ORIGINAL ARTICLE

The Efficiency of General Public Hospitals in Fars Province, Southern Iran

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Abstract

Background: Regarding the increase in expenses for health care services in inpatient settings, much effort has been made to compare the performance of hospitals in recent years and measure their efficiency. In this study, Data Envelopment Analysis (DEA) is applied to measure the technical, scale and economic efficiency of the general public hospitals in Fars Province, southern Iran.

Methods: Twenty one general public hospitals in Fars province, southern Iran in the first and second six months of the years 2005 and 2006 were enrolled. There was an attempt to compare their rate of development or otherwise, using Malmequist index and also to determine their return to scale and rank during these years. The data were collected through a questionnaire by interview and the existing documents were analyzed separately for each year by Algebraic Modeling System (GAMS) software.

Results: Fifteen hospitals (71.4%) were technically efficient and in the next three periods, 14 hospitals proved to be efficient. With respect to scale efficiency in the first 6 months of 2005, 7 hospitals were completely efficient (33.3%), but in the second 6 months of the same year, the number of efficient hospitals was reduced from 7 to 5. In the next two periods, 4 hospitals (19%) were recognized as highly efficient systems. As to the economic efficiency in all 4 studied periods, 4 hospitals (19%) were recognized as completely efficient.

Conclusion: As to the average technical efficiency, state-run public hospitals in Fars Province are in a higher level as compared with those in other studies. However, their average of the scale efficiency is less than that reported in other studies. It seems that the hospitals under the study do not seek profitability since they are public; therefore, they lack any motivation to select a combination of inputs in order to minimize the expenses. It is recommended that hospital managers and decision makers should use DEA to determine the best method of using the available resources.

Keywords: Technical efficiency; Scale efficiency; Economic efficiency; Data development analysis; Return to scale; Malmquist

Introduction

Scarcity of resources in the health care economy is the most important reason to pay attention to productivity and appropriate use of the existing facilities with optimum output in different sectors of health care management. In this regard, hospitals require special attention to be paid to them as the costliest

units of health care system, utilizing an important part of the gross national products.[1,2] Unnecessary increases in the expenses of health care facilities have limited the government's ability to take care of other developmental and social issues, especially those that can positively affect the health care output.[3]

During the recent years, expenses of hospital services have tremendously increased in most countries,[1] so that the hospitals utilize 60% of the total expenses of the health services.[4] Despite the high expenses of the hospitals, a large gap is observed between the development of accessible and necessary resources in this sector. Taking measures to prevent or reduce the

wasting of the allocated resources in hospitals in order to provide widespread services with quality improvement requires comparisons to be made between inputs and outputs, aiming at assessing productivity and efficiency in hospitals.

To increase efficiency, appropriate and reasonable use of the existing resources is necessary. Achieving this goal entails appropriate management and assessment of the output.[1] There are different parametric and non-parametric methods such as ratio, regression and Data Envelopment Analysis (DEA) for measuring the efficiency of hospitals. DEA has been recently used widely due to its potential for measuring numerous inputs and outputs and also its ability in comparing the efficiency of different units.[5,6] It is also considered as a unique and comprehensive measurement method in each unit.[7] Moreover, DEA was introduced as a superior method in the report by WHO in 2003 for measuring efficiency in health systems, and the member countries have been asked to measure the efficiency of their health systems through this method.[8]

Therefore, in the present study, DEA was used for measuring the technical, scale and economic efficiency of general public hospitals in Fars Province in the first and second half of the years 2005 and 2006 to compare the rate of improvement or regression in the hospitals. The Malmquist index and return to scale was also applied to rank the mentioned hospitals as to their efficiency.

Materials and Methods

The present research is a descriptive-analytic study conducted in 2005 and 2006 for measuring the scale, technical and economical efficiency of 21 governmental public hospitals affiliated to Shiraz University of Medical Sciences in Fars Province in the south of Iran. The following hospitals were studied:

Faghihi and Nemazee in Shiraz, Imam Khomeini in Abadeh, Imam Khomeini in Estahban, Valiasr in Eghlid, Omidvar in Evaz, Valiasr in Beiram, Khonj, Imam Hasan in Darab, Raeesi in Sepidan, Imam Sadegh in Saadatshahr, Hazrate Ghaem in Firoozabad, Valiasr in Kazeron, Amiaalmoemenin in Gerash, Imam Reza in Lar, Valiasr in Lamerd, Shahid Motahari in Marvdasht, Valiasr in Mamasani, Fateme al Zahra in Mohr, Shohada in Neyriz, and Vali Asr in Khorambid.

The data were collected using interviews, questionnaires, and available documents in different departments and the hospitals under the study in Shiraz University of Medical Sciences. Algebraic Modeling System (GAMS) was used to analyze the data. To measure the efficiency of the hospitals, DEA as one of the linear and non-parametric techniques for programming, as well as a benchmarking technique were applied in order to examine the efficiency by calculating the ratio of outputs (hospital services) to inputs (hospital resources).

The selection of the most appropriate set of input and output variables is a first step in any study measuring efficiency.[1,4-7,9] Therefore, to measure the technical efficiency, three input variables including the number of fixed hospital beds, the total number of full time equivalent (FTE) physicians, and nurses and other personnel were specified. Moreover, five output variables including bed occupancy rate, patient–day admissions, occupied bed-days, average length of stay (ALS), and the rate of bed turn-over were considered.

As to the measurement of the scale efficiency, the number of fixed hospital beds was specified as input variable and the number of active to fixed beds as output variables. To measure the economical efficiency, the total cost was determined as input variable and occupied bed-day and the number of discharged patients as output variables

Finally, Malmquist index (an index which is used to measure the level of productivity while minimizing the productive factors) was used to determine the progressive and/or regressive trend of hospital efficiency and return to scale was used to show the increase in production while all the resources were increased equally.

Results

The results of the technical efficiency of the first half of the year 2005 showed that 15 hospitals (17.4%) were technically efficient. In the second half of 2005 and first and second six months of 2006, 14 hospitals (66.6%) were efficient and the rest proved to be inefficient. Among the four periods under the study, there was not much difference in the number of efficient hospitals.

Moreover, the results of comparing the scale efficiency in the mentioned hospitals showed that in the first half of the year 2005, 7 hospitals (33.3%) were recognized as completely efficient (with index 1). In the second half of this year, the number of efficient hospitals reduced from 7 to 5 (23.8%). In the first and

second 6 months of the year 2006, four hospitals (19%) were recognized as completely efficient units. These results showed that the process of the scale efficiency in the studied hospitals had a downward trend and during the study period, the number of efficient hospitals decreased from 7 to 4. Among the studied hospitals, the trend of the scale efficiency proved to be fixed in three hospitals so that in all four periods of the study, these three hospitals preserved their scale efficiency. Figure 1 shows the trend of different efficiencies in the hospitals under the study during the study period.

The results of the economic efficiency during the study period showed that four hospitals (19%) were recognized efficient. The average of the economic efficiency was 59% in the first half of 2005, 58% in the second half of the same year, 49% in the first 6 months of 2006, and 46% in the last period, showing a downward trend as to the average efficiency of these hospitals. The obtained results using Malmequist index in different periods of the study showed the following findings:

In the field of scale efficiency during the first 6 months of 2006 compared to the first 6 months of 2005, 14 hospitals (66.6%) had improvement and 6 hospitals (28.5%) had regression. In the second 6 months of 2006 compared to the second 6 months of 2005, 16 hospitals (76.1%) showed improvement. In the field of economic efficiency in the first 6 months of 2006 compared to the

first 6 months of 2005, 8 hospitals (38%) showed improvement. However, in the second 6 months of 2006 compared to the second 6 months of 2005, 16 hospitals (76.19%) had improvement.

With regard to the technical efficiency in the first 6 months of 2006 compared to the first 6 months of 2005, 11 hospitals (52.3%) had improvement and 10 (47.6%) had regression. However, regarding the technical efficiency in the second 6 months of 2006 compared to the second 6 months of 2005, in 12 hospitals there were improvement and 5 hospitals (23.8%) had regression. Among different hospitals in the four studied periods, with regard to achieving efficiency, there were a lot of variations and only in the area of economic efficiency one of the hospitals (No. 20) achieved the top rank in all the four periods of the study.

In general, according to the results of this section, the hospitals showed a progressive trend with regard to technical and scale efficiency so that the number of the hospitals lacking improvement is gradually reducing, but in the field of economic efficiency, these hospitals showed a greater regression trend. The third part of this research is the measurement of return to scale which reveals the rate of increase in production in case all other resources are equally increased. In this comparison, three cases emerged including 1. Constant returns to scale (CRTS), where equal increase in all production factors leads to the same amount of increase in production, 2. Increasing returns
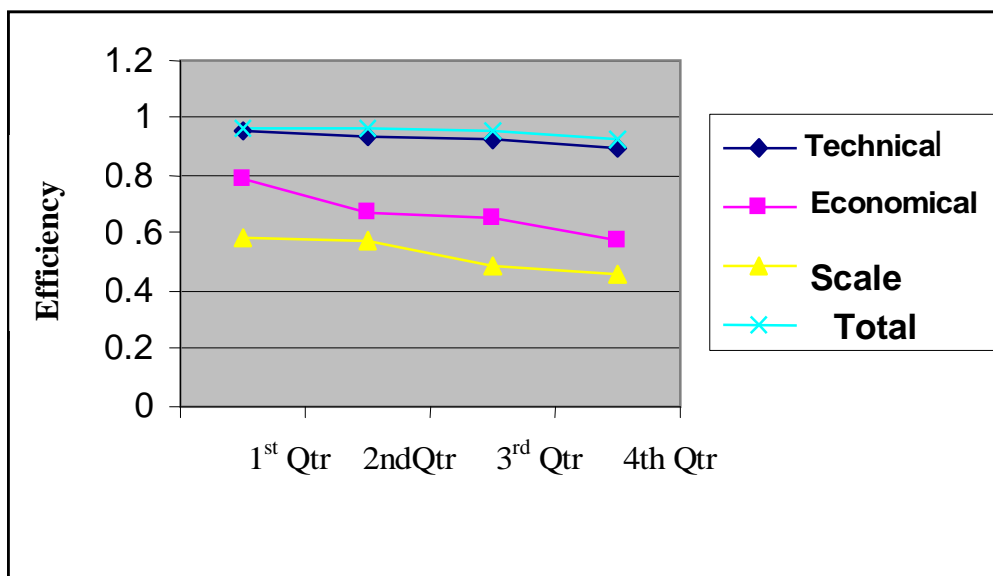

Fig. 1: The mean of efficiency types during the first and second 6 months of the years 2005 and 2006

to scale (IRTS), where equal increase in all production factors leads to more production and 3. Decreasing returns to scale (DRTS), where equal increase in all production factors leads to less production.

According to the above-mentioned points, from the technical efficiency viewpoint, in the first 6 months of 2005, 40% of the efficient hospitals had an input with DRTS. However, in the second 6 months of 2005, this amount reduced to 35.7% of the hospitals while the other hospitals had CRTS. In the first 6 months of 2005, 21.4% of the hospitals had DRTS and in the second 6 months of 2006, this amount increased to 28.5%. In all 4 periods of the study, none of the hospitals in the technical field had IRTS. With regard to the scale efficiency in the first 6 months of 2005, 28.5% of the hospitals had IRTS. In this period, 3 hospitals had DRTS and 2 had CRTS. In the second 6 months of 2005, 40% of the hospitals had IRTS. In the first and second 6 months of 2006, only one hospital had 25% IRTS. In these 4 periods, one hospital had permanent IRTS. With regard to the economic efficiency, in the first 6 months of 2005, among 4 efficient hospitals, 2 (50%) had DRTS. In the second 6 months of 2005, the number of hospitals with DRTS decreased to 3. In the first 6 months of 2006, one hospital (25%) out of 4 efficient hospitals had IRTS and 2 (50%) had permanent DRTS. In the second 6 months of 2006, among the four efficient hospitals, 3 (75%) had DRTS.

The possibility of saving in proper utilization of inputs is presented In Table 1 showing number of beds occupied in the hospitals compared to other inputs that is in a relatively better condition although the findings do not show the conditions to be that satisfactory.

Discussion

Due to the burden pertaining budget and evidence indicating economic inefficiency in health systems, especially hospitals, all developed and some develop-ing countries have extensively taken some measures. The control of expenses in all of these countries with regard to their conditions showed different results.[10] In Iran, hospitals have experienced reduction in budget while there is an increasing demand for health services. Such conditions have caused limitations as to the use of financial resources for governmental organizations such as hospitals.[11] In this condition and with respect to the insufficiency of available resources, implementing management strategies for enhancement of efficiency and improvement of activities in health sectors, and reduction of expenses are inevitable for proper utilization of resources. Due to the differences in the performance and efficiency of hospitals, an important and effective method for their optimization and reconstruction is determining the areas with relatively inefficient functioning.[12]

This study is an attempt to present different dimensions of efficiency to find inefficient areas and give recommendations for enhancement of their efficiency. Based on the results of measuring the technical efficiency, in the four study periods, on average, 67.8% of the hospitals had technical efficiency and total average of this efficiency index was 93%. The study of the process of the technical efficiency shows a decrease in the number of efficient hospitals. It seems that since the studied hospitals are governmental and do not seek profitability, they have no incentive for choosing an appropriate combination of inputs leading to the least expenses or minimum loss. In fact, dependence on governmental resources has caused hospitals to function inefficiently.

With regard to measuring efficiency using DEA method, Kontodimopoulos (2005) conducted a study on the technical efficiency of 17 hospitals. He found that only 5 hospitals (29.4%) were technically efficient.[13] In a similar study, Masiye (2007) concluded that the index of hospital efficiency in Zambia was 67% and only 40% of the hospitals were recognized efficient.[14] Likewise, in 2005, Renner reported that among 37 hospitals, 22 (59%) were recognized effi-

Table 1: Potential saving in inputs in the second half of the year 2006

Inputs	Present use	Best use	Potential percentage of improvement
Fixed bed	2977	2515	15.51
Nurse	758	566	25.32
Physician	344	257	25.29
Other personnel	1419	1094	22.90
Total expenses	311936816019	197106816019	36.81

cient with regard to the technical efficiency. He has reported an average technical efficiency of 63%.[15]

In 2005, Osei *et al.* studied 17 hospitals with regard to the technical efficiency, and reported 9 hospitals (53%) as efficient.[16] Also, the study of Kirigia *et al.* (2001) showed that 56% of the health care centers in Kenya were efficient centers regarding the technical efficiency with an average of 65%.[17]

In another study carried out by Zere *et al.* (2001), the technical efficiency of the hospitals in South Africa was estimated to be about 34-48%.[18] Ferrier *et al.* in 2005 studied the technical efficiency of different hospitals and the average efficiency was 60%.[19]

It can be concluded that our hospitals are more efficient technically as compared with those of the above-mentioned studies. Also, comparison of the technical efficiency of the mentioned studies with that of the present study (93%) shows a higher level of general public hospitals in Fars Province in this regard.

In a study in Iran by Hatam *et al.* (2008), it was revealed that lack of technical efficiency can be due to inappropriate use of inputs (fixed bed, number of nurses, number of physicians, number of personnel) and processing them with required outputs (percent of occupied beds, patients per day, occupied beds per day, the mean length of hospital stay and turn-over of beds) reporting that the most important factors for the decrease of technical efficiency in hospitals are inappropriate use of beds, a decrease in patient-days, and the number of occupied beds.[1]

Comparison of different types of efficiency in the present study and those in other studies reveal that most of our hospitals have better conditions in the field of technical efficiency. This can be due to the existing program for recruitment of human resources in hospitals in Iran and strict supervision and management by the Ministry of Health and other officials providing human resources.

The obtained results of determining the scale efficiency of the hospitals under the study showed that the percentage of hospitals with scale efficiency had a downward trend in the four periods of the study and there was a decrease from 33.3% in the first 6 months of 2005 to 19% in the first and second half of 2006. However, in the present study, the average of efficient hospitals during the study period was 23.8%.

Renner *et al.* (2005) in his research found that 35.1% of hospitals were efficient regarding scale efficiency.[15] Among 17 hospitals being studied by Osei *et al.* (2005), 58.8% were found to be inefficient with regard to the scale efficiency.[16] The downward trend

of the scale efficiency obtained by this research is in line with the results of Zere *et al.* (2006) study.[20]

Moreover, the mean efficiency index (23.8%) shows a great difference with that obtained in other studies.[15,16,19] Also, Kirigia *et al.* in 2001 reported that the average of the scale efficiency among Nakara centers in Siera Leone was 72%, in Kenya it was 70%, and in one of the South African provinces, the scale efficiency was 84%.[17]

As to Kirigia *et al.* study, it is noticed that the scale efficiency of the studied hospitals was in a more unfavorable situation as compared with the hospitals in Africa. As a whole, the above studies show that the average of scale efficiency in the present study (67%) is less than that in the other studies.[16,17] However, the downward trend of this efficiency in general public hospitals in Fars is more obvious as compared with the other studies. To enhance the efficiency level, resources should be appropriately used and the trend be reversed so that they can reach the average of the scale efficiency of other countries. This case needs a proper and effective management in hospitals, efficient health care policies, proper use of hospital beds, and establishment of hospitals with sufficient beds to meet the community needs. The results of the economic efficiency show that in all the four periods studied, only 19% of the hospitals were recognized as efficient and this percentage shows that the least efficiency among them is related to economic efficiency.

Giokas in his study in Greece (2002) used hospital expenses for measuring the efficiency of general public hospitals. Among 72 studied hospitals, 8 (11.1%) were found to be efficient.[3] Also, a survey of the average of the economic efficiency index among the hospitals under the study showed that during the four study periods, this average has decreased from 59% to 46%. It should be mentioned that Giokas reported the average of economic efficiency of Greek hospitals to be less than 70%.[4]

Since the studied hospitals are governmental, dependence on governmental resources has caused lack of efficiency in this regard. Consequently, utilizing suitable programs and policies for the optimal use of financial resources is inevitable. It should be mentioned that it is potentially possible to save resources, using DEA in case hospitals are efficient. The possibility of saving in proper utilization of inputs is presented In Table 1 showing that the most changes for increasing the efficiency can be done by reducing the total expenses and then by decreasing the number of nurses and physicians. The data in Table 1 reveal that

the number of beds occupied in the hospitals compared to other inputs is in a relatively better condition although the findings do not show the conditions to be that satisfactory. Achieving this amount of saving in resources with regard to the limitations of the health care resources can contribute to improvement in functioning and promotion in productivity and efficiency of hospitals.

The Malmequist index was used to determine the level of improvement or regression in the studied units in different time periods. In this study, the first 6 months of the year was compared with that of the previous year and the second 6 months of the year was compared with that of the previous year while considering the type of the mentioned units (hospitals), the possibility of differences in the patients' referral and in hospital expenses, and climatic conditions in different seasons of the year. The obtained results of the scale efficiency show that despite the overall decrease in this type of efficiency, most hospitals show more advancement as compared with themselves (on average 75%). As to the economic efficiency, 57% of the hospitals show an enhancing trend.

With regard to the technical efficiency, 54% of the hospitals had advancement. On the whole, it seems that the studied hospitals pay more attention to advancement in the field of the scale efficiency. In the study period, the number of efficient hospitals with regard to the technical, economical and scale efficiencies were 14, 4 and 5 hospitals, respectively.

With regard to the importance of the use of resources and processing them to hospital outputs, return to scale was used. The following results were obtained:

As to the scale efficiency in the study period, only one hospital had IRTS, one had DRTS and one was always faced with CRTS. In a study of efficiency by Masiye in (2007), among 30 studied hospitals, 13 had IRTS, 13 DRTS and 4 CRTS.[14]

With regard to the economic efficiency, it is of interest that during the study period, only one hospital had IRTS and 62% of the economically efficient hospitals had DRTS. I n other words, allocating more financial resources to these hospitals not only does not increase their economic efficiency, but also leads to a downward efficiency, as compared with increased resources. That is, if we are to allocate more resources to efficient hospitals, it is better to be done for hospitals with increasing return to scale.

In Linna *et al.* study (2006), among the 8 hospitals studied, 5 had CRTS with regard to economy and the others had variable returns to scale.[21] However, in the present study, from the point of technical efficiency, none of the hospitals was IRTS. Considering the obtained results, allocating resources such as increasing the number of beds, the number of nurses, physicians and other personnel in the studied hospitals will not result in considerable changes. Nevertheless, more saving of the resources can considerably contribute to the efficiency of hospitals.

Junoy (2000) in his research in Spanish hospitals indicates that the level of saving in inputs should be improved as much as 7.38% for physicians, 14.12% for nurses and 8.42% for the other personnel. However, it is of interest that he expresses no change for hospital beds, showing the appropriate use of hospital beds in his study.[22]

In the study by Giokas in 2002, the cost of each bed was 46,154 Euros while the optimal amount was 31,675 Euros. Finally, the potential improvement in the total expenses was 31% which is nearly similar to that obtained in the present study (36.81%).[4]

Since the studied hospitals are governmental, it seems that the same factors have caused them not to seek profitability and, therefore, they have no motivation for choosing a combination of inputs with the least expenses and/or they do not intend to minimize the losses. In fact, dependence on governmental resources has caused hospitals to be faced with inefficiency. In order to solve the mentioned problems, the followings measures are recommended. (i). Familiarizing hospital managers with methods of measuring efficiency and the importance of using the obtained results for enhancing the hospital efficiency, (ii). Estimating the hospital efficiency regularly, using Data Envelopment Analysis, (iii). Using the results of Data Envelopment Analysis for efficient use of available resources by hospital managers and decision makers, (iv). Comparing all hospitals in different time periods and measuring their promotion in the mentioned period and (v). Creating more competitive conditions among hospitals, considering the fact that the rank of the mentioned hospitals can effectively help to promote their efficiency.

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References

1 Hatam N. The Role of Data Envelopment Analysis (DEA) pattern to determine the efficiency in Iran Social Security Organization hospitals. *Iranian Red Crescent Med J* 2008; **10**:208-211.

2 Rajabi A. The role of activity based costing (ABC) system in governmental hospital services in Iran. *Iranian Red Crescent Med J* 2008; 10:89-94.

3 New Directions in Health Care Policy". Organization for Economic Cooperation and Development. Health Policy Studies No7, 1995; p. 67.

4 Giokas D. The Use of Goal Programming, Regression Analysis and Data Envelopment Analysis for Estimating Efficient Marginal Costs of Hospital Services . *Journal of Multi-Criteria Decision Analysis* 2002; **11**:261-8. [doi:10.1002/mcda.330]

5 Charles A, Cooper WW, Rhodes E. Measuring Efficiency of Decision-making Units. *Eur J Operational Res* 1978;**3**:429-44.

6 Banker RD, Charles A, Cooper WW. Models for Estimating Technical and Scale Efficiencies in Data Envelopment Analysis. *Management Science* 1984;**30**:1078-92.

7 Mehregan, MohammadM. Quantitative Models for Evaluating Function of Organizations (DEA), Publication of Management Faculty of Tehran University, First Publication, 2004.

8 Health System Performance Assessment. Edited by Murray, C. Evans, D Geneva: WHO, 2003.

9 Hajialiafzali H, Moss, JR, Mahmood MA. Efficiency Measurement for Hospitals Owned by the Irani Social Security Organization. *J Med Syst* 2007;**31**:166-72.

10 Organization for Economic cooperation and Development New Direction in Health Care policy. No 7, 1998; pp. 50-97.

11 Organization for Economic cooperation and Development. Health policy studies. "New Direction in Health care policy". No 1, 1983; pp. 82-87.

12 New Brander W, Kutzin J, Barnum H. Hospital Economic and Financing in Developing countries . World Health organization 1992; pp. 1-80 .

13 Kontodimopoulos N. Balancing Efficiency of Health and Equity of Access in Remote Areas in Greece. Health Policy 2005; pp. 72:11.

14 Masiye F. Investigating health system performance: an application of data envelopment analysis to Zambian hospitals. *BMC Health Serv Res* 2007;**7**:58. [17459153] [doi:10.1186/1472-6963-7-58]

15 Renner A, Kirigia JM, Zere EA, Barry SP, Kirigia DG, Kamara C, Muthuri LH. Technical efficiency of peripheral health units in Pujehun district of Sierra Leone: a DEA application. *BMC Health Serv Res* 2005;**5**:77. [16354299]

16 Osei D, d'Almeida S, George MO, Kirigia JM, Mensah AO, Kainyu LH. Technical efficiency of public district hospitals and health centres in Ghana: a pilot study. *Cost Eff Resour Alloc* 2005;**3**:9. [16188021]

17 Kirigia JM, Sambo LG, Scheel H. Technical efficiency of public clinics in Kwazulu-Natal Province of South Africa. *East Afr Med J* 2001;**78**:S1-13. [12002061]

18 Zere E, McIntyre D, Addison T. Technical Efficiency and Productivity of Public Sector Hospitals in three South Africa Provinces. *South Afr Econom J* 2001;**69**:336-58.

19 Ferrier GD, Valdmanis VG. Peer Effects and Efficiency: The Influence of Competitors' Performance on Hospital Efficiency .*Cost Eff Resour Alloc* 2005;**14**:7.

20 Zere E, Mbeeli T, Shangula K, Mandlhate C, Mutirua K, Tjivambi B, Kapenambili W. Technical efficiency of district hospitals: evidence from Namibia using data envelopment analysis. *Cost Eff Resour Alloc* 2006;**4**:5. [16566818]

21 Linna M, Häkkinen U, Magnussen J. Comparing hospital cost efficiency between Norway and Finland. *Health Policy* 2006;**77**:268-78. [16129509] [doi:10.1016/j.healthpol.2005.07.019]

22 Junoy JP. Partitioning Input Cost Efficiency into its Allocate and Technical Components: an Empirical DEA Application to Hospitals. *Socio-Economic Planning Sciences* 2000;**34**:199-218.