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Measuring Efficiency of General Hospitals in the South of Iran

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Abstract: Governmental general hospitals play main role in providing the health care services in Iran. Besides they consume the largest proportion of health care resources in the country, they renowned for operating inefficiently. Acquire information about magnitude and factor contributing to the inefficiency of the governmental hospital is critical in order to improve efficiency of the hospital in the country Data Envelopment Analysis (DEA) was used to study the relative efficiency of general hospitals affiliated to the Ahvaz Jundishapur University of Medical Sciences in Khuzestan province of Iran. Based on the data from 19 hospitals in the year 2006, the average technical, pure technical (or managerial) and scale efficiency in the hospitals were 0.913, 0.943 and 0.968, respectively. The overall technical efficiency score ranged from 0.695 to 1. Ten (53%) out of 19 hospitals were technically inefficient and approximately 53% of hospitals were operating on non-optimal size. The study indicated inefficiency of resource use in the governmental hospitals in the province is significant. The study provided useful information for policy makers and hospital managers in the province and the national level to develop strategies for improving efficiency of governmental hospitals.

Key words: Technical efficiency · Pure technical efficiency · Scale efficiency · Data envelopment analysis · Return to scale · Khuzestan province

INTRODUCTION

In recent years, the issue of efficient allocation of health care resources, especially in hospitals, has been increasingly considered by health policy makers in Iran. Of the most important reasons of this consideration is rapid increase in health expenditures in the country, which could be mainly attributed to demographic changes and epidemiological transition of disease during the past decades in the country and other factors such as increased expectations of population and rapid growth of using sophisticated technologies [1].

According to WHO [2], the share the health expenditures from the gross domestic product (GDP) increased from 4.7% in 1995 to 7.8% in 2006 (66% growth) and general government expenditure on health as percentage of total expenditure on health increased from 49 in 1995 to 55 in 2006 (11% growth).

About 33% of total health expenditure is allocated to inpatients services provided by hospitals in country [3]. Thus, close examination of the technical efficiency of hospitals is necessary in order to optimize the utilization of the available health care resources and mobilize additional resources for the health system through efficiency gains.

Like other LMICs [4], even though efficiency is accorded a central place in the national policies (especially in Third and Fourth Socio-Economical Development Acts) of Iran for many years, in practice much remain to be done. But, in recent years the government implemented some reforms in order to improve efficiency of health care delivery system. Two important reforms were the separation of provider and purchaser, through establishing of the Ministry of Welfare and Social Security and separation of insurance organizations from the Ministry of Health and starting

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reform of economical and managerial structure of governmental hospitals (including, reforms in structure and forming Board of Trustees in hospitals, implementing performance-based budgeting, establishing hospital information system and maintenance management) [5].

Most of the studies done about hospital efficiency are related to high income countries [6-9] and few studies have been done in this area in LMICs [4, 10-13]. Searching literature about Iran, we found two studies measuring efficiency of hospitals. First study measured efficiency of hospitals affiliated to Social Security Organization (SSO)[14] and the second one efficiency of Cardiac Care Units (CCUs) of Isfahan city Hospitals [15].

The current study, using the data envelopment analysis (DEA) approach, aimed to measure the technical efficiency of general governmental hospitals of Khuzestan province in Iran. These hospitals are acting as the main service providers in the province under the authority of the Medical Sciences University in the province. The authors believed that this study provide information that can be useful for policy, planning and operational management of governmental hospitals in Iran.

MATERIALS AND METHODS

Study Area: According to the 2006 census, the total population of Iran was about 70 million that of which 68 % lived in urban areas within 30 provinces in the country [16]. Public sector plays main role in both financing and provision of health services in Iran [1]. The Medical Sciences Universities as agents of Ministry of Health have a functional authority for managing health services in the provinces. By 2007, 67 % of hospitals (including 71 percent of active hospital beds) in the country were affiliated to Ministry of Health through Medical Universities. Number of authorized hospital beds has experienced a significant increasing during last two decades (about 57% growths between 1986 and 2005) [16].

Khuzestan province is located in the southwest of Iran. Based on 2006 Census, its population was about 4.3 million people (6 % of total population of the country). With 15 % contribution in GDP of the country, Khuzestan province has second rank among the provinces in Iran. Furthermore, it has 45 hospitals, of which 30 are affiliated to the Ahvaz Jondishapur University of Medical Sciences and the others owned by SSO, charities and military organizations [17].

Efficiency Measurement: The efficiency concept used in this study is "technical efficiency" which is a measure based on work of Farrell [18]. A hospital is technically efficient when it is producing the maximum amount of output from a given amount of input, or alternatively producing a given output with minimum quantities of inputs. Thus, when a hospital is technically efficient, it operates on its production frontier [19]. As it has been shown that estimation of frontier function is a very useful tool for efficiency analysis in health care sector [20], a considerable proportion of studies use it for investigating efficiency of health care organizations.

Data Envelopment Analysis (DEA): Two main models for estimating the frontier functions are deterministic and stochastic techniques. DEA is a deterministic and non-parametric linear programming method for evaluating relative efficiency of each production unit among a set of fairly homogeneous decision-making units (DMU_s), e.g. general hospitals, health centers and other health care providers [21]. With applying combinations of inputs and outputs from best performing organizations, DEA construct a production possibilities frontier. Organizations that compose the "best practice frontier" are assigned an efficiency score of one and are supposed technically efficient compared to their peers. Inefficient organizations are 'enveloped' by the efficiency frontier in DEA. The inefficiency of the organizations within the frontier boundary is calculated relative to this surface and those are assigned a score between one and zero [22]. DEA usually introduce in forms of ratios. This model is based on performance of j=1, 2,…,n DMUs which try to transform their inputs to interested outputs. Efficiency of jth DMU is determined as follow:

$$h_j = \frac{\sum_{r=1}^{s} U_{rj} Y_{rj}}{\sum_{i=1}^{m} V_{ij} X_{ij}}$$

U_{rj} and V_{ij} show the weight of rth output and ith input, respectively. X_{ij} is ith consumed input by DMU_j and Y_{rj} is rth output produced by DMU_j. The value of h_j must less than or equal to unity. The input- or output-oriented linear programming models are used to get the score of efficiency. The Charnes, Cooper and Rhodes (CCR) input-oriented model is as follow [23]:

$$\text{Max } z_j = \sum_{r=1}^{s} U_r Y_{rj}$$

Subject to

$$\sum_{r=1}^{s} U_r Y_{rj} - \sum_{i=1}^{m} V_i X_{ij} \le 0$$

$$\sum_{i=1}^{m} V_i X_{ij} = 1$$

$$U_r, V_i \ge 0$$

Using input-oriented technical efficiency measures (which keep output fixed and explore the proportional reduction in input usage which is possible), we employed a model with variable return to scale (VRS) developed by Banker, Charnes and Cooper [24]. This model enables us to divide the total technical efficiency scores to two parts: pure technical efficiency (also known as managerial efficiency) and scale efficiency. Pure technical efficiency is proportion of technical efficiency which is not attributable to divergences of optimal scale and it is related to operation. Scale efficiency indicates the degree to which a hospital is producing at optimal scale [25]. One important justification for selecting input-oriented model related to this fact that hospital managers have more control over inputs rather than outputs [15].

The main reasons for selecting DEA for the current study is that DEA is able to handle multiple inputs and outputs with different units, it is suitable for small sample size studies, it is able to provide additional information in terms of the size of inefficiency and that DEA does not require determination of a functional form for production process in health care [14].

For estimating efficiency score based on DEA we used DEAP 2.1 program which designed by Coelli [26].

Data Source and Sample: Data for the study were obtained from the Statistics Bureau of Ahvaz Jondishapur University of Medical Sciences and in some cases collected directly from the hospitals. The sample included all 26 general hospitals affiliated to the Ahvaz Jondishapur University of Medical Sciences in Khuzestan Province.

Input and Output Variables: Based on literature and considering limitations of data related to performance of the hospitals in the province and also sample size, we used two input variables and four output variables. Input variables were consisted of human resource (including total number of physicians, specialists, nurses and others) and number of beds which is used as a proxy for capital inputs in hospital efficiency studies [27]. Output variables were included of number of outpatient visits, number of inpatient visits, number of surgeries and percentage of occupied beds.

RESULTS

Out of 26 general hospitals, seven hospitals were excluded because they did not have the data required for the analysis. Table 1 provides a summary statistics of input and output variables of the hospitals in 2006. The findings indicate substantial differences in the output and input variables among the hospitals in the province. The size of the hospitals in terms of number of beds ranges from 22 to 504 beds. Bed occupancy rate among the hospitals ranges from 19.8 to 88.4 %. Furthermore, bed occupancy rate in 42% of the hospitals was less than the mean of the total sample. There was, on average, 2.45 staff (medical and non-medical) per active beds in the hospitals.

Table 2 presents the results of DEA model. The results show considerable efficiency differences between the hospitals in the province. The overall technical efficiency score ranges from 0.695 to 1. Ten (53%) out of 19 hospitals were technically inefficient. The average of overall technical efficiency was 0.913 with a standard deviation of 0.102. The average pure technical efficiency (or managerial inefficiency) and scale efficiency was 0.943 and 0.968, respectively. The magnitude of pure technical inefficiency was greater than scale inefficiency (5.7% vs. 3.2%) among the hospitals.

Based on the hospitals on efficient frontier as benchmark, DEA provide insights to inefficient hospitals about output increases and /or input reductions which make them efficient (Table 3). The inefficient hospitals could be technically efficient if they were able to increase their output levels by 1% more inpatient days, 2% more outpatient visits, 6% more surgeries and 7% bed occupancy rate, while holding their current input use constant. Alternatively, the inefficient hospitals could be technically efficient if they were to reduce their current number of human resources by 5% and number of beds by 4.5%, while have their current output level.

Table 1: Summary statistics of input and output variables

Variable	Mean	Standard deviation	Min	Max
Inpatient days	41386.32	34414.00	1592.0	131679.0
Outpatient visits	11633.60	7165.00	764.0	28036.0
Number of surgeries	4521.00	5469.00	161.0	25422.0
Bed occupancy rate (%)	65.20	15.11	19.8	88.4
Human resources	406.69	271.00	91.0	999.0
Beds	165.85	127.00	22.0	504.0

Table 2: Efficiency scores, return to scale, reference set and rank of hospitals

Hospitals no.	Overall technical efficiency	Pure technical efficiency	Scale efficiency	Return to scale	Reference set*
1	1	1	1	Constant	-0
2	1	1	1	Constant	-
3	0.95	1	0.95	Decreasing	-
4	0.916	0.92	0.996	Increasing	1,8,17
5	0.782	0.797	0.981	Decreasing	2,7,8,17
6	0.829	0.843	0.983	Decreasing	2,7,8,17
7	1	1	1	Constant	-
8	1	1	1	Constant	-
9	0.933	1	0.933	Decreasing	-
10	0.773	0.824	0.938	Increasing	2,17,19
11	0.806	0.837	0.963	Increasing	2,8,15,18,19
12	0.883	0.957	0.923	Decreasing	9,13,17
13	1	1	1	Constant	-
14	0.695	0.742	0.937	Increasing	7,8,13,15,19
15	1	1	1	Constant	-
16	1	1	1	Constant	-
17	1	1	1	Constant	-
18	0.791	1	0.791	Increasing	-
19	1	1	1	Constant	-
Mean (SD)	0.913 (0.102)	0.943 (0.087)	0.968 (0.051)	-	-

*. For inefficient hospitals (VRS Model)

Table 3: Total output increases and/or input reductions in inefficient hospitals to reach full efficiency

Variable	Radial movement (R)	Slack movement (S)	Total value (R+S)	Changes (%)
Inpatient days	0.00	5673.46	5673.46	0.72
Outpatient visits	0.00	4135.53	4135.53	1.87
Number of surgeries	0.00	5224.28	5224.28	6.08
Bed occupancy rate (%)	0.00	87.80	87.80	7.09
Human resources	-363.16	0.00	-363.16	-4.70
Beds	-138.78	-2.26	-141.04	-4.47

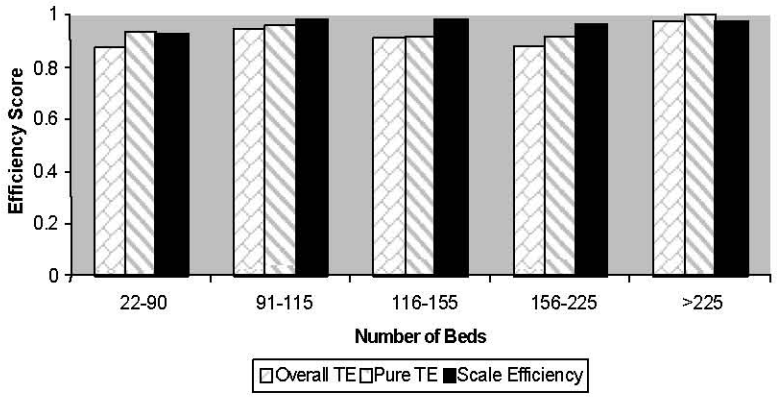

Fig. 1: Relationship between efficiency scores and number of beds
* TE: Technical Efficiency

Based on the results, approximately 53% of hospitals are operating on non-optimal size (26.3% increasing return to scale and 26.3% decreasing return to scale) and need to alter their capacity to increase efficiency. In order to explore the relationship between the efficiency scores and the number of beds, the hospitals were divided to five groups. Figure 1 presents the changes of the efficiency scores as number of beds change in the groups. As can be seen from the figure, the hospitals with beds under 90 and the hospitals with 156 to 225 beds have weaker performance compare to other groups.

DISCUSSION

The current study, using DEA method, measured technical efficiency of general hospitals affiliated to the Ministry of Health in Khuzestan province in south of Iran.

The study indicated that more than half of the hospitals in the province are not operating at the technically efficient levels. This illustrates a considerable possibility to improve performance of the hospitals. According to the findings, average technical efficiency score of the hospitals in 2006 were 0.914. This indicates that, collectively, the hospitals could produce their current level of output with about 9 % reduction in the use of resource inputs included in the model. Moreover, the finding shows that technical efficiency scores ranges from 0.695 to 1, revealing considerable variations in efficiency scores among hospitals in the province.

The results of this study are similar to the findings from a study done by Hajialiafzali *et al.* [14] in the hospitals affiliated to the SSO in Iran. The study found that 27 out of 53 SSO hospitals to be technically inefficient, with average technically score of 90%. In another study in Iran, Ketabi [15] undertook DEA to measure efficiency of CCUs in five different hospital categories in Isfahan city. The study showed that the percentage of inefficient CCUs in teaching, health care network, SSO, private and charity hospitals are 83, 14, 33, 60 and 50, respectively.

Moreover, the findings revealed that more than half of the hospitals are operating on non-optimal size, which among those 26% were operating on increasing return to scale while other 26% were operating on decreasing return to scale. This indicates that improving efficiency of the hospitals would require downsizing the hospitals operating on decreasing return to scale and shifting their resources to those performing on increasing return to scale. Four out of seven hospitals with more than 155 beds were operating on decreasing return to scale, suggesting that they need to decrease their production capacity in order to improve their efficiency. It seems that efficient scale of hospitals is located within 90 to155 beds. It should be considered that improving scale efficiency of the hospitals requires long-term efforts, especially in Iran which hospital managers have limited responsibility to change their staffing profile and capital stock of the hospitals [28].

Lastly, it should be noted that the current study is subject to some limitations upon which future studies should improve. First, given the study were conducted only in one province, the results cannot be generalized to the whole country. It is recommended that similar studies should be conducted in remaining 29 provinces. Further, due to lack of data about variables reflecting severity of diseases and quality of care provided in the hospitals, we were unable to determine in what extent the inefficiency might be caused by quality of care variations. More efforts need to be done for developing appropriate indicators reflecting quality of care in the hospitals in order to improve quality of future studies measuring hospital efficiency.

CONCLUSION

According to the various statements contained in the national health policy and the health sector reforms that the Ministry of Health has been implementing, optimizing the use of the scarce health resources and improving efficiency of health sector is one of the main priorities for health policy makers in the country.

The current study revealed the prevalence of high levels of technical and scale inefficiencies in the governmental hospitals in Khuzestan province. This study can be used as an evidence for empowering health policy makers and managers in the province and in the national level to develop concrete strategies for improving efficiency of the hospitals. The study also provides a baseline for efficiency information that could be used in monitoring the efficiency effects of policy changes and reforms implemented by the Ministry of Health. To estimate the level of efficiency savings in the overall health system, it is also advisable to conduct similar studies in all types of health facilities in the country.

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Conflicts of Interest: The authors declare that they have no competing interests.

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