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ESTIMATING COST RATIOS AND UNIT COSTS OF PUBLIC HOSPITAL CARE IN SOUTH AFRICA REVISITED

John Ele-Ojo Ataguba[1]

1. Corresponding Author: Health Economics Unit, Department of Public Health and Family Medicine, Health Sciences Faculty, University of Cape Town, Anzio Road, Observatory, 7925, South Africa. Tel: +27-21-4047701; Fax: +27-21-4488152; E-mail: John.Ataguba@uct.ac.za; Qualifications: B.Sc.; MPH.

Abstract

Background

Reliable hospital unit cost estimates are limited in developing countries. Usually a simple rule of thumb based on the assumption that the cost of an outpatient visit is equivalent to a fixed proportion of the cost of an inpatient day is used to disaggregate unit costs. The objectives of the paper are to obtain the ratio of cost of an outpatient visit to an inpatient day,and the associated unit costs for different levels of public hospitals in South Africa.

Methods

Four levels of public hospitals were considered. A simplified model was used on data from the South African District Health Information System to compute the ratio of the cost of an outpatient visit to an inpatient day and the associated average financial costs at each hospital level.

Results

An outpatient visit costs about 0.37 (district hospitals) to 0.64 (specialized hospitals) of an inpatient day. Also the average financial cost of a visit (an inpatient day) ranges from R313 (R487) –district hospitals to R810 (R1441) – central or provincial tertiary hospitals.

Conclusions

The ratios of unit cost of outpatient to inpatient utilization used in computing the unit costs vary across public hospital levels in South Africa. The need to continually update these ratios and unit costs is noted.

Keywords: Unit costs; Public hospitals; Patient day equivalent; Outpatient visit; Inpatient day.

Introduction

Hospital unit costs are key ingredients in many policy decision making processes in the health care sector. They may be used in assessing efficiency of units, treatments, and facilities as well as for budgeting and resource allocation [1-4]. They can also be inputs to further analysis such as benefit incidence analysis (BIA) and economic evaluation of health care programmes (e.g. cost-effectiveness analysis) [3, 5, 6]. Despite the importance of such costs, reliable estimates are rarely available in developing countries [1-4, 7, 8]. This is largely due to unavailability of reliable data, poor infrastructure and poor record keeping culture [4, 7, 8].When they are available, they are often limited to a specific facility or facility type [7, 9-11], or for specific diseases [12-14]or not regularly updated. Only few studies in developing countries [7, 11] obtain detailed unit costs at facility level. Even at that, they are still limited to selected facilities, usually district hospitals. Kirigia*et al*. [13] showed in the context of treating malaria in Kenya that the selective choice of hospitals could bias the results and conclusion about unit costs and cost saving. The most widely available hospital level expenditure data relates to recurrent and capital expenditure breakdown across different expenditure categories such as salaries and wages, medical supplies, pharmacy, training, purchase of equipment, etc. [4, 7, 11].

The standard methods of allocating costs are the step-down method (or macro costing) and the ingredients (or micro costing) approach. The step-down method is usually considered as the 'gold standard' [1, 2] while the ingredients approach is considered difficult to implement because it may be costly and time consuming and requires extensive data [15]. To implement the step-down approach, several methods have been proposed [2]. Conteh and Walker [8] provide a summary on how to proceed with the step-down approach. The most straightforward of these is the patient day equivalent (PDE) method. This is the popularly used method in many African countries [11]including South Africa. It is often routinely produced from hospital utilization and expenditure data. The key assumption upon which this is built is a simple rule of thumb that is seldom empirically derived. Such a rule of thumb is based on the assumption that the cost of an outpatient visit is equivalent to a fixed proportion of the cost of an inpatient day [1, 7, 12, 16]. Usually, an inpatient day is considered to be equivalent to three or four outpatient visits [1, 16]. In some instances

it could be considered to be even higher [17].

The major criticism of this rule of thumb principle is that it is somewhat arbitrary especially when the same ratio is applied to all types of hospitals (e.g. district or central) within a country [7, 16]. It is well known that hospital costs "depend on factors such as size, the level of sophistication of services, the quality of services, the types of services offered, case-mix and case-severity, and occupancy rates" [4 p.208]. Therefore such "simple rules of thumb do not prove to be an accurate basis for cost estimates … [*as*] ratio of inpatient to outpatient unit costs varies with …hospital size" [1 p. 1700]. As an alternative to the rule of thumb, cross-country models may be fit to estimate country specific costs [1]. However, it is not able to account for potential differences across countries such as political, cultural, economic or social differences, and other factors that might have an impact on unit costs.

This paper therefore presents an empirical method to compute the ratios or patient day equivalents that are not based on the simple rule of thumb. To achieve this, the paper extends the simple relationship model developed in Lombard *et al.* [16]. The model is then used to calculate the cost per inpatient day and per outpatient visit at different levels of public hospitals in South Africa.

The rest of the paper is structured as follows. The next section briefly introduces the South African health system. The section after this provides the data and methodology. Thereafter the results are presented followed by the discussion and conclusion sections.

Brief overview of the South African health system

The South African health system consists of both private and public sectors. The pre-democratic (pre 1994) period was characterised by the apartheid system that impacted on the South Africa health care system. During this period the health care system was highly fragmented such that different groups have their own health department [18, 19]. Health services for the black majority were heavily underfunded and the rural areas were neglected [19]. During the period of democratic transition there were 14 separate health departments operational in the country and the post-apartheid government was faced with huge challenges of redressing existing inequalities and inequities. All the health administrations were amalgamated into one national and nine provincial health

departments [18] with leading importance attached to primary health care. Currently South Africa operates a three-tier hospital structure (tertiary, regional, and district) and primary health care system (comprising clinics and community health centres) run mainly by nurses [18, 20]. There are over 200 district hospitals and over 50 regional hospitals. For the public sector, the national department of health is charged with the responsibility for overall guidance and national health policy and the provincial departments are responsible for provincial health policy in line with the broad national policy framework. They are the main providers of health services through hospitals and primary care clinics [20]. Private health sector comprises general practitioners, private hospitals and traditional health care providers [20]. Though total health care expenditure accounts for over 8% of the country's GDP, the health sector continues to face several equity challenges. For example over 50% of both financial and human resources are allocated to the private health sector [18] and it is estimated that over two-thirds of private hospitals are located within three of the nine South African provinces [18]. Inequity also exists within and across facility levels. While about 11% of total public health spending is devoted to non-hospital primary care services that cater mainly for the poor, over 44% is accounted for by academic and other tertiary hospitals [18]. These challenges further require that available resource is used in an efficient manner and that resource allocation issues are based on evidence.

Methodology

It is important to note here that health facilities where there is no mix of inpatient and outpatient services, computation of unit costs are relatively straightforward. This is obtained simply by dividing the total expenditure of the facility by the total number of output (e.g. total number of visits or total number of patient days) produced within a specified period. Where there is a mix between inpatients and outpatients, such as the various hospitals considered in this paper, the procedure is rather not straightforward.

(a) *Data*

The South African District Health Information System (DHIS) 2006/2007 database was used to extract information on the total number of inpatient days and outpatient visits (this includes both new and review visits), the total number of nurses and doctors in each hospital at all hospital levels, and the average bed occupancy ratios. Data on recurrent expenditure in each hospital was also

extracted from the DHIS database and supplemented with reports produced by the National Treasury of South Africa. While efforts were made to obtain data for all the nine South African provinces, two provinces – North West and Eastern Cape –were omitted from the analysis due to missing expenditure data in the former and missing data on the total number of health care workers in the latter. Further, some hospitals within the remaining provinces had missing information on one/more of the variables of interest. These hospitals were also omitted. The dataset therefore contains hospitals with complete information on the variables of interest.

Based on the information available from the DHIS 2006/07 database, there were a total of 257 district hospitals, 59 regional hospitals and 68 specialized hospitals. The number of national central hospitals and provincial tertiary hospitals were smaller. Due to the relatively small number of facilities at some of these hospital levels (for example, national central hospitals), data were combined and four broad types of facilities were distinguished for which ratios and unit costs were estimated: (1) district hospitals, (2) regional hospitals, (3) national central and provincial tertiary hospitals, and (4) specialized hospitals.

(b) ***The model***

Cost of care is related to all the characteristics of care [21]. Barnett [21] expresses this as a linear function of the characteristics of the patient and the characteristics of the health facility.

$$C = c(X_p, Y_f) \quad (1)$$

Where C is the cost of care to a patient, X_p are the characteristics of the patient, and X_f are the characteristics of the health facility. In public sector settings, there are no routine data available on the costs or expenditure incurred in the treatment of one specific patient. However, one can often obtain data on total expenditure or total costs at the facility. Facilities with a mix of inpatient admissions and outpatient attendances, a procedure is therefore needed to allocate these expenditures to inpatient and outpatient services, through some proportioning, in order to calculate the unit costs (i.e. the average cost per inpatient day or outpatient visit). In order to achieve this, this paper borrows from an initial study in South Africa by Lombard *et al.*[16] and extends the arguments further by accounting for the relative size of each facility in the estimation sample.

Annual utilization (inpatient days and outpatient visits) and expenditures are considered to avoid any fluctuation in use

and spending over the year. We then assume that there is some ratio π_j of the cost of an inpatient day to an outpatient visit which is specific to the facility level j (e.g. the district hospital). The unit cost can be estimated as:

$$C_j = EXP_j / (I_j + \pi_j \times O_j) \quad (2)$$

where C_j is the unit cost of an inpatient day spent at facility level j; I_j is the aggregate annual number of inpatient days at facility level j, O_j is the aggregate annual number of outpatient visits to facility level j, and EXP_j is the total annual recurrent expenditure at facility level j. Here the denominator is the patient day equivalent in inpatient days' terms.

Similarly, we express C'_j – the unit cost of an outpatient visit as:

$$C'_j = EXP_j / (\pi_j^{-1} \times I_j + O_j) \quad (3)$$

The denominator in equation (3) measures the patient day equivalent in outpatient visits' terms. We can manipulate equation (2) slightly to obtain

$$EXP_j = \alpha_1 I_j + \alpha_2 O_j \quad (4)$$

Where $\alpha_1 = C_j$; $\alpha_2 = \pi_j C_j$.

If this identity holds, then we can easily verify that

$$\alpha_2 / \alpha_1 = \pi_j \quad (5)$$

This gives us back the initial ratio π_j.

A multiple regression model can be fitted on equation (4) such that the parameter estimates of α_1 and α_2 can be recovered to verify the appropriate ratio π_j. However, this method does not control for the variations in the sizes or scale of the facility. It assumes that all facilities within a certain level are the same in scale and size (i.e. all district hospitals for instance are of the same size).

To improve on this, and to control for variations in scale and size, we expressed (4) as:

$$y_{ij} = \alpha_1 x_{ij1} + \alpha_2 x_{ij2} + \Sigma_k \gamma_k z_{ijk} + \varepsilon_{ij} \text{ for each } j \quad (6)$$

where y_{ij} is the total annual recurrent expenditure in hospital i at level j (e.g. district hospitals), x_{ij1} and x_{ij2} are the respective aggregate annual number of inpatient days and number of outpatient visits, α_1 and α_2 are their respective coefficients, z_{ijk} comprises variables that account for the size of the facilities and γ_k the associated coefficients, and k is the total number of variables you wish to control for. These z_{ijk} variables are used to account for the relative size heterogeneity across facilities. Here, ε_{ij} represents the error term. We implement equation (6) controlling for the total number of doctors and the total number of nurses (the sum of professional nurses, student and pupil nurses, and assistant nurses) in each

facility.Average bed occupancy ratio rather than the number of beds was considered as an indication of *effective* size. However, its inclusion was not statistically significant for some levels of care. In the cases where it was significant, the impacts on the relevant ratios were not significant. The regression is then estimated for each facility type j using theStata® 11 routine with robust standard errors and the model was assessed for multicolinearityand heteroscedasticity.

After estimating equation(6) for each facility level (e.g. district hospital), we obtainπ_j and apply equations (2) and (3) to obtain the unit cost per inpatient day and outpatient visit respectively.

Results

In table 1 we present the results of the regression output based on equation(6). Though we report robust standard errors, it is important to note that our interest is not in the absolute magnitudes of the coefficients but their relative magnitudes. The coefficients on outpatients and inpatients are all positive which implies that increasing the number of inpatients days will increase expenditure at each facility level. If we apply equation (5) we obtain the ratios contained in table 2.

The ratio of the cost of an outpatient visit to an inpatient day ranges from 0.371 in district hospitals to 0.643 in specialized hospitals. This means that an outpatient visit in a district hospital costs about 0.37 times an inpatient day (or the cost of one inpatient day is equivalent to 2.7 times the cost of an outpatient visit). A regional hospital visit costs about 0.42 times an inpatient day cost (or the cost of one inpatient day is equivalent to 2.4 times the cost of an outpatient visit). A national central or provincial tertiary hospital visit costs about 0.56 times the cost of an inpatient day (or the cost of one inpatient day is equivalent to 1.8 times the cost of an outpatient visit). In specialized hospitals, an outpatient visit is about 0.64 times the cost of an inpatient day (or the cost of one inpatient day is equivalent to 1.6 times the cost of an outpatient visit).

Table 1: Regression output based on selected health facility variables

Dependent variable =	Public hospitals categories			
Total recurrent expenditure	District Hospitals (DH)	Specialized Hospitals (SH)	Central and Provincial Tertiary Hospitals (CPH)	Regional Hospitals (RH)
Outpatients	208.6***	493.1***	495.7***	283.5**
	(54.81)	(154.50)	(167.11)	(125.65)
Inpatients	562.3***	766.8**	882.4**	677.9***
	(93.66)	(375.47)	(365.57)	(185.75)
Number_of_doctors	540043.3***	1088743.4***	1033221.0***	598368.0***
	(132263.91)	(140931.57)	(134898.98)	(204372.85)
Number_of_nurses[a]	43923.6**	-96614.4	-117343.5	18024.0
	(21902.31)	(105818.78)	(94492.40)	(39512.87)
R-Squared	0.95	0.95	0.94	0.97
Number of observations	149	57	52	39

Note:
***, ** Statistically significant at 1% and 5% levels respectively
Robust standard errors are reported in parenthesis
[a]Includes student nurses, professional nurses, pupil nurses and nurse assistants
The average number of nursesper DH, SH, CPH and RH is130;114; 1867 and 406 respectively.
The average number of doctorsper DH, SH, CPH and RH is13; 5;523; and 73respectively.
The average annual outpatient visits per DH, SH, CPH and RH is 34,804;10,823; 490,514 and 117,633 respectively.
The average annual inpatient days per DH, SH, CPH and RH is 32,212; 58,751; 443,769; and 112,136 respectively.

An outpatient visit is therefore relatively more costly at a higher facility level than at a lower level in comparison to an inpatient day at that level. Similar results were obtained inLombard *et al.*[16]. The lowest ratio here is for the district hospital.

Table 2: Cost ratio of an outpatient visit to an inpatient day

Hospital category	Cost ratio
District Hospitals	0.371 (=1 : 2.70)
Regional Hospitals	0.418 (= 1 : 2.39)
National Central and provincial Tertiary	0.562 (= 1 : 1.78)
Specialized Hospitals	0.643 (= 1 : 1.56)

The ratios contained in table 2 are used to generate and allocate the unit cost (per outpatient visit and per inpatient day) for the various hospital levels. Though the ratios are reflective of the hospital level, the unit costs may not necessarily be in that order. As shown in table 3, in 2006 a district hospital visit in South Africa for instance costs about R315 ($45) while a specialized hospital visit is R313 ($44.7) – which is lower.National central or provincial tertiary hospital visit costs more than double that of a district hospital visit. Similarly, a night in a district hospital will cost about R850 ($121.4) while in the specialized hospital it costs about R490 ($70). The highest cost is for a night in a central or provincial tertiary hospital.

Discussion

This paper uses a procedure to empirically determine the ratio of the cost of an outpatient visit to an inpatient day at different levels of South African public hospitals. This builds on earlier work by Lombard *et al.* [16] that focused only on hospitals in the Cape Province. The current study extends this analysis to include other provinces. It also improves on the previously used models by controlling for the relative size of each hospital in estimating the cost ratios. This study confirmed that unit cost ratios between outpatient visits and inpatient days vary depending on the hospital level. The ratio was found to be smaller for district hospitals and larger for specialized hospitals and other higher hospital levels.This is also in keeping with international literature.

Table 3: Unit cost of an inpatient day and outpatient visit to various facility levels, South Africa (2006 Rand)

	Utilization and expenditure in millions of Rand					Unit cost (2006 Rand)[a]	
	Total recurrent expenditure	Inpatient days	Outpatient visits	Total recurrent (inpatient)	Total recurrent (outpatient)	/Inpatient day	/Outpatient visit
District Hospital	6,456	5.43	5.84	4,615	1,841	**849.17**	**315.04**
Regional Hospital	7,826	5.27	5.40	5,478	2,348	**1,040.20**	**434.80**
Central/Provincial tertiary Hospitals	7,835	3.34	3.73	4,817	3,019	**1,441.01**	**809.85**
Specialized Hospital	525	1.00	0.11	489	36	**487.18**	**313.26**

Note: the expenditure and utilization figures are based on the hospitals where data are available.

[a]US$ 1≈ 7South African Rand.

In a review, Mills [4] noted that the "common pattern appears to be for outpatient care to absorb approximately 20% of hospital current expenditure…. Evidence suggests that the less specialized the hospital, the greater is its outpatients' role." In district hospitals, it was found that the financial cost of a visit is about 0.37 times the cost of an inpatient day. In regional hospitals a visit costs about 0.42 times an inpatient day. The cost of a visit in a national central/provincial tertiary hospital is about 0.56 times that of an inpatient day. This unit cost ratio is higher (0.64) in a specialized hospital. In a dated study (1987/88) in Malawi using direct allocation of expenditure (a step-down approach), the ratio of the costs of a new outpatient visit to an inpatient day for district hospitals ranged from 0.10 in Kasungu to 0.32 in Rumphi[7]. In two district hospitals in Kenya (Kilifi and Malindi), using also direct allocation, the ratios were respectively 0.46 and 0.32 [11].

The unit cost ratios obtained in this study, when applied to 2006 expenditures and hospital utilization data, show that in monetary terms, a district hospital visit (an inpatient day) costs about R315 (R849). The unit cost of a visit, and an inpatient day were highest at central/provincial tertiary hospitals (R810 for a visit and R1441 for an inpatient day). This also conforms to international evidence. Mills [4] writes in the context of Malawi that "general hospitals cost more per unit of output than district hospitals, and central hospitals cost more per unit of output than general hospitals" (p. 208). This has also been reported elsewhere for countries such as Zimbabwe, Malaysia, Papua New Guinea, Thailand, Tunisia, Belize and Colombia [4]. For example in Malawi (1983/84), Zimbabwe (1979), and Belize (1985/86), the unit cost of an inpatient day in a central hospital is 2.4 times, 5.5 times and 1.3 times respectively higher than those in a district hospital [4]. In this current study in South Africa, though the unit cost ratios follow expectations, the average financial costs in specialized hospitals were found to be lower than those at any other hospital level. While this cannot be explained by the results of this research, it is likely due to the small recurrent expenditure and utilization in comparison to those at other hospital levels. Also Lynk[22] would argue that detailed studies of specialized hospitals have found evidence of strong economies of scale that drives down unit costs. While these may be speculative it is important to investigate further why average costs tend to be lower at specialized

hospitals even though the ratio of the cost of an outpatient visit to an inpatient day is consistent with expectation.

These unit cost ratios (and the resultant unit costs), with increasing emphasis on efficiency and waste minimization, are not only useful at the hospital or facility level but could be relevant for planning and resource allocation at a broader level. While at a broader level these could guide the implementation of effective referral systems, at the hospital level, efficiency can be enhanced through, for example, the use of cost-effective input mix [4] and replacing inpatient care by outpatient care in cases where this is feasible [7]. The unit cost ratios and unit costs could also be useful to researchers as inputs for other research activities. These include studies that involve some costing such as cost-effectiveness analysis, BIA and also studies that involve rationalizing costs of inpatient days and outpatient visits.Also, the unit costs estimates will be helpful in improving policy and decision making processes of governments and could be very vital in further research in the hospital sector. For example, based on the results of this study, the current initiative to move toward a universal health system will imply that adequate referral system would be important because bypassing the referral system will impose greater costs on patients seeking care directly at higher hospital levels for cases that can be handled at lower levels.

The method used, because of data limitation, does not investigate the determinants of variations in unit costs across hospital types. For the cost per inpatient day, it is usually the case that male and female wards are cheaper than children's and maternity wards [7]. While it is likely that quality of services may vary across hospitals [7, 11], the method used in this paper does not explicitly account for quality of service differences between hospitals at the same level (e.g. district hospitals) and treatment case-mix that occurs within health facilities. This is mainly because only aggregative data is available for analysis and the measurement of quality of care is not available and could be subjective. The data could not be further disaggregated to, for instance, show the amount of time spent by medical staff at different wards, and division of staff time across inpatient and outpatient care. These could have proved helpful in refining the analysis.

As mentioned earlier, the analysis excludes two provinces (North West and Eastern Cape). Also hospitals that do not have complete information on the variables of interest were excluded. It is possible that the exclusion of such hospitals due to unavailability of data, particularly those from Eastern Cape, could have an impact on the unit costs and ratios. These notwithstanding, the ratios of unit costs of outpatient to inpatient care obtained are still relevant to the health system in planning and decision making processes. The ratios, which follow international trends, are lower at lower hospital levels and higher at higher levels. The current methodology can still be improved upon with the availability of timely and relevant data. Such timely and reliable data are important sources of evidence based policy making and further research and analysis. The ratios (i.e. PDE) and resulting unit costs can then be computed regularly and updated. This can be achieved through setting up and strengthening routine information systems at different levels within the country [4]. In this regard it is suggested that future research is required to use datasets that are as complete as possible in the estimation of ratios and unit costs of hospitals in South Africa. Further research is also important to produce these ratios across time using data from different years, and updating these as soon as new data are available.

Conclusion

The ratio of the cost of an outpatient visit to inpatient day has been traditionally based on a simple rule of thumb. While that may be the easiest assumption to make in the face of data constraints they are not based on empirical findings. The results of this paper have shown that in South Africa differences in these ratios reflect the different hospital levels. Lower hospital levels tend to have lower ratios of costs of outpatient to inpatient care while higher level hospitals have the reverse. Caution is therefore required when patient day equivalent ratios that are not empirically derived are used for resource allocation and for other analyses. There is therefore need for researchers to invest in computing and updating the ratios over time.

Author contributions

JEA conceived and designed the study; analysed and interpreted the data; drafted and revised the paper; and also gave final approval for submission.

Conflict of interest

None declared

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