owing to unavailability of data. The equipment at the facility attracts a monthly usage charge that is reimbursed to the private managing agent, and depreciation was therefore not calculated. The bottom-up approach was used to calculate the cost of clinical support, and pharmaceuticals and consumables. These costs were assigned to each ICU based on resource utilisation. The hospital uses cost-centre accounting, and we were therefore able to obtain the total costs for equipment and goods and services for the ICUs. The top-down approach was used to allocate equipment and goods and services per ICU based on the proportion of patient days per ICU.

The unit costs of laboratory and radiography investigations, consumables, and goods and services were obtained from hospital administrative databases. Human resource costs were obtained from the hospital human resource database and included all nurses, doctors and managers employed full-time at each of the ICUs.

The clinical costs for the medical, surgical and neurosurgical ICU were disaggregated to the medical/surgical and neurosurgical sections using the bottom-up approach. The remaining costs were allocated to the medical and surgical and neurosurgical sections based on the number of inpatient days. All costs were based on SA rands at the average exchange rates for 2015: ZAR13.48 = USD1.00, ZAR14.85 = EUR1.00.[11] A sensitivity test based on including land and building costs at a rate of ZAR10 000.00 per square metre and varying inpatient days was conducted.

Permission to conduct the study was obtained from the hospital management and the KwaZulu-Natal Department of Health Research Committee. The study was approved by the Biomedical Research and Ethics Committee of the University of KwaZulu-Natal (ref. no. BE053/14).

Results

Cost per admission

During the 2015/16 financial year there were 544 admissions in the two ICUs with a total cost of ZAR114 055 104, which is equivalent to 5.3% of the total hospital expenditure for the financial year (Table 2). The 323 admissions to the combined ICU accounted for 59.4% of admissions, of which 215 (39.5%) were to the neurosurgical section and 108 (19.8%) to the medical and surgical section. The combined ICU accounted for more than two-thirds of the cost (ZAR79 162 985). The mean cost per admission for both ICUs was ZAR209 660. The mean cost per admission was ZAR157 883 in the trauma ICU, ZAR201 347 in the neurosurgical section and ZAR332 161 in the medical and surgical section of the combined ICU.

Estimated cost per patient day

The cost per patient day in the two ICUs was ZAR22 870. The cost per patient day was 58% higher in the combined ICU (ZAR26 954) than the trauma ICU (ZAR17 021). Of the 2 937 inpatient days in the combined ICU, 1 636 were in the neurosurgical section of the combined ICU and 1 301 in the medical and surgical section. The cost per patient day in the neurosurgical section of the ICU and the medical and surgical section showed a very slight difference (ZAR26 461 v. ZAR27 574) despite the fewer inpatient days in the medical and surgical section.

Component costs

Human resources costs were the highest ICU cost driver (55%). Other direct patient activity costs (clinical support, consumables and pharmaceuticals) accounted for 24% of the total ICU costs. A fixed cost driver at this specific facility is the equipment cost, which accounts for 14% of the ICU cost (Fig. 1). The cost per day, excluding direct patient activity costs and clinician costs, was ZAR13 433.

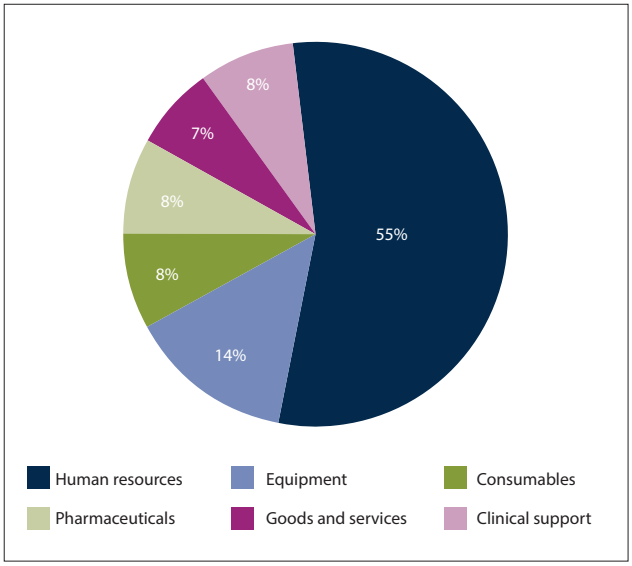

Fig. 1. Contribution of the different components to ICU costs, 2015/16. (ICU = intensive care unit.)

Table 1. Cost components included in the analysis of ICU services

Human resources	Clinical support	Consumables	Equipment	Goods and services
Operational manager	Radiography	Intravenous fluids	Medical equipment	Utilities
Clinicians	Laboratory	Drugs	General equipment	Patient catering
Nurses		Total parenteral nutrition	Information technology	Security
Ward clerk		Blood and blood products		Cleaning
		Disposables		Waste management
				Other general overheads

ICU = intensive care unit.

Table 2. Summary of cost data for ICU services, 2015/16

Cost components	Medical, surgical and neurosurgical ICU	Trauma ICU	Total
Equipment (ZAR)	13 125 236	3 322 934	16 448 170
Medical equipment	5 725 594	1 324 240	7 049 834
Non-medical equipment	7 399 642	1 998 694	9 398 336
Human resources (ZAR)	42 795 728	20 429 080	63 224 808
Nurses	29 363,645	14 583 059	42 751 503
Doctors	13 234 556	5 648 494	18 883 050
Administrative	197 527	197 527	395 054
Good and services (ZAR)	5 060 382	2 333 768	7 394 150
Consumables (ZAR)	5 382 911	3 591 859	8 974 770
Pharmaceuticals (ZAR)	6 664 597	2 718 940	9 383 538
Medicine	3 439 268	846 596	4 285 864
IV fluids	596 256	204 902	801 158
IV feeds	110 831	471 247	582 078
Blood and blood products	2 518 242	1 196 195	3 714 437
Clinical support (ZAR)	6 134 131	2 495 537	8 629 669
Laboratory	4 482 982	1 574 504	6 057 487
Radiology	1 651 149	921 033	2 572 182
Total (ZAR)	79 162 985	34 892 119	114 055 104
Cost in USD	5 872 625	2 588 436	8 461 061
Cost in EUR	5 330 840	2 349 638	7 680 478
Admissions, *n*	323	221	544
Inpatient days, *n*	2 937	2 050	4 987

ICU = intensive care unit: IV = intravenous.

Sensitivity analysis

Two scenarios were modelled, taking into consideration the unique situation of the hospital. This hospital provides tertiary and quaternary levels of care, and patients are meant to be transferred back to the referring hospital once they are stable and no longer need specialised care. Owing to lack of availability of the patient transport system, patients may spend extra days in the ICU after they have been deemed fit for transfer. We therefore looked at the effect of inpatient days on the ICU costs by increasing and decreasing the inpatient days by 25%. We also estimated land and building costs to determine the effect these would have on the total costs.

The number of inpatient days has a major influence on the cost of managing patients in the ICU (Fig. 2). A 25% decrease in the number of inpatient days resulted in a 33% increase in the cost per inpatient day without adjusting any of the other fixed costs. Land and building costs increased the overall cost per inpatient day by ~ZAR2 000.

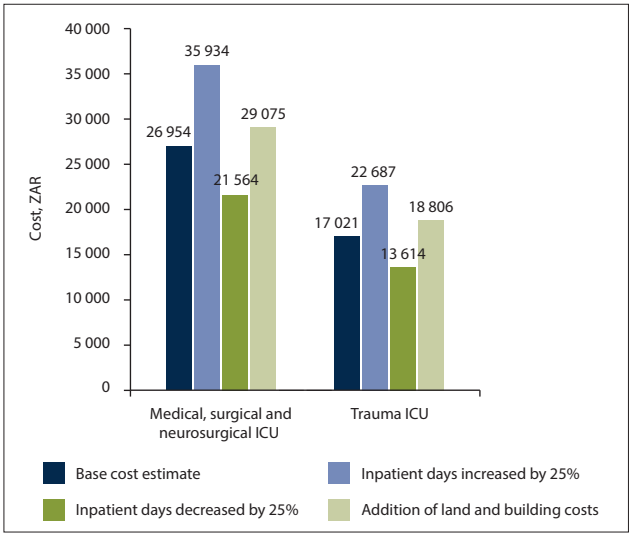

Fig. 2. Sensitivity analysis of ICU costs, 2015/16. (ICU = intensive care unit.)

Discussion

A limited number of studies have been conducted on the cost of treatment of patients admitted to ICUs in low- to middle-income countries. Owing to the different types of ICUs, the wide spectrum of disease presentation and the availability of numerous diagnostic and treatment options, the cost of ICU admissions varies tremendously.[12] The diversity of costing methodologies used to calculate ICU costs also makes comparative analyses a challenge.[13]

In the USA, ICUs accounted for 13.5% of total hospital expenditure in 2005,[14] while an earlier study in The Netherlands estimated that ICU costs represent ~20% of the total hospital budget.[15] In contrast to these studies, our study showed that the cost of ICU admission at a public sector hospital in SA accounts for an estimated 5% of the total hospital expenditure. However, it must be noted that we included costs for only two ICUs in the hospital. If costs of the specialised and paediatric ICUs were included, the proportion of ICU costs would be higher. In SA the ratio of public sector ICU beds to the population varies across provinces from 1:20 000 in the Western Cape to 1:150 000 in Limpopo.[4] The contribution of ICU costs to total public hospital expenditure is therefore likely to be lower in SA than in countries with higher ICU bed-to-patient ratios such as the USA, with an estimated 20 - 30 beds per 100 000 population.[16]

The cost per ICU day (USD2 000/EUR1 815 in the trauma ICU and USD1 263/EUR1 146 in the combined ICU) in the current study is higher than the cost per day of USA193 in a medical ICU in a tertiary hospital in Sarajevo,[17] and EUR144 across 13 ICUs in Hungary. Our cost per ICU day is also higher than the USD255

reported in a tertiary ICU in India in 2011. Similarly, our cost per admission (USD15 553) is more than five times higher than the reported cost in India (USD2 818).[18] In contrast, our findings indicate a much lower cost than the cost of ICU care at teaching hospitals in Canada (CAD4 186),[19] and our figures are slightly lower than but comparable to mean direct costs for an ICU day (EUR1 383) determined by the standardised costing methodology across four European countries.[20] Intensive care costs are influenced by the length of stay of the patients and the case mix. In our setting, which is the only hospital in the province providing quaternary services, it is likely that the patients in the ICUs had more complicated clinical conditions warranting a higher level of care than patients in ICUs at tertiary or regional hospitals. The costs calculated in this study are therefore likely to be higher than ICU costs incurred at these lower-level facilities. The association between length of stay and cost per patient day is important, and mechanisms should be in place for patients to be transferred out of the ICU as soon as this is possible. In our hospital setting, the trauma ICU in particular is faced with patients awaiting transport to the referring hospital, as there are no step-down trauma beds in the hospital.

The high cost in the current study can be attributed to the contribution of human resources costs, which has been demonstrated in other countries and other clinical settings such as Europe and the UK, where human resources costs in the ICU contributed 61% and 67%, respectively.[20,21] In a costing study conducted in SA in the 1990s, human resources was the highest contributing cost, with nurses accounting for the highest proportion of human resources costs.[22] The high human resources cost is due to the salaries of specialist professional nurses and specialist clinicians, and the involvement of a multidisciplinary team in patient care. In the present study, the actual contribution of human resources costs incurred by intensive care services would be higher than 55%, as we were unable to include the salaries of medical and surgical registrars who provide services in the ICUs on a rotational basis. These registrars are paid externally through a health professional training grant. We were also unable to allocate direct costs for other specialists who consult with patients in the ICU and for allied healthcare professionals (physiotherapists, occupational therapists, pharmacists) and hospital management.

Clinical support, pharmaceuticals and consumable costs accounted for 24% of the total cost of an ICU admission, lower than the 34% reported in the UK and 36% across four European countries.[20,23] Our study site is a public sector hospital, and it is likely that the lower prices of consumables and pharmaceuticals, obtained at government tender prices, resulted in a lower proportional cost of pharmaceuticals and consumables.

Equipment was the third contributing cost driver in our setting and may be explained by the financing mechanism of the hospital. The hospital runs on a public-private partnership agreement, in which the private consortium manages the medical equipment and non-clinical services and receives a monthly operational payment.

Interestingly, the cost per patient day in the public sector, excluding direct patient activity costs and clinician costs (ZAR13 433), is similar to the tariff charged to patients by private sector hospitals per day in ICUs (Mediclinic ZAR14 006, Netcare ZAR12 943).[24,25] However, this finding must be viewed with caution as the hospital in which this cost analysis was conducted operates using a different financial model to other public sector hospitals. In the private sector patients are billed separately for all investigations, pharmaceuticals and consumables used during their ICU stay, and for clinician consultations. It is therefore likely that the cost per admission in the private sector would be higher than in the public sector. Obtaining private sector cost data is extremely difficult owing to the competitive nature of the industry. Although we are unable to determine the cost drivers for ICUs in the private sector, this study provides an initial cost estimate that could be used to inform the debate on cost recovery in both sectors, as well as to reconsider the feasibility of 'buying' ICU beds during shortages in the public sector.

The costs of managing a patient are often not considered in the public sector, as hospitals seldom bill patients for services received. This is likely to change with the introduction of National Health Insurance, as hospitals will be expected to be competitive and efficient while recovering their costs through the insurance system. Costing of individual patient services in both the public and private sectors is therefore an important precursor to the implementation of National Health Insurance.

Study limitations

The mixed-methods approach to our cost analysis has limitations. Microcosting using the bottom-up approach with all costs calculated per patient activity is the best approach to costing health services, but this was not possible in the current study owing to the unavailability of disaggregated costing data for all components at the patient level. Costs were apportioned based on inpatient days and do not include the time spent on the activity. The costs in the current study were calculated as a cost per admission and cost per day, but we did not consider the fluctuations in the intensity of treatment provided during the patient's ICU stay. Studies have shown a higher cost for the first day of admission in an ICU.[20,26]

Conclusions

Despite the limitations of this cost analysis, this study provides useful data that managers in the health sector could use in the planning and provision of intensive care services. These results may be of value when considering the financing and reimbursement model in National Health Insurance. Further research into the contribution of clinician costs in the private sector will provide a platform for the exploration of the use of closed ICUs, as in the public sector.

Declaration. None.

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Author contributions. SM conceptualised the research, collected and analysed the data, and wrote all versions of the manuscript. OM assisted with data analysis and reviewed all versions of the manuscript.

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Conflicts of interest. None.

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