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Original Research Article

Pharmacoeconomic evaluations of ceftriaxone and cefixime in the surgery department in a tertiary care teaching hospital

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ABSTRACT

Background: Pharmacoeconomics involves the analysis of the cost of drug therapy in the health systems which will play a significant role in drug product selection for formulary, comparison of alternative therapies pricing a product and evaluating a drug product and expected quality of life improvement. Objective were to assess pharmacoeconomic evaluation and cost minimization analysis of ceftriaxone and cefixime in the surgery department in a tertiary care teaching hospital.
Methods: This prospective observational study conducts to pharmacoeconomic evaluation of ceftriaxone and cefixime. It analyses the number of available brands and generic drugs and performs a cost-minimization analysis for these drugs used in the surgery department.
Results: The study includes a total of 173 patients, among them 68 patients (39%) were using ceftriaxone, 39 patients (23%) were using cefixime and 66 patients (38%) were using ceftriaxone and cefixime (IV-PO) for various surgery cases. Monocef (₹121.04; $1.04 per day) was the most commonly used ceftriaxone brand, while Gramocef (₹114; $1.38 per day) least and Xone (₹112; $1.38 per day) were the cheapest options. The mean ceftriaxone cost for a vial is 56.67±10.04 and the tablet is 113.33±20.08 per day. Cost minimization analysis shows that most prescribed drugs were costlier than least prescribed drugs. Taxim-O (₹107.72; $1.30 per strip) was the most prescribed cefixime brand and the least Tanfix ($ 1.3: ₹107 per strip). The mean of cefixime cost per strip is 107.6±0.28; $1.31 and per day 21.51±0.05; $ 0.26. There is no major cost difference or price variation in cefixime brands (0.69%).
Conclusions: The cheaper drugs should be prescribed to patients rather than the costlier and it should be the duty of healthcare professionals to consider the pharmacoeconomic value of drugs while prescribing the medications.

Keywords: Pharmacoeconomic, Cost Minimization Analysis, Ceftriaxone, Cefixime

INTRODUCTION

The branch of health economics known as pharmacoeconomics studies, measures, and contrasts the costs and benefits of pharmaceutical products and services. It facilitates the development of economic relationships involving drug research, manufacturing, distribution, storage, cost, and subsequent human use. Among the techniques employed in pharmacoeconomic analysis are cost minimization, cost-effectiveness, cost-benefit, and cost-utility analysis. The appropriate application of pharmacoeconomics will facilitate decision-making when assessing the accessibility and affordability of the appropriate medication for the appropriate patient at the appropriate time, as well as enable pharmacy practitioners and administrators to make better and more informed choices regarding the goods and services they provide when comparing two drugs from the same therapeutic class.[1] Pharmacoeconomic studies examine the costs, clinical, and humanistic effects

of different treatments; the evaluation procedures outlined are frequently helpful in highlighting the financial impact of novel treatments, leading to greater acceptability by healthcare professionals, administrators, and the general public. Pharmacoeconomics is defined by the international society for pharmacoeconomics and outcomes research (ISPOR) as "the field of study that evaluates the behavior of individuals, firms, and markets relevant to the use of pharmaceutical products, services, and programs, and which frequently focuses on the costs (inputs) and consequences (outcomes) of that use".[2]

This study focuses on cost-minimization analysis (CMA), one of the four fundamental evaluation studies. In CMA, the costs of the interventions that are being assessed are measured. Only in situations where the health benefits of healthcare interventions are the same or comparable can CMA be applied, negating the need for separate analysis. A common example of this is when a doctor decides to prescribe a generic drug instead of a branded medication because it will cost less and have the same benefits.[1] Only the cost of the medication itself needs to be compared when comparing drugs that have the same components, dose, method of administration and pharmaceutical characteristics as each other because the results should be the same.[3]

The need for pharmacoeconomics must be emphasized more when dispensing drugs in a developing country like India, where poverty and ignorance are pervasive. Prescription of generic drugs is one of the most important steps towards making the prescription affordable. to encourage doctors who treat patients with mild cognitive impairment (MCI) in its states to adopt generic drugs "Every doctor should ensure that medications are prescribed and used rationally, and to the greatest extent feasible, provide medications with generic names".[4] Even with a national surgical antimicrobial prophylaxis (SAP) guideline, surgical site infections (SSI) continue to be recorded, which increases the morbidity, mortality, and direct and indirect costs associated with patient care.[5]

Cephalosporin antibiotics are most commonly prescribed antimicrobial medications in the world for surgical practice, and they are used almost simultaneously for both therapeutic and SSI. Main goal of surgical site infection treatment is to reduce mortality and morbidity after surgery. When choosing right medication for SSI, pricing is another factor to take into account. Reasonable recommendations for type and length of therapy can significantly affect cost containment.[6]

Ceftriaxone exhibits broad spectrum antibiotic efficacy against aerobes, both gram-positive and gram-negative, which are commonly associated with severe medical conditions. Comparative studies showed that ceftriaxone significantly reduced hospitalisation costs for patients with severe infections (mostly infections of the skin, joints, and bones), allowing them to get all or part of their antimicrobial medication while in the hospital.[7]

For certain individuals on ceftriaxone, ceftazidime, or ceftizoxime, cefixime-the first oral third-generation cephalosporin available in Canada-can be used as an oral stepdown medication. This reduces price of purchasing and delivering medication. IV-PO stepdown, when used appropriately, can significantly save hospitalisation costs, improve medicine delivery, lessen chance of IV-related problems, and enable early discharge.[8]

The present study aims to analyze the pharmacoeconomic evaluation, especially on cost minimization of the cephalosporin antibiotics (ceftriaxone and cefixime) in the surgery department. The cost differences between the brands of the drugs are analyzed and ensure that the patient gets the best treatment in association with reducing the cost of treatment by choosing the most appropriate cheapest drugs for the patient to reduce barrios associated with the cost of treatment.

METHODS

A prospective observational study was carried out at the department of surgery in Adichunchanagiri hospital and research centre (AH and RC), B.G Nagara. Karnataka, India from January 2022 to October 2022. The study received ethical approval from the institutional ethical committee of AH and RC (Adichunchanagiri hospital and research centre) B. G. Nagara. The study population of this prospective observational study was a random sample of patients admitted to the surgery department from January 2022 to September 2022. The study included a total of 173 patients aged above 18 years with prescribed medications of ceftriaxone and cefixime in the surgery department and excluded outpatients and patients below 18 years. The participants were briefed on the study and signed informed consent prior to the data. The pharmacoeconomic evaluation of ceftriaxone and cefixime will be analyzed by evaluating the total number of brands and generic named drugs prescribed in the surgery department and evaluating cost minimization analysis for ceftriaxone and cefixime by analyzing their cost of drugs based on the strip and duration of drug use per day.The data were collected from patient profile forms and patient prescriptions. The collected data are documented and subjected to statistical analysis. The statistical package for social sciences version 20 (SPSS) was used for data analysis. All parameters in this study were expressed in frequencies and percentages. The mean values of the price of drugs are subjected to the cost-minimization analysis. The data of all the cost Indian rupee (INR; ₹) converted into US dollars (USD; $) at the rate of 1$=81.93 INR value in June 2023.

RESULTS

A total of 173 patients, males (105; 60 %) and females (68; 39.31%) participated in study. The majority of the participants were in age group of 40-60 years (58.95%). Table 1 shows demographic details of participants. Usage of cefixime, ceftriaxone and both cefixime and

ceftriaxone in whole participants in department of surgery during study period. Ceftriaxone (68; 39%) most used cephalosporin antibiotic, followed by both cefixime and ceftriaxone (66; 38%) and least used by cefixime (39; 23%). Patient received both cefixime and ceftriaxone, based on this, starts with ceftriaxone in IV route of administration and then continues with oral dose of administration of cefixime by discontinuing ceftriaxone.

Table 1: Patient demographics.

Variables	Categories	N	Percentages (%)
Age (In years)	>18-39	28	16.18
	40-60	102	58.95
	>60	43	24.87
Gender	Male	105	60.69
	Female	68	39.31

In Table 2 usage of ceftriaxone, cefixime and both ceftriaxone and cefixime for various infections in surgery department. Study shows that ceftriaxone was most used for treatment of cholelithiasis (16.20%) followed by acute appendicitis (11.80%), hernia and intestinal obstruction (10.30%). Acute appendicitis and cholelithiasis (17.10%) were most diagnosed diseases that use cefixime for antibiotic activity, followed by cysts, hernia (12.20%). Hernia (18.80%) was most used disease used both ceftriaxone, cefixime treatment. Varicose vein (12.50%) was 2nd most common disease used in both cefixime and ceftriaxone followed by cholelithiasis (10.90%).

Table 3 shows the pharmacoeconomic evaluation of the ceftriaxone antibiotic based on its brand and price range. There were 7 brands that are mainly used in the surgery department in the hospital. The most commonly used brand of ceftriaxone was Xone, Cadiceft, Monocef, Mocef, Biocef, C-one and Gramocef. Among all these seven brands costliest brand was found to be monocef (₹121.04; $1.04 per day) and the most prescribed drug among all. The least prescribed brand was Gramocef (₹114; $1.38 per day). The cheapest brand was Xone (₹112; $1.38 per day). The mean of ceftriaxone cost per vial was 56.67±10.04 and the mean of ceftriaxone tablet strips per day was ₹ 113.33±20.08. Cost minimization analysis shows that among all seven brands, the most prescribed drugs were costlier than least prescribed drugs.

Table 4 shows pharmacoeconomic evaluation of cefixime by its brand used in surgical department. Cefixime was one of the other drugs commonly used in surgery department. Each strip contains 10 tablets of dose 200 mg. Only 3 brands were available in hospital pharmacy. Taxim-O, Gramocef-O and Tanfix. Among these three brands most prescribed brand was Taxim-O ₹ 107.72; $ 1.31 per strip (200 mg/10 Tablet) and the least prescribed brand was Tanfix rupees ₹ 107; $ 1.30 (200 mg/10 tablet) and the brand Gramocef-O rupees ₹ 107.74; $ 1.31 per strip (200mg/10 Tablet). Mean of cefixime cost per strip ₹ 107.6±0.28; $ 1.31±0.0034 and mean of cefixime per day ₹ 21.51±0.05 $ 0.26±0.00061. There was no major cost difference/price variation in these 3 brands (0.69%).

Table 2: Usage of ceftriaxone, cefixime and both ceftriaxone and cefixime for various infections in surgery department.

Diagnosis	Ceftriaxone		Cefixime		Ceftriaxone and cefixime	
	N	%	N	%	N	%
Abscess foot	0	0.00	1	2.40	1	1.60
Acute appendicitis	8	11.80	7	17.10	4	6.30
Calculus cholecystitis	5	7.40	3	7.30	2	3.10
Acute gastroenteritis	0	0.00	0	0.00	2	3.10
Breast lump	5	7.40	2	4.90	3	4.70
Cellulitis	1	1.50	1	2.40	1	1.60
Cholelithiasis	11	16.20	7	17.10	7	10.90
Chronic fissure	1	1.50	0	0.00	1	1.60
Ulcer	1	1.50	3	7.30	1	1.60
Diabetic foot	4	5.90	1	2.40	4	6.30
Cyst	1	1.50	5	12.20	4	6.30
Fistula in ano	2	2.90	0	0.00	3	4.70
Gynecomastia	3	4.40	1	2.40	0	0.00
Hemorrhoids	5	7.40	2	4.90	5	7.80
Hernia	7	10.30	5	12.20	12	18.80
Intestinal abscess	0	0.00	0	0.00	1	1.60
Intestinal obstruction	7	10.30	2	4.90	2	3.10
Adenocarcinoma	1	1.50	0	0.00	0	0.00
Pneumothorax	1	1.50	0	0.00	0	0.00
Rectal prolapse	0	0.00	0	0.00	1	1.60
Sinus	0	0.00	0	0.00	1	1.60
Varicose vein	2	2.90	1	2.40	8	12.50
Wound debridement	3	4.40	0	0.00	1	1.60

Table 3: Distribution based on brands of ceftriaxone.

Brands of ceftriaxone	Price per vial (1 gm) (INR (₹); USD ($)	Price per day (INR (₹); USD ($)	No. of samples	Percentage (%)
Xone	₹ 56.00; $ 0.68	₹112; $ 1.37	10	15
Cadiceft	₹ 57.80; $ 0.71	₹ 115.6; $ 1.41	11	16
Monocef	₹ 60.52; $ 0.74	₹121.04; $ 1.48	18	27
Mocef	₹ 57.50; $ 0.70	₹ 115; $ 1.40	9	13
Biocef	₹ 59.00; $ 0.72	₹ 118; $ 1.44	9	13
C-one	₹ 60.50; $ 0.74	₹ 121; $ 1.48	8	12
Gramocef	₹ 57.00; $ 0.70	₹ 114; $1.36	3	4
Mean	₹ 56.67±10.04; $ 0.69±0.12	₹ 113.33±20.08; $1.38±0.28	68	100

Table 4: Distribution based on brands of cefixime.

Brands of cefixime	Price per strip	Price per day	No. of samples	Percentages (%)
Gramocef-O	₹ 107.74; $ 1.32	₹ 21.54; $ 0.26	14	36
Tanfix	₹ 107; $ 1.31	₹ 21.40; $ 0.26	7	18
Taxim-O	₹ 107.72; $ 1.31	₹ 21.54; $ 0.26	18	46
Mean	₹ 107.6±0.28; $ 107.6±0.0034	₹ 21.51±0.05; $ 0.26±0.00061	39	100

DISCUSSION

This study was conducted for patients in the surgery department to assess the pharmaco-economics evaluation and cost minimization of ceftriaxone and cefixime. This is done by the comparison of the different brands of the same drug among the study population. The cost of other drugs and other associated medical costs were not included in the analysis. The total cost for the actual prescribed drug along with low-cost drugs was compared for cost-minimization analysis.

A total of 172 admitted patients were involved in this study in the surgery department. among them most of the participants are from the age category of 41-60 years (58.95%). which indicates that most of the surgeries are carried out in this age group in this study site. In a similar study conducted by Gururaja et al among patients admitted to the Medicine and Surgery ward there was a preponderance of those above the age of 60 years (31.75%) This factor may have influenced antibiotic prescribing as older patients were more likely to be sick and to have more serious illnesses associated with SSI.[9]

The total use of ceftriaxone and cefixime was analyzed in the surgery department. Among 173 patients' ceftriaxone (68; 39%) is the most used cephalosporin antibiotic and followed by both cefixime and ceftriaxone (66; 38%) and the least are used by cefixime (39; 23%). A similar study conducted by Shankar et al assessed that of the 687 patients hospitalized, 203 patients were co-prescribed with other antimicrobials and 98% of patients were prescribed a single antimicrobial 68 patients were prescribed with ceftriaxone and study conducted by Gururaja et al. The most commonly prescribed antibiotic along with cephalosporins in medicine and surgery ward was metronidazole which accounted for 15.48% and 20.25% respectively.[10,9]

Out of 68 patients, 18 patients were prescribed brand Monocef, 11 patients were prescribed brand Cadiceft, 10 patients were prescribed brand Xone, 9 patients were prescribed brand Mocef, 9 patients were prescribed brand Biocef, 8 patients were prescribed brand C-one and 3 patients were prescribed brand Gramocef. Among all these seven brands costliest brand was Monocef rupees 121.04 per day and the least priced brand was Xone rupees 112; $ 1.37 per day. A similar study conducted by Anderson et al shows that the acquisition costs of cefotaxime and ticarcillin plus clavulanic acid were less than those of ceftriaxone. The estimated cost of treating the infective complications in the group of patients who received ticarcillin plus clavulanic acid ($128.039) was greater than the cost associated with the groups being treated with cefotaxime ($91.243) or ceftriaxone ($96.095).[11]

From this study, it was found that the Mean of ceftriaxone cost per vial ₹56.67±10.04; $ 0.69±0.12 and mean of ceftriaxone per day ₹113.33±20.08; $ 1.38±0.24. Cost minimization analysis shows that among all seven brands, the most prescribed drugs were costlier than the least prescribed drugs. The cost of most prescribed drugs i.e., costlier drugs was 8.07% higher than the other study drug. A similar study conducted by Woodfield et al shows that Ceftriaxone decreased the frequency but not the cost of chest and urinary infection (frequency R 6%, C 11%, $p<0.02$, cost R $1273±2338, C $1615±4083). Ceftriaxone decreased either the frequency or the cost of different postoperative infections.[12] In the study conducted by Mazza et al ceftriaxone decreased either the frequency or the cost of different postoperative infections and clinical outcomes and financial benefits appear to

support the use of ceftriaxone as a regular preventive antibiotic. for patients undergoing orthopedic surgery and study conducted by Naimi et al showed no significant correlation among price, brand, and efficacy of ceftriaxone sodium against *S. aureus*, an important consideration when treating *S. aureus* infection in Afghanistan and elsewhere.[13,14]

Among 173 patients 39 patients were prescribed cefixime. Only three brands are available in the hospital pharmacy. Out of 39 patients, 14(36%) patients were prescribed the brand Gramocef-O, 7 patients (18%) were prescribed the brand Tanfix, and 18 patients (46%) were prescribed the brand Taxim-O. The mean of ceftriaxone cost per strip ₹ 107.6±0.28; $ 1.31 and the mean of ceftriaxone per day ₹21.51±0.05; $ 0.26. There is no major cost difference or price variation in these three brands (0.69%).

Indian population faces many difficulties during payments of medications, the reason behind this is that they are aware much about various health policies and govt. schemes and they need to pay the bills by their own pockets. In India, due to various microbial issues and low bioequivalence is the major issue that has been observed in generic medicines. Therefore, branded medicines are preferred more by the Indian population over generic drugs. Since branded drugs have a wide variety of variance in their prices, physicians should always consider the prices of drugs while prescribing them. Costlier drug prescriptions usually lead to prescription non-adherence. This can be increased by prescribing the same efficacy drugs of other cheap brands. It will ultimately lower the overall per-prescription burden and simultaneously increase the medication goal of a physician. A similar study conducted by Kumari et al suggests that considering the inappropriateness of surgical antimicrobial prophylaxis (SAP) practiced, monitoring of guideline implementation and awareness among healthcare professionals is necessary to prevent SSIs and to decrease economic burden on the patients.[15] and study conducted by Munckhof W third-generation Cephalosporins were prescribed to 87.79% of patients for surgical prophylaxis which was inappropriate. For surgical prophylaxis, it was important to select antibiotic with the narrowest antibacterial spectrum to reduce the emergence of resistance and also broad-spectrum antibiotics could be required later if a patient developed serious sepsis. Therefore, it was recommended that use of third-generation Cephalosporins could be avoided in surgical prophylaxis.[16]

Although extensive in its scope, the current study is limited by a factor that should be considered. the study's nine-month timeframe might limit the scope and depth of the results, possibly missing long-term patterns or variances that might appear over an extended period of time. An expanded chronology could also help the research in assessing trends and changes over time more precisely.

CONCLUSION

Surgical site infection remains the most common surgical complication. The rates of SSI are increasing globally even in hospitals with the most modern facilities. The most important risk factors for SSI are the type and duration of surgery, operative technique, surgeon's skill, and pre-operative preparation of the surgical site. Our study revealed variations in the cost of treatment for infections depending on the type of prescribing of medicines–branded. By incorporating pharmacoeconomic studies into treatment recommendations in order to eliminate price variations caused by prescribing branded or generic medications, the financial burden of treating infections on patients can be greatly decreased. Despite existing steps, more must be done to address concerns with excessive brand costs, ensuring the quality of generics, enhancing the ceiling price policy, and implementing regulations. Last but not least, healthcare practitioners should be aware of drug costs while prescribing to reduce their patients' out-of-pocket expenses. Even if a doctor wishes to recommend a branded medication, they should choose the most reasonably priced option. The outcome of this study suggests that cheaper drugs could also be prescribed to the patients rather than costly drugs that will further increase the overall drug adherence and therapeutic outcomes of the particular disease. It will also reduce the health-related cost burden per prescription. It should be major responsibility of healthcare professionals to prescribe drugs that are lower in cost and have same clinicalvalue.

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Ethical approval: The study was approved by the Institutional Ethics Committee of AH and RC (Adichunchanagiri hospital and research centre), B. G. Nagara. (No: IEC/AH&RC/AC/002/2021)

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