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# Inpatient Case-mix Cost Vs Average Cost for Health Care Services in King Fahd Central Hospital, Saudi Arabia: A Comparative Study

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## Abstract

Health care systems aim to deliver high-quality medical care while considering efficient resource usage and cost-effective forms of interventions. Such purposes require scientific tools or mechanisms which aid in cost assessment before the efforts of cost reduction are considered. Diagnosis-related groups based costing methodology (Case-mix) is considered one of the preferred costing approaches in the health care sector. King Fahd Central hospital Jazan, the only tertiary hospital in the Jazan region, was selected for case-mix system-based patient-level costing of health services. The study's objective was to estimate the cost per Diagnosis-Related Group (DRG) per inpatient admission and compare it with the already established average cost of health care services for inpatients. We applied a cross-sectional retrospective approach to categorize the inpatients based on their diagnosis and procedures and then estimate the actual cost of health care services provided to inpatients during 2018 and compared it with the average cost of the health services. There was a considerable difference between DRG-based costing (SAR 269,663,897) and average costing (SAR 247,035,938). The Diagnosis Related Group costing was found to be more reliable and representative of the services provided to the patients and is recommended to be used for reimbursement purposes.

## Keywords

case-mix costing, average costing, health services costing, health economics, patient-level top-down costing, Saudi Arabia

## Highlights

- What do we already know about this topic?  
We have already published two articles related to hospital services cost estimation.
- How does your research contribute to the field?  
In Saudi Arabia, the cost of health care services is not available, and this research will help establish a reimbursement system in hospitals.
- What are your research's implications towards theory, practice, or policy?  
It will help to establish a case-base payment system and reimbursement policy at public hospitals.

some of the costliest operational units in the health care system which utilize ample resources to deliver the kind of services they are purposed to do so.<sup>1</sup> A significant effort is required to limit the cost of health services. But it poses a challenge to determine what services need to be selected for cost cutting or what departments or units need to be looked at, in terms of minimizing the resource spending.<sup>2</sup> Besides, variations in output, size, service, quality, and efficiency substantially affect hospital services costing.<sup>3</sup> The cost assessment of services will be vital as it plays a critical role in enhancing hospital productivity, resource distribution,

## Introduction

Hospitals are multiproduct organizations that provide a wide range of services of variable quality and cost. They also house

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future planning, and comparing performance with other hospitals.<sup>4</sup>

According to World Health Organization, within the hospital the inpatient care, outpatient care, and medical supplies are 3 critical functional areas that consume more than 70% of the total hospital resources.<sup>3</sup> A well-developed costing methodology, accounting system, and standardized patient data are required to estimate the cost of these critical functional areas. There are many approaches to health care costing worldwide. The choice of costing approach mainly depends on the purpose and objectives of the costing exercise and services provided in health care settings.<sup>5</sup> Case-mix system/ Diagnosis-related groups (DRGs) based costing methodology is considered one of the preferred costing approaches in the health care sector.<sup>6-8</sup> DRGs were introduced in 1983 to classify each patient based on diagnosis and other features such as patient's age and gender, the severity of illness, and procedures performed.<sup>8</sup> In this system, the patients are grouped into more expressive and resource identical groups that can define the hospital health service product.<sup>9</sup> All case-mix systems used Diagnosis-related groups to define their products related to health services.<sup>10</sup> Accurate DRG-based cost information enables policymakers to detect resource consumption and sources for different treatment options more efficiently.

In 2020 we conducted a study in Saudi Arabia to estimate the average cost of hospital services. One of the critical outcomes of this study was estimating the average departmental cost and the average cost of each patient per day.<sup>11</sup> It was intended that such information would permit a valuable comparison of the cost performance by using the case mix methodology within hospital departments and across hospitals.

This study was a second phase of the aforementioned work that examines the extent of cost variation using a different methodology. Here, we estimated the cost per DRG per inpatient admission and compared it with the already established average cost of health care services for inpatients at King Fahd Central Hospital, Jazan, Saudi Arabia.

## Methodology

It was a comparative study focusing on average health care cost and cost based on case mix system/DRGs. We conducted this study in King Fahd central hospital, Jazan, Saudi Arabia. It is a tertiary-level hospital with 500 patient beds capacity. The hospital had 8 specialty wards, and due to social norms, each ward had male and female sections. The total inpatient admissions for the calendar year 2018 were 12,979, whereas 336,000 outpatients visited the outpatient clinics during the same period.

The hospital recently implemented a standardized classification system (International Classification of diseases (ICD-10) Australian Modification) to code the patient clinical data. We developed and assigned DRG codes to each patient by using the clinical data of the patients and applied a top-down costing approach for cost estimation.

We observed that out of 12,979 patient cases, 888 patient records were incomplete as some variables of the patients were missing, like date of admission, gender, diagnosis, and procedures. We selected the remaining 12,091 patient cases for the DRG assignment. After processing the input file through DRG software, 492 error DRGs were assigned to patient cases. Finally, we had 11,599 patient cases with valid DRG codes that were selected for this study, as given in flow chart (Figure 1).

## Case-Mix Costing Approach

In this study, we compared the DRG-based health services cost with the already established average health services cost for inpatients. For this purpose, we followed the methodology adopted by Zafar A.<sup>9</sup> to develop cost centers and phased the study into 2 parts. Part 1 was related to the patient DRGs classification based on the clinical data, while Part 2 dealt with patient-level costing. The Figure 2 explains the steps followed to classify the patients into groups and estimate the patient level cost based on these groups.

## Results

The bed occupancy rate of the hospital was 98.71%. Out of the 11,599 patients selected for the study, 5015 were male patients, while 6584 were female. The highest number of patients were discharged from the Pediatric ward was 33.50% of the total patients discharged from the hospital. In comparison, the gynecology ward had the second-highest patients with 22.7%. Table 1 shows the details with respect to the wards.

We identified the cost for each cost center and then stepped down the overhead cost to the intermediate and final care cost centers. At the end we stepped down the cost of intermediate cost center to the final care cost centers and estimated the total cost of the Inpatients by following the case-mix system. We compared the cost estimated by case-mix system with already established average cost for health care services. The total

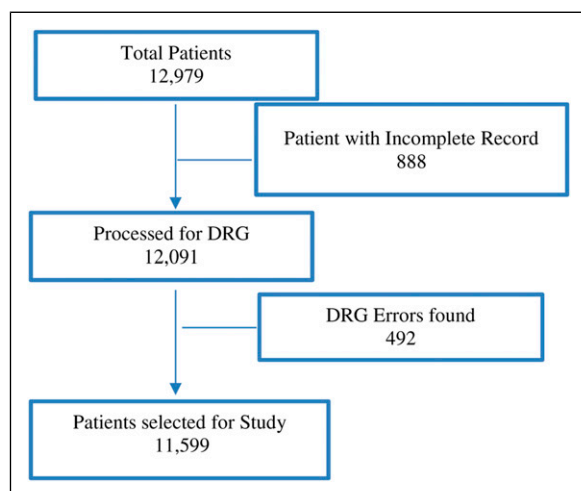


Figure 1. Flow chart for patient selection.

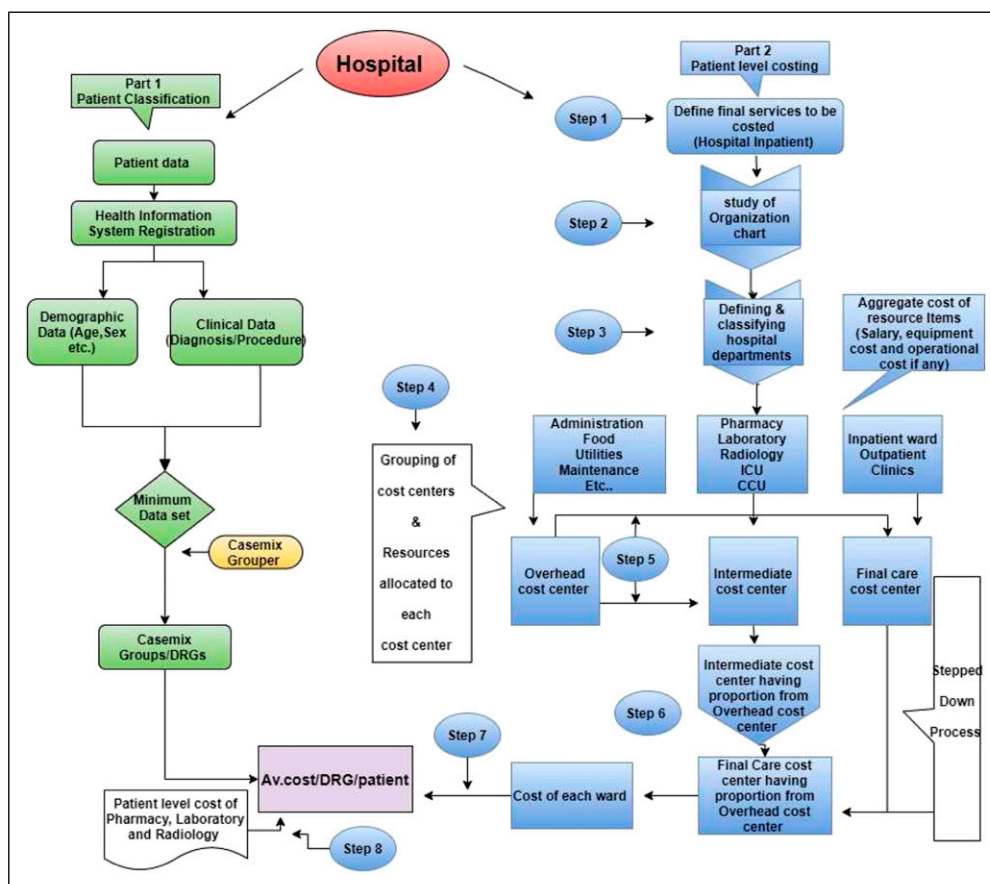


Figure 2. Case-mix costing steps.

Table 1. Ward Wise Distribution of Patients at KFCH.

Wards	Male Patients	Female Patients	Total Patients	Percentage%
M and F. Orthopedic	505	164	669	5.8
M and F. Medical	1172	1096	2268	19.6
Gynecology	—	2632	2632	22.7
M and F. Surgery	716	604	1320	11.4
Neurosurgery	351	126	477	4.1
Pediatric	2038	1848	3886	33.5
Plastic surgery	233	114	347	3.0
Total	5015	6584	11,599	

estimated case-mix cost for health services was SAR 249,949,763, while the average cost of the health care services was SAR 247,035,938. The details of cost comparison for each ward are given in Table 2.

We estimated the cost per patient in each ward by following the case-mix system and compared with already established patient average cost in each ward as shown in Table 3.

We also calculated and compared the cost per patient per day estimated by case-mix system with already established patient average cost per patient per day as shown in Table 4.

In this study, we calculated the patient level cost of pharmacy, laboratory, and radiology separately. We summed up inpatients total cost, patient-level pharmacy, laboratory, and radiology cost and estimated the total inpatients cost at King Fahd Hospital that was SAR 269,663,897, as given in Table 5.

We also calculated the total number of patients in each DRG in each ward and estimated DRG per day cost. It was observed that the maximum average cost was for the DRG "I-4-10-I" (Acute Myocardial Infarction–Mild), which was SAR72,987. The second highest average cost (SAR64,877)

**Table 2.** Total Cost of Final Care Cost Centre (Inpatient).

Final Cost Centre	Total cost of FCC	
	case-mix cost (SAR)	Average cost <sup>11</sup> (SAR)
M and F orthopedic	18,918,455	62,096,980
M and F medical	67,528,865	47,301,317
Gynecology	40,990,970	31,814,248
M and F. Surgery	42,685,275	43,868,028
Neurosurgery	16,643,976	12,917,859
Pediatric	52,414,946	40,680,719
Plastic surgery	10,767,276	8,356,787
Total cost (SAR)	249,949,763	247,035,938

was for the DRG "I-4-16-I" (Atherosclerosis-Mild). The list of top ten DRG with the highest cost is given in [Table 6](#).

## Discussion

The cost of a particular health care service may vary considerably according to the costing objective.<sup>12</sup>

Costs were allocated by calculating the specific services used by the patient. The high number of patient cases and the considerably long study period (1 year) increased confidence in the validity of cross-sectional clinical and financial context variations.

The bed occupancy rate of the hospital was 98.7%, and according to Rahman (2012), the suggested range of hospital

**Table 3.** Comparison of DRG Cost per Patient with Average Cost per Patient.

Wards	Total cost per patient	
	Case-mix cost (SAR)	Average cost <sup>11</sup> (SAR)
M and F. Orthopedic	28,279	108,561
M and F. Medical	29,788	20,450
Gynecology	15,568	8636
M and F. Surgery	32,337	33,033
Neurosurgery	34,893	23,444
Pediatric	13,488	9579
Plastic surgery	31,030	29,425

**Table 4.** Comparison of DRG cost per patient per day with average cost per patient per day.

Wards	Avg. cost per day	
	Case-mix cost (SAR)	Average cost <sup>11</sup> (SAR)
M and F. Orthopedic	1230	5428
M and F. Medical	4501	2556
Gynecology	3114	1727
M and F. Surgery	4042	3670
Neurosurgery	1745	781
Pediatric	2248	1197
Plastic surgery	2387	2102

**Table 5.** Total Cost for Inpatients.

Inpatient cost breakup	Total cost	
	Case-mix cost (SAR)	Average cost <sup>11</sup> (SAR)
Cost of final care cost center	249,949,763	247,035,938
Patient level cost for pharmacy	15,425,089	Not available
Patient level cost for laboratory	1,364,245	Not available
Patient level cost for radiology	2,924,800	Not available
Total cost for inpatient (SAR)	269,663,897	247,035,938

**Table 6.** Top ten diagnosis related groups average cost per day.

DRG Description	DRG Code	Av. cost per DRG per day (SAR)
Acute myocardial infarction–mild	I-4-10-I	72,987
Atherosclerosis–mild	I-4-16-I	64,877
Heart failure–mild	I-4-12-I	51,219
Operation of soft tissues–moderate	M-1-50-II	31,030
Intraocular and lens operations–minor	H-1-30-I	27,803
Cranial and peripheral nerve operation–minor	G-1-20-I	22,584
Transient ischemia–mild	G-4-16-I	20,477
Cardiac congenital and valvular diseases–mild	I-4-18-I	18,557
Carpal tunnel operation–minor	G-1-13-I	18,343
Angina pectoris and chest pain–mild	I-4-20-I	18,031

bed occupancy rate is between 70%-80%.<sup>13</sup> The bed occupancy rate in any hospital is a significant indication for assessing the performance of health facilities.<sup>14</sup>

The total estimated cost of the final care cost center by using the case-mix system was higher than the average cost, as shown in Table 2. In the final care cost center, the same ward cost also differs from each other by using different methodologies. The cost of each ward was found a little higher in the case-mix system than the average cost estimation. The cost estimation process by using the case-mix system is more specific and representative of the services provided within a specific period. The results of this study can be compared with other studies conducted in the Philippines, India, Myanmar, and Iran, where the cost estimated by the case-mix system was more representative of the services.<sup>15-17</sup>

The cost of medical supplies was found low in the average cost estimation process due to the non-availability of total hospital medical supplies data. To overcome this issue in case-mix costing, we considered patient-level pharmacy, laboratory, and radiology data that is more specific, and representative of the services provided to patients. We also compared the results of our study with Pakistan, Vietnam, and the Philippines, that reported the medical supplies and pharmacy services as the first or second-largest component of the health care services and used the patient-level data for cost estimation.<sup>15,17-19</sup>

The total average cost of each patient in each ward was compared with the cost estimated by the case-mix system and we found a considerable difference in the costs of orthopedic ward. In the case-mix system, the patients were classified by DRG, and the cost was specific to disease and procedures performed. The cost per patient estimated by the case-mix system was low compared to the average estimated cost. The cost per patient in other wards was also different when estimated using the case-mix system, as given in Table 3.

In this study, we estimated the average cost of DRG per day per patient. We observed that the DRG “Acute Myocardial Infarction-Mild” had the maximum average cost per day that was SAR72,987. The other DRGs with the maximum cost was “Atherosclerosis-Mild” and “Heart Failure-Mild,”

SAR64,877 and SAR51,219. The cost of cardiology cases in our study was higher than the study conducted in Malaysia, where the cost of cardiology medical cases was RM4,277, and cardiology surgical cases were RM6,530.<sup>20</sup> In contrast, a comparative cost study conducted for Norway and Finland reported that the cost of cardiology cases was on number 4 in both hospitals.<sup>21</sup> The cost of the same DRG in different wards was found different. Ideally, it should be the same as DRG represent the type of resources used by the patient at a specific time. If the patients have the same disease and are treated in the same way but in different wards or locations, then the cost of the same DRG can have different costs. This may be due to the social norms as if a hospital has separate male and female wards for the same category of patients, and it directly affects the resources consumed by each ward.

## Conclusion

This study revealed that data on specific cost resources and components was challenging to estimate. We identified that patient case-mix and ward types are the major factors for unit cost variations. It was also noted that the unit costs were also influenced by patients’ medical services, consumption of resources, and the availability of hospital services. This study offered necessary cost details to help policymakers. Moreover, the findings can help estimate the cost for prospective payment systems that is also a part of Saudi Vision 2030. In the future, various factors can affect the health care services costing, including the replacement of fee for services reimbursement system and the standardization of the electronic medical record and its maintenance.

This study presented opportunities for public hospitals to set up a case-based payment system in the region and throughout the country. Costs were estimated for the health care services provided in tertiary care hospitals in the Jazan region of Saudi Arabia.

This study also revealed that case-mix cost modelling for unit cost estimation is more representative of the services provided in the hospital and can be used for reimbursement

purposes. This costing model can be used as a reference for further study and expected to give better results.

### Limitation

The most challenging aspect of this costing analysis was monitoring the hospital's general ledger's costs and using it for a specific purpose. It was the first case-mix costing study in the selected hospital and in the region, so it lacked resources such as costing support software and related programs. There was no well-established program or well-informed and qualified managers to handle such comprehensive information.

### Recommendation

The study's findings and conclusions may be used for vital purposes including as a means of guidance to make the necessary changes in the hospital payment system. This study may provide the foundation for the formation of national cost weights. It is necessary to estimate national average costs and cost weights regularly for a case-based payment system. The top-down costing methodology followed in this study is recognized as an inexpensive, quick, and precise cost estimation methodology. This study will serve as a helpful guide and context to understand and initiate costing-related efforts.

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### Author Contributions

Asim Mehmood identified the problem and idea of the study. Zafar Ahmed, Khalid Ghilan, Asim Mehmood was responsible for study design.

Asim Mehmood, Fahad Khan, conducted data collection.

Zafar Ahmed, Asim Mehmood did data analysis.

Asim Mehmood, KF drafted the manuscript, and all authors commented on and refined the draft. Zafar Ahmed and Khalid Ghilan did general supervision.

Zafar Ahmed, Khalid Ghilan edited the final version.

All authors read and approved the final manuscript.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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### Ethics Approval

The ethical committee of Jazan University, Saudi Arabia, and Jazan Research Ethics Committee, Directorate of Health Affairs Jazan region, approved this study.

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