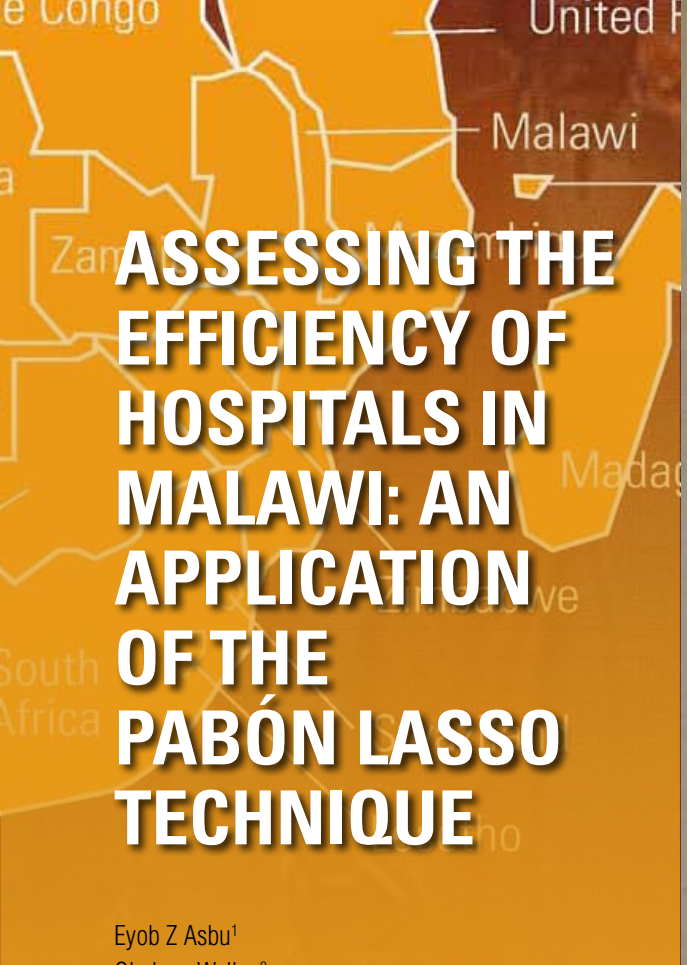

ASSESSING THE EFFICIENCY OF HOSPITALS IN MALAWI: AN APPLICATION OF THE PABÓN LASSO TECHNIQUE

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Studies on capacity utilization, using the Pabón Lasso (PL) technique have not been conducted in Malawi before. This study examines the technical efficiency of district-level public and mission hospitals. The Pabón Lasso technique is applied in assessing the relative performance of a sample of 40 district hospitals (60% public and 40% mission) in Malawi. The computation of hospital utilization ratios and construction of the Pabón Lasso diagram was performed using STATA 10. Only 27.5% of the hospitals were located in the desirable region of the Pabón Lasso diagram (right upper region), while close to 50% were located in the left lower region, which is the most undesirable situation, characterized by a low turnover ratio and low bed occupancy rate. Capacity utilization is better in public primary level hospitals compared with the mission hospitals. Despite a low bed density, there is a gross underutilization of the existing supply of inpatient beds. It is essential that the underlying causes be identified and appropriate demand-creating interventions be instituted to counter this problem. Furthermore, in order to identify inefficiencies related to scale/size, it is necessary to conduct an assessment using frontier techniques of efficiency measurement (e.g. data envelopment analysis or stochastic frontier models including production and cost functions).

RÉSUMÉ

Aucune enquête relative à l'utilisation des capacités basée sur la technique Pabón Lasso (PL) n'a été conduite au Malawi jusqu'à ce jour. La présente étude examine l'efficacité technique des hôpitaux publics et confessionnels au niveau du district. La technique Pabón Lasso est appliquée en évaluant la performance relative d'un échantillon de 40 hôpitaux au niveau du district (60 % d'hôpitaux publics et 40 % d'hôpitaux confessionnels) au Malawi. Le calcul des taux d'utilisation des hôpitaux et l'élaboration du diagramme Pabón Lasso ont été effectués à l'aide de STATA 10. Seulement 27,5 % des hôpitaux se situaient dans la zone souhaitable du diagramme de Pabón Lasso (la zone la plus en haut à droite), alors que près de 50 % d'entre eux se trouvaient dans la zone la plus en bas à gauche, qui correspond à la situation la moins souhaitable et se caractérise par un faible ratio de rotation associé à un faible taux d'occupation des lits. L'utilisation des capacités est meilleure dans les hôpitaux publics de premier niveau, en comparaison avec les hôpitaux confessionnels. En dépit d'une faible densité de lits, le constat d'une utilisation largement insuffisante de l'offre actuelle des lits de patients s'impose. Les causes principales doivent être identifiées et des actions appropriées de génération de la demande entreprises pour juguler ce problème. En outre, pour identifier les inefficacités liées à l'échelle/taille, il faut mener une évaluation à l'aide de techniques de pointe pour mesurer l'efficacité (par exemple une analyse d'enveloppement des données ou des modèles de pointe stochastiques, incluant les fonctions de production et de coût).

RESUMO

Os estudos sobre a utilização das capacidades usando a técnica Pabón Lasso (PL) ainda não tinham sido conduzidos anteriormente no Malawi. Estes estudos avaliam a eficiência técnica dos hospitais públicos e dos hospitais missionários a nível distrital. A técnica Pabón Lasso é aplicada na avaliação do desempenho relativo de uma amostra de 40 hospitais distritais (60% públicos e 40% hospitais missionários) no Malawi. O cálculo das taxas de utilização dos hospitais e a construção do diagrama Pabón Lasso foram efectuados utilizando o STATA 10. Apenas 27,5% dos hospitais encontravam-se localizados na região desejada do diagrama Pabón Lasso (região superior direita), enquanto que cerca de 50% encontravam-se localizados na região inferior esquerda, que é a situação menos desejada, caracterizada por um índice de rotatividade e uma taxa de ocupação de camas baixos. A utilização da capacidade é melhor nos hospitais públicos de nível primário comparativamente com os hospitais missionários. Apesar de uma baixa densidade de camas, existe uma enorme subutilização do fornecimento existente de camas hospitalares. É essencial que as causas subjacentes sejam identificadas e que sejam instituídas intervenções apropriadas de criação de procura para contornar este problema. Além disso, de forma a identificar as ineficiências relacionadas com a escala/tamanho, é necessário conduzir uma avaliação utilizando técnicas de fronteira de medição da eficiência (por ex.: análise de englobamento de dados ou modelos de fronteira estocástica incluindo funções de produção e custos).

Inefficiency in the allocation and use of health sector resources is one of the inherent problems of health systems in sub-Saharan Africa. Cognizant of this fact, in 2006, at a special session of the African Union, health ministers undertook to institutionalize efficiency monitoring within national health management information systems.[1]

The few studies on the technical efficiency and productivity of hospitals conducted in Africa indicate the pervasiveness of technical inefficiency and wastage of resources that could have been used to improve access and quality of care.[2,3,4] Zere *et al* (2001)[2] in their study of the technical efficiency and productivity of public sector hospitals in South Africa found technical inefficiency levels ranging between 34–38%. **The efficiency saving that could have been realized was equivalent to the amount needed for the construction of about 50 clinics.** This implies that there is a significant potential to mobilize resources from within the system if technical efficiency levels are improved.

As is the case in other countries in sub-Saharan Africa, per capita spending on health in Malawi is low despite a growing burden of disease. In 2005/2006 per capita spending on health in Malawi was estimated at US$ 25,[5] which is far less than the US$ 34 recommended by the WHO Commission on Macroeconomics and Health to provide a basic package of services in low-income countries.[6] Hence, to provide health services with such a low level of funding, it is very important to avoid wastage in the use of the meagre resources available. Technical inefficiency contributes to the shortage of resources and adversely affects governments' initiatives to improve access and bridge any inequities in health care.

In sub-Saharan Africa, hospitals account for the bulk of government's health sector expenditure, ranging between 45–69%.[7] Malawi is no exception to this. Moreover, district/primary level hospitals play a significant role in providing support to primary care teams to ensure comprehensive responsibility for their population[8] and therefore, facilitate the implementation of the Primary Health Care approach. The need to assess the technical efficiency of district hospitals cannot be overemphasized.

Studies on capacity utilization using the Pabón Lasso[9] technique have not been conducted in Malawi before. The current exercise is therefore aimed at bridging the information gap and generating important evidence on the state of capacity utilization of district, community and rural hospitals for the purposes of planning and resource allocation.

This study seeks to examine the technical efficiency of district, community and rural hospitals (henceforth called primary level hospitals), including both public and private with a view to assessing efficiency and pave the way for further detailed studies of efficiency and its determinants using more robust frontier techniques.

Malawi

COUNTRY PROFILE

Malawi is a low income country in Southern Central Africa. The total population is estimated at a little more than 13 million.[10] With a human development index (HDI) in 2005 of 0.437, the country is classified with the group of low human development countries, most of which are in sub-Saharan Africa.[11]

The gross domestic product (GDP) per capita was US$ 154 (in constant 2000 prices) in 2005.[12] About 52% of the population is classified as poor, i.e. below a national poverty line of the equivalent of US$ 147.[12]

Health and development indicators of Malawi are those typical of other low-income countries in sub-Saharan Africa, as depicted in the Table 1.

Table 1. Selected health and development indicators

Indicator	Value
Life expectancy at birth, 2007 (both sexes)	50
Infant mortality rate, 2006 (per 1000 live births)	69
Under five mortality rate, 2006 (per 1000 live births)	118
Maternal mortality ratio (per 100 000 live births)	807
Total fertility rate	6.3

Sources: 13, 14, 15.

Malawi, like many countries of sub-Saharan Africa, faces a growing burden of disease. The epidemiological profile is characterized by a high prevalence of communicable diseases including malaria, tuberculosis and HIV/AIDS; high incidence of maternal and child health problems; an increasing burden of noncommunicable diseases and resurgence of neglected tropical diseases.

The per capita total expenditure on health (THE) that stood at US$ 25 in 2005/2006 falls short of the US$ 34 recommended by the WHO Commission on Macroeconomics and Health to provide the basic package of services in low income countries. The health expenditure per capita is also not adequate to cover the Malawi Essential Health Package (EHP) that is estimated to cost about US$ 22 (it should be noted that this includes interventions not included in the EHP and health system administration costs). The health system suffers from a critical shortage of human resources for health. In the period 2000–2007 there were about 6 nursing and midwifery personnel per 10 000 population. The number of doctors per 10 000 was less than one.[13]

To address the health and health care challenges effectively the government adopted the sector-wide approach (SWAp) in 2004 and designed an essential health care package that addresses the most common causes of morbidity and mortality to be provided at community, primary and secondary levels of the health care system. The government in conjunction with its development partners has formulated a six-year Emergency Human Resources Programme (2005–2010) at an estimated cost US$ 272 million to ameliorate the chronic shortage of human resources for health.

The country's health service delivery system is four-tiered, consisting of community, primary, secondary and tertiary care levels. At the community level, service is provided through health surveillance assistants. The focus is on preventive interventions. Primary care is delivered through clinics and health centres. District and central hospitals provide secondary and tertiary care services respectively. The private not-for-profit sector plays a significant role in service provision. A health facility survey conducted in 2002–2003 indicated that there were 14 612 inpatient beds giving a bed density of 13 per 10 000 population.[15]

THE MEASUREMENT OF HOSPITAL EFFICIENCY: BASIC ISSUES

The performance of hospitals can be evaluated using ratios that mainly measure capacity utilization or frontier techniques such as data envelopment analysis (DEA) and stochastic frontier methods including production and cost functions that are more robust.[16]

Ratio analysis involves the piecemeal examination of different key ratios, such as average cost per inpatient day, bed occupancy rate or cost per child immunized. Although easy to use, ratios have some pitfalls. First, the requirement for identical measurement units makes the identification and measurement of inputs and outputs difficult. Second, ratios are only meaningful and easy to understand in single input, single output situations. Comparisons of multiple outputs by means of ratio analysis require *a priori* weights and/or a standardizing measurement to get an overall indicator. The arbitrariness and pre-determination of these weights and standardization has often been questioned.

Performance indicator ratios commonly used by hospitals include:

Average length of stay (ALS): This measure refers to the average number of days that a patient stays in a hospital. It is calculated using the following formula:

$$ALS = \frac{inpatient\ days}{admissions} \quad (1)$$

Bed occupancy rate (OCC): The occupancy rate is a measure of utilization of the available bed capacity. It indicates the percentage of beds occupied by patients in a defined period of time, usually a year. It is computed using the following formula:

$$OCC = \frac{inpatient\ days}{bed\ days} \times 100 \quad (2)$$

Where,

$inpatient\ days = admissions \times ALS$; and

$bed\ days = number\ of\ beds \times 365$ $(i.e.\ the\ number\ of\ days\ in\ a\ year)$

This is a method commonly used in assessing hospital performance. Barnum and Kutzin suggest that hospitals would be operating efficiently at an occupancy rate of 85–90 percent.[17]

Bed turnover ratio (BTR): The turnover ratio is a measure of productivity of hospital beds and represents the number of patients treated per bed in a defined period of time (usually a year). It is computed as follows:

$$BTR = \frac{total\ patient\ admissions}{number\ of\ beds} \quad (3)$$

Turnover ratio in acute care hospitals is expected to be higher than chronic care hospitals.

THE PABÓN LASSO (PL) TECHNIQUE

It has to be stressed that an assessment based on only one of the ratios of hospital bed capacity utilization (see box opposite) may be flawed and misleading. For example, bed occupancy rate may be relatively high in the presence of unnecessarily high average length of stay emanating from such factors as poor nursing care, improper scheduling of diagnostic and therapeutic interventions and the development of nosocomial infections. Thus, although the bed occupancy rate may indicate that there is a good level of capacity utilization, the reality is that this is due to under performance/inefficiency of the hospital. Therefore, to avoid such misleading conclusions, it becomes necessary to make use of all three indicators simultaneously so as to have a better picture. To this end, the method devised by Pabón Lasso to analyse the performance of a

group of hospitals in Colombia is useful.[9]

The PL technique is a graphical method that makes use of the three indicators (BTR, OCC and ALS) concurrently in assessing the relative performance of hospitals. In this method, the occupancy rate (horizontal axis), is plotted against the turnover ratio (on the vertical axis), with vertical and horizontal lines dividing the diagram into four regions. The horizontal and vertical demarcations represent the mean values of the turnover ratio and occupancy rate. It follows from the functional relationship of the three measures that the slope of the line linking the origin to any of the observations (any point on the graph) represents the reciprocal of the ALS of the hospital under consideration. Figure 1 represents the possible features of hospitals located in each of the four regions.

The setting of the cut-off points at the mean values of the BTR and OCC may be contentious. However, Pabón Lasso also suggests using other cut-off points (e.g. allowing a margin of one standard deviation from the mean).[9]

The size of a hospital may sometimes be a cause for inefficiency.[4] A hospital may be too large for the volume of activities that it undertakes; and therefore, may experience diseconomies of scale. On the other hand, a hospital may be too small for its level of operation, and thus experience economies of scale. In the presence of diseconomies of scale, a hospital is inefficiently large. Unit costs increase as the scale of production increases. Diseconomies of scale may arise due to problems such as red tape, poor communication and poor labour relations that are often encountered in large organizations. In the presence of economies of scale a hospital is inefficiently small. Unit costs decrease as the scale of production increases, thus an inefficiently small hospital may improve its efficiency by increasing its size. Economies of scale may occur as a result of staff being able to specialize in their areas of expertise, the ability to spread overhead costs over a larger number of output units, discounts from bulk buying of supplies and the ability to use expensive diagnostic equipment at full capacity. Hence, the assessment of hospital efficiency should also take into account inefficiencies caused by a non-optimal hospital size, which may not necessarily be under the control of the hospital management.

Figure 1. The four zones of the Pabón Lasso diagram

Bed turnover (patients/bed)	Occupancy rate	
	Region II (high BTR, low OCC) • excess bed capacity • unnecessary hospitalization • many patients admitted for observation • predominance of normal deliveries	**Region III (high BTR, high OCC)** • good quantitative performance • small proportion of unused beds
	Region I (low BTR, low OCC) • excess bed supply • less need for hospitalization • low demand/utilization	**Region IV (low BTR, high OCC)** • large proportion of severe cases • predominance of chronic cases • unnecessarily long stays

DATA AND METHODS

SAMPLING

Based on the availability of usable data, a sample of 40 of district level hospitals in Malawi were included in the study. These included both public sector and mission hospitals. Non-public hospitals are of different categories and therefore to ensure comparability, the study team deliberately selected those that are comparable with government district hospitals.

DATA COLLECTION

Data for the financial year 2005/2006 was collected using a questionnaire that included information on inputs, outputs and other factors that influence

the technical efficiency of hospitals.

DATA ANALYSIS

The computation of hospital utilization ratios and construction of the Pabón Lasso diagram was performed using STATA 10.

RESULTS

GENERAL DESCRIPTION

Analysis was performed on data from 40 hospitals, 60% of which were public and the rest were mission hospitals. A descriptive of the statistics of the relevant input and outputs is depicted in Table 2.

It is observed from Table 2 that the primary level hospitals have a wide variation in terms of size and resource endowment. For example, in terms of bed capacity, the range is between 30 beds for Kaluluma rural hospital to 450 beds for Mangochi district hospital. The input and output profile of the hospitals was influenced by the ownership type of the hospitals as can be discerned from Table 3.

Public hospitals are larger than the mission ones in terms of bed capacity and have more staff. Furthermore, public hospitals produce more outputs as measured by outpatient days and inpatient visits. This is, however, more than proportionate to their relative resource endowment. For example, while public hospitals have about 1.4 times more beds than the mission hospitals, their output in terms of inpatient days is about two times more than that of mission hospitals.

CAPACITY UTILIZATION RATIOS

There is a wide variation in the performance of the hospitals as measured by capacity utilization measures: bed occupancy rate, bed turnover ratio and average length of stay. The bed occupancy rate ranged from 14–105%, while the bed turnover ratio fluctuated between 15 and 204 (Table 4).

As can be seen from Table 4, public hospitals had higher bed occupancy rate and turnover ratio. The average length of stay for both types of hospitals was within the range of 3–5 days recommended for acute care hospitals. The occupancy rates are far below the conventionally accepted norm of 80–85% indicating the presence of a significant proportion of unutilized capacity. Hospital capacity utilization measures for each hospital are presented in Table 5.

As discussed earlier, analysis based on only one of the above mentioned capacity utilization ratios may not give a comprehensive picture. Hence, it is necessary to use the three

Table 2. Descriptive statistics: inputs and outputs

Variable	Mean	Standard deviation	Minimum	Maximum
Bed	171.5	90.1	30	450
Outpatient visit	84 709	119 699	7996	522 974
Inpatient day	34 660	26 395	1866	114 605

Table 3. Summary statistics: inputs and outputs by hospital ownership

	Doctor		Nurse		Bed		Outpatient		Inpatient days	
Ownership	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Mission	6	4.2	22	15.6	135	58.8	15 469	9619.1	21 321	16 658
Public	10	8.3	32	25.2	196	100	130 868	136 661	43 552	12 180
Total	8	7.2	28	22.2	171	90.1	84 708	119 699	34 660	26 395

Table 4: Capacity utilization measures by ownership type

	Average length of stay (days)		Bed turnover ratio		Bed occupancy rate (%)	
Ownership	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Mission	4.3	1.7	34	14.3	40	21.2
Public	3.8	4.4	62	40.2	56	26.9
Total	4.0	3.6	51	35	50	25.6

measures simultaneously using the Pabón Lasso diagram as shown in Figure 2.

In Figure 2A , the vertical and horizontal lines are set at the mean values of the bed occupancy rate and bed turnover ratio, while in 2B, the vertical line is set at the accepted norm of 85% for bed occupancy rate.

Table 5. Hospital capacity utilization measures, 2005/2006

Hospital ID	Hospital	Average length of stay (days)	Bed turnover ratio (patients per bed)	Bed occupancy rate (%)
1	Balaka	2.3	118	74.0
2	Chikwawa	6.7	51	93.8
3	Chiradzulu	5.1	33	46.2
4	Chitipa	2.5	41	28.7
5	David Memorial	8.1	21	46.0
6	Dedza	1.7	205	95.1
7	Dowa	5.4	47	70.5
8	Dwambazi	1.7	31	14.2
9	Ekwendeni	2.6	32	23.0
10	Embangweni	4.2	26	30.3
11	Holy Family	5.7	35	54.6
12	Kaluluma	2	66	36.0
13	Karonga	4.3	55	65.3
14	Kasungu	2.4	61	40.7
15	Likuni	5.2	50	72.4
16	Machinga	3.8	91	93.7
17	Madisi	3	33	26.6
18	Mangochi	4	37	40.5
19	Mchinji	2.3	133	84.6
20	Montfort	3	27	22.6
21	Mponela	3.1	45	37.6
22	Mulibwanji	8	25	54.0
23	Mwanza	5	77	105.4
24	Mzambazi	3.7	21	21.3
25	Mzimba	5.1	52	72.4
26	Ngabu	2.6	60	42.2
27	Nkhamenya	4	52	56.8
28	Nkhatabay	1.7	55	25.8
29	Nkhotakota	6.2	15	26.2
30	Nsanje	3.8	38	39.4
31	Ntcheu	4.5	48	58.8
32	Ntchisi	5.7	51	79.3
33	Rumphi	4.9	38	50.3
34	Salima	5.4	12	17.9
35	Sister	4.1	18	20.5
36	St Anne's	3	50	41.5
37	St Gabriel's	4.8	70	91.7
38	St John's	3	36	29.7
39	St Martin's	4.4	34	40.6
40	St Peter's	2.8	21	15.6

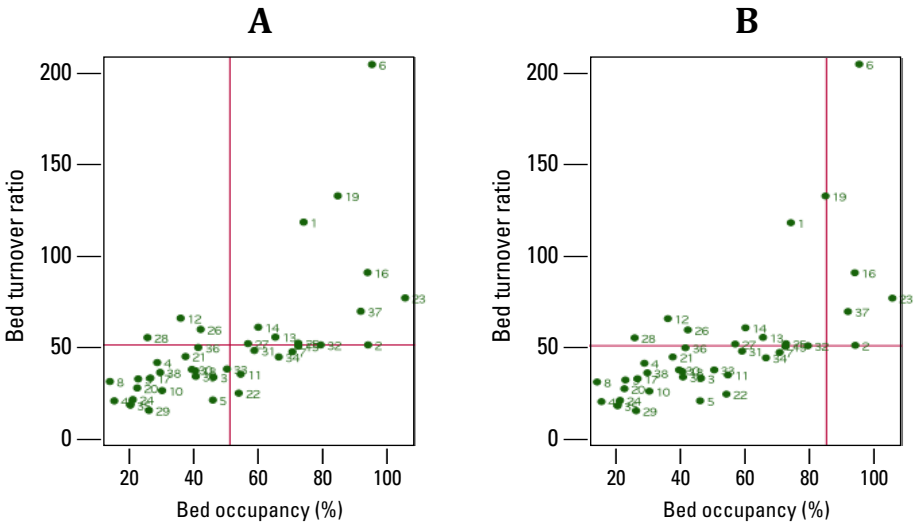
From Figure 2A, it is observed that only 27.5% of the hospitals are located in the desirable region of the Pabón Lasso diagram (right upper region), while close to 50% were located in the left lower region, which is the most undesirable situation that is characterized by low turnover ratio and low bed occupancy rate. When the cut-off for the bed occupancy rate is increased to the conventionally suggested benchmark of 85%, the number of those hospitals located in the desirable (efficient) region decreases to only 12.5%, while the proportion of those located in the most undesirable region increases to 65%. The distribution of hospitals among the four regions of the Pabón Lasso diagram is depicted in Figure 3.

It is observed that even when the mean occupancy rate of the group of hospitals in the study is used as the benchmark, most of the hospitals lie in the region which lies below the means of the occupancy rate and turnover ratio (left lower region). This implies one or more of the following scenarios:

- excess bed supply
- less need for hospitalization
- low demand for or utilization of hospital services

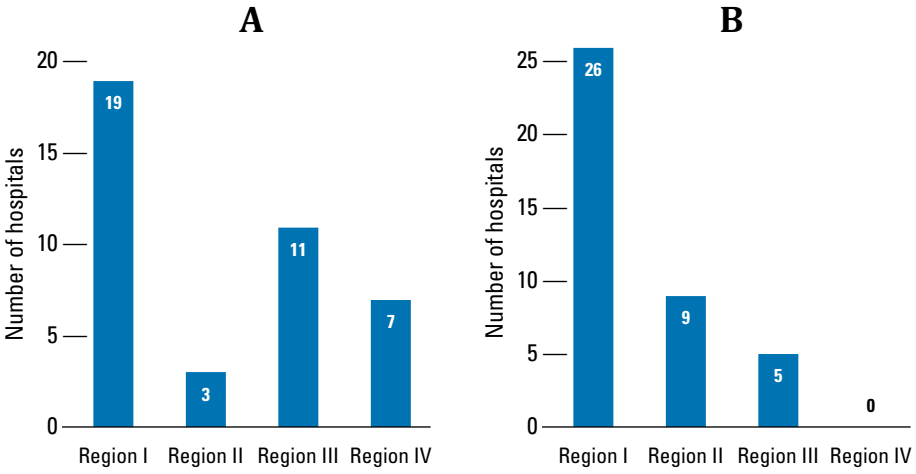
It is also observed that when the benchmark occupancy rate is increased to 85%, the number of hospitals with the above

Figure 2. Pabón Lasso diagram, 2005/2006



Note: The numbers attached to the scatter plots are hospital IDs.

Figure 3. Distribution of hospitals among the four regions of the Pabón Lasso diagram



mentioned scenarios increases. Given the scope of the study, it is not possible to identify the exact nature of the problem. However, whether due to less need for hospitalization or low demand for hospital services, there is an excess supply of hospital beds that merits further investigation. Given the low bed density in the country, we would expect the presence of unmet need for hospitalization and therefore, the case for less need for hospitalization may not be a plausible explanation. Only a few of the hospitals are located at the right upper region, which is the desirable state of capacity utilization.

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This study has assessed the technical efficiency of primary level hospitals using hospital capacity utilization ratios and the Pabón Lasso method. The use of the Pabón Lasso technique helps to draw more robust conclusions by using the three measures of hospital capacity utilization (average length of stay, bed turnover ratio and bed occupancy rate) simultaneously, as using each of the measures separately may lead to misleading conclusions.

The findings clearly indicate the presence of excess bed capacity given the current level of utilization. It should, however, be noted that this does not imply the presence of excess capacity relative to need. In fact, the bed density in Malawi is far lower than that recommended for the size of the population. There may possibly be demand-side barriers of any type (e.g. financial, geographical, cultural etc) that negatively influence utilization of hospital services.

The evidence indicates that capacity utilization is better in public primary level hospitals compared with the mission ones. Public hospitals have

more resources in terms of staff and beds compared with the non-public ones. However, their output, as measured by outpatient visits and inpatient days, is more than proportionate to their resource endowment.

Issues related to economies of scale may also contribute to capacity underutilization and inefficiency. Some hospitals may experience economies of scale (inefficiently small size) and others may be experiencing diseconomies of scale due to their inefficiently large size. Identification of economies or diseconomies of scale is beyond the scope of the analytical technique used and calls for further study using frontier techniques of efficiency measurement.

In the light of the findings discussed above, the following recommendations are proposed with a view to improve hospital efficiency and capacity utilization:

1. Studies need to be conducted to identify individual, household and systemic level barriers to utilizing hospital services and institute appropriate measures that will enhance optimal use of the existing hospital capacity. Demand-creating interventions have to be instituted to counter barriers related to health-seeking behaviour of individuals and households. Systemic bottlenecks need tailor-made interventions depending on the nature of the problem. These, will in the end, stimulate demand/utilization.

2. Given the low bed density in the country, the supply of beds may not match the population's need for hospital services. Therefore, it is not desirable to reduce the number of hospital beds. However, in the interim, that is until the demand-creating interventions bear the desired behavioural change, innovative ways of using the existing relative excess capacity need to be explored.

3. In order to identify inefficiencies related to scale/size, it is necessary to conduct an assessment using frontier techniques of efficiency measurement (e.g. data envelopment analysis or stochastic frontier models including production and cost functions). Furthermore, to assess changes in productivity over a period of time, efforts must be made to collect panel data.

4. As the Pabón Lasso technique is a valuable tool that is easy to use, it is recommended that annual health management information system (HMIS) reports include this kind of analysis in order to provide evidence for management decision-making purposes.

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