Bulletin of High Institute of Public Health
Vol. 38 No. 2 [2008]

Identification of Drug Cost Reduction Opportunities in A University Hospital in Saudi Arabia

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ABSTRACT: Background: Expenditure on medications represents significant proportion of the total hospital budget. Establishing an effective drug cost management program is a priority area for hospitals that must begin with determining the current costs and pattern of use of medications. **Objectives:** The aim of the present study is to determine the cost and pattern of drug utilization at the study hospital in order to identify cost reduction opportunities. **Methods:** A descriptive retrospective design was used to examine the cost and pattern of drug utilization for all admissions during the period from: 1st January 2006 to 30th June 2006 in a university hospital in Eastern Saudi Arabis. Electronic patient data as well as manual drug cost data were obtained and merged to create the analysis database. **Results:** The study revealed that the total drug cost at the study hospital was SR 11,823,666.9 (mean per admission = SR 2123.5 and median per admission= SR 357.3) during the study period. Antibiotics were responsible for 35.8% of the total inpatient drug costs followed by blood products which accounted for 20.6% of the total inpatient drug costs. Further investigation of both groups revealed that the combination of piperacillin and tazobactam represented 4.5% of prescribed drugs and accounted for almost half of the inpatient antibiotic costs (SR 2,064,916.8) and 17.4% of the total hospital's inpatient drug costs. Human albumin and intravenous immunoglobulin were responsible for the majority of cost of blood products. **Conclusions:** Piperacillin and tazobactam, human albumin, and intravenous immunoglobulin other than Rho (D) immunoglobulin are responsible for high percentage of drug expenditure at the study hospital while being prescribed to a limited number of patients. Designing a drug cost management program to target these three drugs will increase the likelihood of achieving significant cost reduction.

INTRODUCTION

The cost of providing healthcare, and medications in particular, has dramatically increased over the past few decades. It is estimated that the costs of medications to treat patients will soon equal that of the hospitalization itself.(1) The Saudi Arabia's drug market is the largest in the Gulf Cooperation Council (GCC). In 2001, the healthcare budget allocation for Saudi Arabia was US$5.84 billion; nearly 20% of

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it was spent on medicines alone.[2] In 2007, it was reported that drug expenditure in Saudi Arabia reached SAR8.52 billion (US$2.27 billion). Drug expenditures in Saudi Arabia is expected to rise at a faster rate than they have in the past years; with an average increase rate of 6.8% annually to reach a value of SAR11.83 billion (US$3.2 billion) by the end of 2012.[3]

Factors that contributed to the growth in overall drug expenditure include price, utilization, mix, and innovation. Price inflation is an increase in the unit price of existing medications. Utilization is an increase in use of a drug, such as an increase in number of users, days of therapy, or dose per day of therapy. Mix changes when newer, more expensive therapies are used in place of older, less expensive but equally effective drugs. Utilization and mix factors can be attributed to physician prescribing practices. Innovation occurs when expensive, new medications become available to treat conditions previously untreatable with drug therapy (i.e., innovative therapy).[4]

Several strategies were implemented to manage increasing pharmaceutical expenses including better drug data management, prescriber education and collaboration to improve cost-effectiveness of treatments, implementation of practice guidelines, forecasting of future expenses, use of therapeutic interchange and providing feedback to physicians.[1,5-9] Prioritization of these methods depends on determining the potential benefit of each method and estimating the relative ease or difficulty of attaining the benefit. Drug-cost management strategies that are under the direct and exclusive responsibility of the pharmacy department (e.g., purchasing, inventory management, and waste reduction approaches) are generally easier to implement and provide more immediate benefits. These activities, however, often provide smaller or onetime financial benefits. Utilization management tactics,

(e.g., clinical practice guidelines, and therapeutic interchange) generally provide greater financial benefits, but these efforts have correspondingly higher degrees of difficulty and complexity.[10]

As the first stage of establishing an effective drug cost management program begins with determining the current costs of medications, the present study aims at determining the cost and pattern of drug utilization at the study hospital in order to identify cost reduction opportunities.

MATERIAL AND METHOD

The study was conducted at a 444-bed University Hospital in Eastern Saudi Arabia. The total annual admissions for the year 2006 were 12652 patients. The study utilized a descriptive retrospective design to examine the cost and pattern of drug utilization in the year 2006. All consecutive inpatient admissions during the period from: 1st January 2006 to 30th June 2006 were included in the study. A total of 5778 patients were admitted during that period.

The Electronic Medical Record (EMR) "Mysis System" was utilized to obtain drug utilization data. The system is a combined Electronic Medical Record/ Computerized Physician Order Entry (EMR/CPOE) system.[11] The following data were obtained in electronic format from: the hospital EMR:

1. Patient's identification: a unique identifying number of each admission, medical record number, birth date, gender, nationality, admission date, discharge date, treating physician, speciality, ward, and discharge type. Subspecialties were grouped into 7 major specialities which are obstetrics and gynecology, pediatrics, internal medicine, surgery, ENT, ophthalmology, and psychiatry.
2. Administered drugs: Product code, trade name, strength, route of administration, category name, category code. Data were obtained for each administered dose amounting to 1,406,583

doses belonging to 721 administered drugs during the study period. Drug information were incomplete (incomplete dose, route, and/ or strength) for 210 admissions (3.63% of admissions during the study period). Paper records of these patients were reviewed to complete the missing data; however, paper records lacked the missing data. Consequently these admissions were not included in the analysis.

3. ICD-9 CM codes: Primary and secondary diagnoses codes were obtained. Diagnoses were grouped into three-digit ICD-9 codes in the analysis to obtain meaningful ICD-categories.

4. Direct drug cost data: Drug cost data were obtained from the year 2006 drug tenders. The tenders used were in manual format and indicated the cost of purchasing of 1090 drugs at the study hospital during 2006. The cost of each unit of the drug was calculated based on the number of units of each package. Drug costs were manually entered to a database to create an electronic version that can be linked to the downloaded electronic patient data. Fixed and indirect costs, such as labor to prepare or administer medication or non-pharmaceutical materials were not included in the present study.

A relational database was developed using Microsoft Access Database to manage the downloaded drug data and their costs. Structured Query Language (SQL) was used to write queries to combine patients, drugs, and cost data from: several data tables. To obtain the total cost for each drug per admission, a query was developed to calculate the total number of administered doses, then to multiply the number of doses by the cost of each dose. The average daily drug cost was obtained by dividing the total drug cost by patient's length of stay. To identify diagnoses that have high impact on inpatient drug expenditure two criteria were set (1) a median cost of more than SR1000

per diagnosis; (2) at least 12 patients admitted with that diagnosis during the study period (average of 2 patients a month). Patients fulfilling these two criteria were ranked based on their median cost and the top 10 diagnoses are presented in results section.

Statistical analysis:

Statistical analysis was carried out using the Statistical Package for Social Sciences version 13 (SPSS). The distribution of the number of drugs and drug costs were skewed. Descriptive statistics were presented in the form of mean, median and inter quartile range. Logarithmic transformation did not achieve normality, so nonparametric techniques including Mann Whitney U test and Kruskal-Wallis H one-way analysis of variance tests were applied.[12] The cut off value for statistical significance was set as 0.05.

RESULTS

Table 1 shows that the most frequent age category was between 18-39 years, accounting for 39.5%. Females had a higher proportion (54.8%) of admissions than males (45.2%). Obstetrics and gynecology patients accounted for the highest percentage of admissions (23.8%), followed by pediatrics (23.2%). The majority of patients were discharged home, constituting 95.9% of cases. Regarding the number of prescribed drugs per admission, the mean number of drugs per admission was 4.9 (SD= 4.6) and median number of drugs per admission was 4 (IQR= 4). Patients who expired had the highest median number of drugs per admission and the highest variability, (median= 15 & IQR= 16) followed by patients aged 60 years or above (median= 8 & IQR= 8). Internal medicine had the highest median number of drugs per admission (7 drugs) among all specialties.

The total, mean, and median per admission as well as the average daily inpatient drug costs are presented in table 2 according to demographic

characteristics, specialty, and discharge type. The total drug cost at the study hospital was SR11,823,666.9 during the period of study (mean per admission = SR2123.5 and median per admission= SR357.3). The highest mean drug cost and average daily inpatient cost among all studied variables were among patients who expired being SR17111.5 and SR905.4, respectively. Regarding patient age, patients aged 60 years or above, had the highest mean cost of drugs (SR6789.1) and the second highest average daily drug cost (SR151.4) among all age groups. Regarding specialties, internal medicine had the highest mean cost and the second highest mean daily cost (being SR4612.4 and SR168.0, respectively), followed by surgery where mean drug cost per patient was SR3318.6. With the exception of nationality, the differences in the mean daily drug cost among age, gender, specialty and discharge type were statistically significant.

Over one-third (35.8%) of the total inpatient drug costs was attributed to antibiotics which constituted 17.0% of the total number of prescribed drugs, (Table 3). Blood products accounted for 20.6% of the total inpatient drug costs (SR2,436.674.5) and 1% of the total number of prescribed drugs. Potassium removing agent accounted for 0.4% of prescribed drugs and 6.1% of the total inpatient drug costs. The table shows that 9 drug categories accounted for 87.59% of the total inpatient drug cost and 49.5% of the number of prescribed drugs.

The most expensive 2 drug categories which are antibiotics and blood products are further analyzed in tables 4 and 5. The most frequent prescribed antibiotic was amoxicillin and potassium clavulanate followed by gentamicin, being 28.1% and 24.0%, respectively (Table 4). Amoxicillin and potassium clavulanate accounted for 28.6% of inpatient antibiotic costs and 10.2% of the total hospital's inpatient drug

costs (SR11,823,666.9). The combination of piperacillin and tazobactam represented 4.5% of prescribed drugs and accounted for almost half of the inpatient antibiotic costs (SR2,064,916.8) and 17.4% of the total hospital's inpatient drug costs. Human albumin accounted for 54.1% of prescribed blood products and 76.7% of their total cost. Immunoglobulin other than Rho (D) had the second highest cost (16.4%) and third frequently used blood product (16.6%), (Table 5)

The highest 10 diagnoses that had median cost of more than SR 1000 and had at least 12 patients during the study period are presented in table 6. The total cost of these 10 diagnoses constituted 16.7% of the total inpatient drug expenditure (SR1,969,602.1 out of SR11,823,666.9) and accounted for 7.8% of patients. Arthropathy had the highest median cost per patient (SR3730.8) followed by pneumonia (SR3,092.0). The number of patients who received four high cost drugs (piperacillin and tazobactam, human albumin, intravenous mmunoglobulin, and potassium removing agents) is presented for each of the 10 diagnoses. With the exception of asthma and bronchopneumonia, piperacillin and tazobactam were used in at least one case of the identified high cost diagnoses. Intravenous immunoglobulin was used mainly in cases of arthropathy while human albumin was used in all high cost diagnoses except for acute appendicitis and arthropathy. Potassium removing agents were mainly used in cases of chronic renal failure. High variability is noted among chronic liver diseases patients, and patients with fetal or placental problems; as shown by the high inter quartile range (SR12838.8 and SR9466.0, respectively).

DISCUSSION

The present study established baseline drug cost and use information at the study hospital. Identifying and quantifying cost reduction opportunities must be completed before prioritization and selection of appropriate cost reduction strategies begins. The present study revealed that the median number of prescribed drugs per admission was 4 and the median cost per admission was SR357.3. Marked variability in the number and cost of drugs per admission was found as evident by the non-normal distribution of the number and cost of drugs within and between groups. Moreover, the mean cost of drugs per admission (SR2123.3) is almost six times the median cost of drugs per admission (SR357.3). This denotes the importance of identifying and isolating patient groups or drug categories contributing to high drug expenditure in order to be the target of future cost containment efforts. A recent landmark[10] study on medications cost management strategies stressed the importance of identifying and focusing on key drug expenditures. It was found that the Pareto Principle, or 80/20 rule, applies to drug budgeting. A relatively small number of drugs (50–60) typically account for 80% of most hospital drug budgets. Therefore, budgeting and cost-containment efforts should focus on those drugs, and the cost management plan should especially concentrate on those top drugs for which it is feasible to influence prescribing patterns.

In order to identify patients and drugs contributing to high percentage of the drug budget at the study hospital, the present study investigated the cost of categories of drugs and diagnoses responsible for high percentage of drug expenditure. Analysis of the cost of drug categories revealed that two categories of drugs, namely, antibiotics and blood products were responsible for

high drug expenditure. Both categories accounted for 56.4% of the total drug expenditure while they constituted 18% of prescribed drugs. (Table 3) These two groups have been found in other studies to be responsible for high percentage of drug costs.[13-16] In Russia and Croatia, antibiotics were reported to represent 19% to 34% of the hospital pharmacy budget.[16]

The combination of piperacillin and tazobactam represented 4.5% of prescribed drugs and accounted for almost half of the inpatient antibiotic costs (SR2,064,916.8) and 17.4% of the total hospital's inpatient drug costs. A study conducted in 2004 used the "Pareto" technique to identify high cost drugs identified piperacillin and tazobactam as second highest cost drug accounting for 5.6% of the total hospital budget.[17] Another study that investigated antibiotic utilization prevalence in two medical departments in a tertiary care university hospital revealed that piperacillin and tazobactam combination to be the most expensive antibiotic in use.[13] Moreover, the present study revealed that piperacillin and tazobactam were used in at least one case of the identified high cost diagnoses; with the exception of asthma and bronchopneumonia (table 6) which may denote the absence of clear guidelines for their use in a specific group of patients. A study, revealed that the majority of courses with piperacillin-tazobactam was empirically selected and continued[18] while another study revealed inadequate physicians' perceived knowledge of the clinical criteria for appropriate piperacillin-tazobactam use.[19] Evidence from the present study and the literature stresses the importance of targeting the utilization of piperacillin and tazobactam antibiotic combination at the study hospital.

Analysis of blood products prescribed at the study hospital revealed that human albumin constituted over 75% of the cost of these products and 15.8% of the hospital

drug budget. Moreover, the present study revealed that human albumin was used in all high cost diagnoses except for acute appendicitis and arthropathy (table 6). Metanalysis study comparing the effect of intensive treatment with colloid solutions (such as albumin) versus crystalloids on mortality does not support the continued use of the former for volume replacement in critically ill patients.[20] Following this study, several studies were performed in different countries to evaluate the use of albumin against model guidelines. These studies found that the majority of use was inappropriate and has important economic repercussions.[14,21]

Intravenous immunoglobulins accounted for more than 20% of prescribed blood products in the present study. A study conducted at a teaching hospital in Saudi Arabia[15], revealed that the annual cost of intravenous immunoglobulin (IVIG) was $1.75 million, and 24.4% of which was considered inappropriate use. High economic impact of inappropriate use of IVIG was reported in other studies.[15,22-23] The present study revealed that arthropathy had the highest median cost per patient among the identified high cost 10 diagnoses during the study period (table 6). Out of the 14 cases coded as arthopathy (ICD 9 CM = 710), 6 cases received intravenous immunoglobulin. Although the use of intravenous immunoglobulin for treatment of systemic lupus erythematosus was found to be beneficial in a number of studies[24,25], a study[26] conducted in 2007 stressed the need for multicenter trials approved by the Food and Drug Administration to better define the role of IVIG in many autoimmune and chronic inflammatory disorders. This demonstrates the need for establishing criteria of use for identified high cost drug categories especially when there is no decisive evidence of their usefulness.

The present study recognized the economic impact of few drugs, namely, piperacillin and tazobactam, human albumin, and intravenous immunoglobulin other than Rho (D) immunoglobulin. These three drugs cost SR4334976.4 or 36.6% of hospital drug budget while accounting for 394 admissions (7% of admissions). Additionally, the inappropriate use of these products in Saudi Arabia and worldwide demonstrates the need to target their use at the study hospital.

The present study analyzed direct cost of drugs only. Fixed and indirect cost of drugs, were not included which may have reduced the cost of drugs reported in the present study. Also, drug information was incomplete for 3.63% of admissions and was excluded from: the analysis which may have also affected the results of the study. However, one of the strengths of the present study is the analysis of drug cost at the level of individual patients which facilitated identification of patient and drug categories that had the highest impact on hospital drug budget. This is unlike studies which analyzed the cost of drugs as a total of hospital drug expenditure, as the later are affected by hospital utilization such as bed occupancy rate and are unable to identify patient groups that can be targeted for drug containment efforts.

CONCLUSION AND RECOMMENDATIONS

The study provided drug cost and utilization data at the study hospital. Piperacillin and tazobactam, human albumin, intravenous immunoglobulin other than Rho (D) immunoglobulin are responsible for high percentage of drug expenditure at the study hospital while being prescribed to a limited number of patients. Designing a drug cost management program to target these three drugs will increase the likelihood of achieving significant cost reduction.

Table 1: Distribution of admissions and number of prescribed drugs according to demographic characteristics, specialty and discharge type

Characteristics	Admissions n= 5568		No. of prescribed drugs		
	No.	%	Mean	Median	IQR
Age(years) n=5566					
<18	2065	37.1	3.9	4	2
18-39	2199	39.5	3.9	3	3
40-59	876	15.7	6.9	5	7
60+	426	7.7	10.5	8	8
Gender					
Female	3049	54.8	4.6	4	4
Male	2519	45.2	5.2	4	4
Nationality					
Saudi	3836	68.9	4.8	4	4
Non Saudi	1732	31.1	5.0	4	4
Specialty					
OB& GY	1325	23.8	3.4	2	2
Pediatrics	1290	23.2	4.3	4	2
Surgery	1200	21.6	4.6	3	3
Internal Medicine	1172	21.0	7.9	7	7
ENT	291	5.2	2.8	2	1
Ophthalmology	167	3.0	5.8	5	4
Psychiatry	123	2.2	3.8	3	3
Discharge Type					
Discharged home	5340	95.9	4.7	4	4
Left against medical advice	129	2.3	4.7	4	4
Expired	73	1.3	15.9	15	16
Transferred to other facility	6	0.1	11.0	7.5	13
Other (e.g., escape)	20	0.4	6.7	5	10

OB & GY = Obstetrics and gynecology

Table 2: Drug cost according to demographic characteristics, specialty, and discharge type

Variable	Cost of drugs (SR)				p*
	Mean	Median	IQR	Average Daily	
Age (years) n=5566					
<18	1045.6	357.3	534.8	178.7	
18-39	1533.6	206.1	1,206.1	60.8	<0.001
40-59	3879.5	425.3	1,882.2	84.4	
60+	6789.1	930.5	6,258.4	151.4	
Gender					
Male	2599.4	357.3	1,217.0	115.4	<0.001
Female	1730.4	357.3	1,205.0	89.3	
Nationality					
Saudi	2075.8	357.3	1,213.9	100.6	0.65
Non Saudi	2229.2	357.3	1,200.3	104.7	
Specialty					
Internal Medicine	4612.4	804.9	3,647.7	168.0	
Surgery	3318.6	585.4	1,674.9	104.7	
OB& GY	649.7	30.9	815.3	13.7	<0.001
Pediatrics	975.5	357.3	325.6	181.9	
ENT	424.9	81.2	441.7	25.6	
Ophthalmology	639.2	68.6	283.0	19.2	
Psychiatry	699.8	182.1	385.3	11.3	
Discharge Type					
Discharged home	1908.1	357.3	1,172.5	99.4	
Left against medical advice	1714.0	357.3	966.8	111.9	<0.001
Expired	17111.5	5,574.9	22,826.4	905.4	
Transferred to other facility	10922.2	185.0	17,262.6	115.9	
Other (e.g., escape)	4929.5	662.5	3,179.5	146.4	

p* = significance testing of the difference in average daily cost
OB & GY = Obstetrics and gynecology

Table 3: Distribution of drug categories according to their cost at the study hospital

Category	No. prescribed drugs		Cost (SR)	
	No.	%	***Total***	%
Antibiotic	4611	17.0	4,230,774.2	35.8
Blood products	266	1.0	2,436,674.5	20.6
Anti-ulcerative agent	2079	7.7	809,503.1	6.8
Potassium removing agent	99	0.4	719,072.4	6.1
Corticosteroids	1011	3.7	637,748.1	5.4
IV fluid	1713	6.3	635,284.6	5.4
Anticoagulant	1382	5.1	313,213.3	2.6
Vaccine	1761	6.5	300,970.5	2.5
Thrombolytic therapy	498	1.8	255,437.1	2.2
Other drug categories	13713	50.5	1,484,989.1	12.6
Total	**27133**	**100.0**	**11,823,666.9**	**100.0**

Table 4: Type of prescribed antibiotics and their cost

Antibiotic	Prescribed drugs		Cost (SR)	
	No.	%	Total	%
Amoxicillin and potassium clavulanate	1296	28.1	1,211,311.7	28.6
Gentamicin	1106	24.0	22,386.6	0.5
Ampicillin	274	5.9	86,699.5	2.0
Sodium Fusidate	218	4.7	3,233.9	0.1
Piperacillin and tazobactam	206	4.5	2,064,916.8	48.8
Ofloxacin	129	2.8	908.6	0.02
Tobramycin and dexamethasone	105	2.3	645.0	0.02
Amoxicillin	94	2.0	451.5	0.01
Cefuroxime	87	1.9	16,137.0	0.4
Azithromycin	83	1.8	166,320.0	3.9
Others antibiotics	1013	12.9	657,763.6	15.6
Total	4611	100.0	4,230,774.2	100.0

Table 5: Type of prescribed blood products and their cost

Blood Product	Prescribed drugs		Cost (SR)	
	No.	%	Total	%
Human albumin	144	54.1	1869511.2	76.7
Rho (D) immunoglobulin	54	20.3	90961.9	3.7
Other intravenous immunoglobulin	44	16.6	400548.4	16.4
Plasma protein fraction 5%	20	7.5	72000.0	3.0
Coagulation factors	4	1.5	3653.0	0.2
Total	266	100.0	2,436,674.5	100.0

Table 6: Top 10 diagnoses fulfilling the median cost and number of patient criteria

Diagnosis	ICD9 Code	No. of patients	Number receiving expensive drug category	Mean cost	Median cost	Total cost
Arthropathy	710	14	1+, 6#	10,048.5	3,730.8	140,679.5
Pneumonia	486	34	6+, 2*f*, 4^	5,283.6	3,092.0	179,643.5
Chronic renal failure	585	40	8+, 1*f*, 20^	7199.5	3,079.8	287,979.9
Chronic liver disease and cirrhosis	571	17	2+, 10*f*	11,867.4	3,040.3	201,746.3
Acute myocardial Infarction	410	35	3+, 2*f*, 2^	6943.5	2,648.8	243,025.8
Disorders of urethra and UT*	599	37	5+, 1*f*, 2^	8119.8	2,204.8	300,433.9
Asthma	493	64	1*f*	2831.5	1,979.2	181,215.4
Bronchopneumonia	485	88	1*f*, 1#	2170.2	1,649.4	190,976.4
Fetal and placental problems	656	35	1+, 2*f*, 3#	2864.7	1,276.5	100,265.7
Acute appendicitis	540	70	7+,	2051.9	1,238.1	143,635.7
Total	-	434			1793.4	1,969,602.1

UT = urinary tract, OB&GY = Obstetrics and gynecology

Expensive Drug Category

\+ = Piperacillin and Tazobactam,

f = Human Albumin

\# = Intravenous immunoglobulin

^ = Potassium removing agent

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