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RESEARCH ARTICLE

Development of Casemix-based Patient Classification for Patient-Level Costing in a Tertiary Hospital, Saudi Arabia

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ABSTRACT

The current study was performed to develop a Diagnosis Related Group (DRG) based casemix classification for inpatients. We applied a cross-sectional retrospective approach to categorize the inpatients based on their diagnosis and procedures at King Fahd Central Hospital (KFCH) Jazan, Saudi Arabia. Inpatient discharge data from 2018 was considered, and patients were categorized based on the casemix system. During the study period, 12,979 patients were discharged from the hospital. Of these, 38% of cases were related to surgical procedures, and 62% were treated under different medical specialties. The maximum number of procedures (19.8%) performed were under the Case-Mix Group (CMG) "O" (deliveries). The highest number (22.2%) of inpatient medical cases were observed in CMG "B" (pancreatic system). 269 DRGs from different severity levels were assigned to patient cases, and among these maximum number of patients (12.1%) were found under DRG "Other liver diseases-mild." We developed the DRG casemix system and categorized the patients according to their Casemix and services provided during their stay at the hospital. Patient identification and grouping based on the diagnosis and procedure is an essential part of resource estimation process and can bring transparency to the clinical practice. This study can potentially help public hospitals to implement a DRG system for patient classification.

INTRODUCTION

Casemix defines a system in which patients are classified through a system that groups the patients by using a predetermined factor. The patients are grouped into more expressive and resource-identical groups to define the hospital health service product (Hovenga, 1996; Turner-Stokes et al., 2012). The casemix system can provide a clear picture of the treatment cost for different groups and individual patients. It has also become a universal measurement tool to analyze differences in clinical practices (Aisbett et al., 2007). All casemix systems use DRG to group the patients and define their products related to health services (Hovenga, 1996; Matsuda, 2007).

DRG classification system was developed in 1960 by the Yale cater of Health studies to manage inpatient resources (Averill et al., 1998). The objective of this classification was to motivate healthcare professionals to use resources economically, document and relate medical decisions, and define hospital services by diagnosis and procedures. DRG can classify patients based on procedures, diagnosis, and other features such as gender, age, and the severity of illness (Gabinete et al., 2022; Rimler et al., 2015).

Saudi Arabia, one of the fastest-growing countries in the Middle East, is transforming and restructuring the healthcare system to cope with the healthcare challenges (Alharbi, 2018; Johnston et al., 2015; Khamsiriwong, 2018). The government is shifting towards a social or national insurance-based system and institutional privatization to solve healthcare financing challenges (Alkhamis, 2017). The patient grouping based on DRG and cost estimation of the specific services provided to these groups during their stay at the hospital are critical steps and prerequisites for implementing the insurance system and privatization in the healthcare sector (Mathauer and Wittenbecher, 2012; Pujani and Handika, 2018). In Saudi Arabia, recent studies were performed to estimate the average cost of healthcare services (Ghilan et al., 2021; Mehmood et al., 2021). However, the patient classification based on the DRG/casemix system was not performed. This may be due to the implementation issue related to the International Classification of Disease (ICD) classification system in hospitals. Only a few hospitals adopted this classification system at total capacity. Without the ICD classification system, we cannot standardize the patient clinical data. If the clinical data are not standardized, we cannot classify the patients based on the diagnosis and procedures, known as DRG. Casemix/DRG patient classification system can provide the base for defining the patient groups and help approximate resource consumption (Bane, 2015; Lehtonen, 2007). The study was conducted at KFCH Jazan, Saudi Arabia. The main objective was to develop diagnosis-related groups for standardized patient classification, which would be helpful for the resource estimation process since the standardized procedure codes were unavailable and were assigned manually.

METHODS

We considered one calendar year (2018) of inpatient discharged data and applied a cross-sectional retrospective approach to categorize the inpatients based on their diagnosis and procedures, followed by Zafar et al. (2005).

We developed DRG codes based on the already available patient demographic and clinical data using the standardized DRG software tool (UNU Open Source). DRG software requires consistent data sets in a standardized format, and the required data is categorized as Minimum Data Set (MDS).

Demographic data included patient registration number, age, gender, date of admission and discharge, length of stay, and discharge status. Meanwhile, the clinical data included the patient's diagnosis, procedures, and intermediate services during hospital admission. The hospital used a standardized classification system (ICD-10) to code the patient diagnosis; however, standardized procedure codes were unavailable and assigned manually. According to the DRG software input file format, we also coded patient variables that required standardized coding assignments before processing through the DRG grouper software for DRG code generation. Figure 1 explains the flow of patient information in the hospital, considered to generate the DRGs.

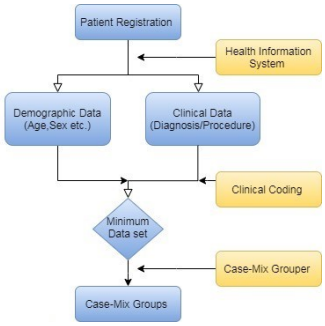

Figure 1: Patient classification process

During the study period, 12,979 patients were discharged from the hospital. Out of 12,979 discharges, 888 were excluded from further analysis because of incomplete data, such as admission date, gender, diagnosis, and procedures. We selected the remaining 12,091 discharges for the DRG assignment. After processing the input file through DRG software, we observed 492 error DRGs assigned to the patients and excluded from further analysis. In the final analysis, 11,599 patients with complete data and correct DRG codes were considered, as depicted in Figure 2.

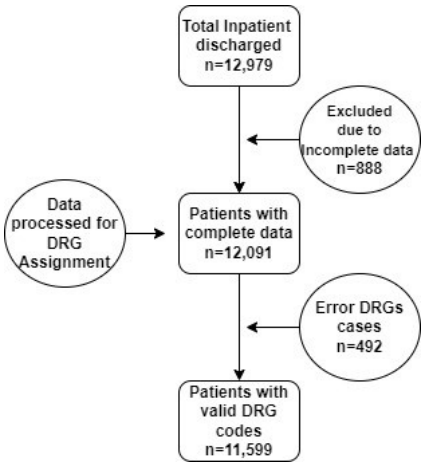

Figure 2: Patient selection process

RESULTS

Among the 11,599 patients selected for the study, 5,015 (43.2%) were male, while 6,584 (56.8%) were female. The highest number of discharges, i.e., 3,886 (33.5%), were from the pediatric ward, followed by the gynecology ward with 2,632(22.7%) discharges. The discharges from the medical, surgical, orthopedic, neurosurgery, plastic surgery, and cardiac unit are shown in Table 1.

Table 1: Distribution of inpatient discharges by ward

Wards	Male Patients	Female Patients	Total Patients	%
Orthopedic ward	505	164	669	5.8
Medical ward	1,155	1,079	2,234	19.3
Gynecology ward	--	2,632	2,632	22.7
Surgical ward	733	604	1,320	11.7
Pediatric ward	2,038	1,848	3,886	33.5
Burn Unit	233	114	347	3.0
Neurosurgery ward	351	126	477	4.1
Total	5,015	6,584	11,599	

We observed that 269 DRGs were assigned to patient cases from different severity levels. Among these 269 DRGs, five DRGs represented 40.3% of the total patients that were DRGs "Other Liver diseases-mild," "other factors influencing health status-mild," "cesarean section," "vaginal delivery-mild," and "c connective tissue diseases-mild."

The highest number of patients (12.1%) were observed with DRG "other liver diseases – mild" in the Pediatric ward. The second-highest number of patients were also found in the Pediatric ward with DRG "other factors influencing health status – mild" with 1226 (10.6%) patients. Table 2 contains the top ten DRGs in different wards.

Table 2: Top ten DRG by ward

DRG Description	Ward	Total Patients	%
Other Liver Diseases - Mild	Pediatric	1396	12.1
Other Factors Influencing Health Status - Mild	Pediatric	1226	10.6
Cesarean Section - Minor	Gynecology	806	6.9
Vaginal Delivery - Mild	Gynecology	801	6.9
Connective Tissue Diseases - Mild	Medical	448	3.9
Intraocular & Lens Operations - Minor	Surgical	219	1.9
Tonsil & Adenoid Operations - Minor	Surgical	202	1.8
Prepartum Diseases - Mild	Gynecology	191	1.6
Other Factors Influencing Health Status -Mild	Gynecology	163	1.4
Urethral & Transurethral Operations -Minor	Medical	145	1.3

We categorized the patients based on CMG type. We found that the highest number of patients were from CMG type "4" (inpatient medical), with 6,767 (58.4%) patients. In contrast, CMG type' 1" (inpatient procedure) had 3,180 (27.4%) patients, and CMG type "6" (inpatient childbirth) had only 1,652 (14.4%) patients, as shown in Table 3. We also observed 492 (4.4%) error DRGs assigned to patient cases.

Table 3: Distribution of patients by type of discharges

CMG Type	Description	Total patients	%
1	Inpatient Procedure	3,180	27.4
4	Inpatient Medical	6,767	58.4
6	Inpatient Childbirth	1,652	14.4

We found 21 CMG assigned to patient cases. Out of these, five CMG represented 58.9% of the total patients that were CMG "B" (hepatobiliary & pancreatic system), "o" (deliveries), "z" (factors influencing health status & other contacts with health services), "m" (musculoskeletal system & connective tissue), and "k" (digestive system).

We categorized the CMGs into medical and procedural groups and calculated procedural and medical case percentages. We found that 4,413 (38.0%) procedures were performed during the study period, while 7,186 (62.0%) inpatients' medical cases were treated during the same period.

Among the procedural category, the highest number of procedures were performed under CMG "o" (deliveries), with 19.1% of the total procedures. In comparison, the highest number of inpatient medical cases were from CMG "b" (hepatobiliary & pancreatic system), with 22.2% of the total medical cases. The detail of other inpatient procedures performed and medical cases in each CMG are given in Table 4.

Table 4: Patient distribution by procedure performed and medical cases

Case-Mix Main Groups (CMG)	Inpatient Procedures	%	Inpatient Medical	%
Infectious & Parasitic Diseases	0	-	112	1.6
Hepatobiliary & Pancreatic System	100	02.27	1,596	22.2
Myeloproliferative System & Neoplasms	0	-	4	0.1
Haemopoietic & Immune System	17	00.39	197	2.7
Endocrine System, Nutrition & Metabolism	49	01.11	233	3.2
Mental Health and Behavioral	0	-	5	0.1
Central Nervous System	200	04.53	359	5.0
Eye and Adnexa	311	07.05	28	0.4
Cardiovascular System	136	03.08	106	1.5
Respiratory System	51	01.16	295	4.1
Digestive System	599	13.57	233	3.2
Skin, Subcutaneous Tissue & Breast	217	04.92	178	2.5
Musculoskeletal System & Connective Tissue	654	14.82	597	8.3
Nephro-Urinary System	313	07.09	352	4.9
Deliveries	842	19.08	810	11.3
Injuries, Poisonings & Toxic Effects of Drugs	159	03.60	82	1.1
Substance Abuse & Dependence	0	-	4	0.1
Ear, Nose, Mouth & Throat	442	10.02	64	0.9
Male Reproductive System	137	03.10	59	0.8
Female Reproductive System	186	04.21	474	6.6
Factors Influencing Health Status & Other Contacts with Health Services	0	-	1,398	19.5

We also analyzed the surgical and medical cases separately in each ward. We observed the maximum number of surgical cases in the gynecology ward, with 25.5% of the hospital's total surgical cases. The maximum number of medical cases was observed in the pediatric ward, 49.2% of the hospital's total medical cases.

DRG software also categorized the patients into

resource intensity/severity levels (I, II, III). The resource intensity level was based on the number of diagnoses and procedures performed. We observed that most patients fall in severity level "I" (only one diagnosis/procedure), with 11,200 patients who were 96.6% of the hospital's total cases.

DISCUSSION

Several Casemix systems have been developed in different acute healthcare settings. However, the main cornerstone of all these systems focused on grouping the patients into homogeneous and clinically coherent groups. Predicting resource usage by considering the case-mix system is mainly determined by casemix class, like DRGs (Hopfe et al., 2015). While developing the DRG casemix system, several challenges were identified, such as the need for standardized patient clinical data and mismatch in the diagnosis and procedures. The hospital information system only recorded the procedure description without the standardized codes. We assigned the standardized procedure codes based on primary and secondary diagnoses. 48.9% of the total DRG errors were due to "No CMG assignment." The error DRGs could have been due to a need for trained clinical coders and staff training. Another reason for error DRGs can be attributed to the quality assurance and auditing system gaps that do not focus on the data entry and validation processes. Such issues were also observed in prior studies that reported DRG coding errors due to a higher mismatch between surgical and diagnosis codes (Hof et al., 2017; Zafirah et al., 2018). Studies conducted in Iran and Australia reported 6% and 0.2% error DRG after grouping. The reasons for error DRGs associated with coding quality were coding standards, lack of trained clinical coders, and irrational use of the ICD-10 classification system (Ekanayake et al., 2019; Ghaffari et al., 2008). The DRG coding error could impact the payment as the patient had to pay almost twice the treatment cost. Coding error cases within the surgical discipline could be directly related to profit gains (Ekanayake et al., 2019; Jackson, 2001; Zafirah et al., 2018).

Our study observed patients with 659 different DRGs from different severity levels from 21 casemix groups. The highest number (14.6%) of patients were admitted with casemix group "B" (hepatobiliary & pancreatic system).

The percentage of surgical cases was 38.0%, and out of that, the highest (19%) were performed under casemix group "o" (deliveries) in the gynecology ward. The second highest,14.8%, was under casemix group "m" (musculoskeletal system & connective tissue). Among the medical cases, most of the patients (49.2%) were treated under casemix group "b" (hepatobiliary & pancreatic system) in the pediatric ward. These results can be compared with the study conducted in Iran, where the surgical DRGs represented 37.4% of the total cases while medical DRGs were 61.9% of the total grouped cases (Ghaffari et al., 2008).

We observed that 97% of the cases were at severity level "I." It shows that the treated patients were not resource-intensive, diagnosed with one disease, and had one surgical procedure. Each severity level needs different services to treat the patient's condition, contributing to a different resource requirement. The selection of comorbidities during treatment is highly dependent on the treating physician and, later, the medical coding that is also directly related to resource consumption. By ensuring the medical coding and high-quality data collection, we can characterize the accurate costing for casemix patients (Zhaoxin et al., 2014).

One of the study's limitations was that we only considered the inpatient data as it is more complex and critical than the outpatient data since about 75% of hospital resources are consumed by inpatients (Shepard et al., 2000).

CONCLUSION

In this study, we developed the DRGs codes for the patient cases, and to our knowledge, it was a novel study in Saudi Arabia. DRG/case-mix system is an excellent patient classification tool that can enhance the quality and efficiency of health care services. By classifying the patient based on DRGs, we can bring transparency to the clinical practice. After the DRG development, we have a clear picture of patient cases treated in the hospital. These cases can be systematically related to the resource utilization and estimation of the unit cost variations in clinical practice.

This practice can influence the management decisions while admitting the patient, considering different

treatment options and length of stay in the hospital. This study presents opportunities for public hospitals to implement a DRG system for patient classification, which can be further used to allocate resources and estimate costs. Nevertheless, we need to establish a sound health information system that promptly provides standardized data to implement this system.

Authors' contributions

Zafar Ahmed conceived the idea and designed the study. Asim Mehmood and Fahad Khan Azeez collected the data and wrote the first draft of the manuscript. Khalid Ghailan, Asim Mehmood and Wajiha Rehman performed the analysis. Sumaira Idrees and Sohail Akhtar participated in the clinical coding of the data and helped in writing the manuscript. All authors read and approved the final manuscript.

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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 vide Registry number 081 Dated September 20, 2018.

There was no direct contact with the patients and data was extracted without patient identifiers.

Competing interests

The authors declare that they have no competing interests

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