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An observational study of drug usage and cost analysis of drugs used in coronary artery disease and angioplasty patients at a tertiary care hospital

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Abstract

Background: The prevalence of the cardiovascular disorder, in particular coronary artery disease, remains one of the major causes of morbidity and mortality in both developed and developing countries. The current study has been conducted to analyze the pattern of drug usage and cost of medication used in CAD and angioplasty patients in a tertiary care hospital with an additional aim of determining the adherence to the guidelines of ESC 2019.

Methods: A total of 115 prescriptions of CAD and angioplasty patients were reviewed. The drug class distribution, pattern of prescribing, adherence to guidelines as per ESC, and the cost of various medications were studied. Cost difference among prescribed drugs was evaluated using the ANOVA test.

Results: The overall prescription was according to the guidelines in 80.86%, and in 19.13%, these guidelines were not followed. Anticoagulants were the most prescription given category with a percentage of 98.26%, antihyperlipidemics were prescribed in 45.22%, and beta-blockers in 38.26%. Most the medicines were prescribed with their generic name, so the treatment was not costly. The distribution of cost variation within each drug category was statistically significant with a p-value of less than 0.05 as was evidenced by ANOVA test.

Conclusion: This study provided an overview of prescribing patterns among the CAD and angioplasty patients; ESC guidelines of adherence to prescription, as well as the use of generics. Findings proved the need for systematic monitoring as well as strategies that may improve rational prescribing and bring down the costs of medication in boosting better patient outcomes.

Keywords: Coronary artery disease, angioplasty, drug usage, cost analysis, European Society of Cardiology guidelines, rational prescribing.

Introduction

CVDs have been regarded as the leading cause of death worldwide, accounting for several million deaths every year. Coronary artery diseases, or ischemic heart disease, are the most common out of these and account for a major proportion of global morbidity and mortality.[1] CAD results from the condition wherein the coronary arteries responsible for supplying oxygenated blood to the heart musculature narrow down or become blocked.[2] This congestion is very much associated with the development of atherosclerosis, a process in which deposits of fatty material in arterial walls occur. Prolonged deposition of such plaques may cause their rupture and, thus, trigger mechanisms leading to the complete obstruction of the arteries by clots of blood, occasionally causing lethal diseases like myocardial infarction.[3]

The CAD events have been on the rise in recent times, meaning more medical interventions must be provided. Angioplasty remains a common procedure applied for restoring blood flow in blocked coronary arteries.[4] In patients with CAD, the procedure commonly known as angioplasty-PCI-involves the insertion of a balloon catheter and, in most cases, a stent to maintain the patency of the artery. While this has been an important evolution in the treatment of patients with CAD, management clearly does not stop at the time of angioplasty but involves comprehensive pharmacological therapy aimed at reducing the risk of recurrent events and improving long-term survival.[5,6]

The treatment of CAD patients includes several classes of drugs, such as anticoagulants, antiplatelets, beta-blockers, antihyperlipidemics including statins, and angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers. All these classes have an important role in impeding disease progression and reducing complications, thus improving the overall prognosis for the patient.[7,8] This includes the action of anticoagulants and antiplatelets in preventing clots in the blood, beta-blockers act by reducing heart rate and blood pressure, statins lower cholesterol, while ACE inhibitors or ARBs aid in the dilation of blood vessels. Their judicious use, often in combination, is considered essential in the management of CAD.[9]

However, despite guidelines such as those developed by the European Society of Cardiology and the American College of Cardiology, prescribing practice remains variable. Deviation from guideline recommendations can bring about suboptimal outcomes, apart from but including increased risk of recurrent events due to cardiovascular problems, extended hospitalization, and higher overall healthcare costs. The knowledge of the pattern of prescribing in real-world settings is crucial for the identification of gaps in guideline adherence and the development of strategies to enhance the rational use of drugs.[10,11]

The other important consideration in treatment associated with CAD involves the cost of the medications. The burden of cardiovascular diseases has not only been reflected in impacts on the health of the patients but also in the financial costs associated with long-term treatment. The high cost of cardiovascular drugs, especially branded medications, is a major challenge to health care systems, especially in resource-limited settings.[12,13] Generic drugs, although being bioequivalent to their branded counterparts but largely cheaper, offer a potential cost-effective alternative. However, the real-world replacement rate is highly variable between generics and branded drugs, and this variability is known to greatly influence the overall cost of treatment.[14] The present study will try to address two pertinent issues in CAD management: drug utilization pattern and pharmaceutical cost at a tertiary care hospital. In other words, prescription of drugs in coronary artery diseases and angioplasty patients.[15,16] This study tries to provide insights into how health professionals can best optimize pharmacotherapy in CAD patients by analyzing the patterns of prescriptions, their adherence to ESC 2019 guidelines, and the cost of medications. It also examines the degree to which drugs are prescribed by generic name compared with brand name, along with estimating the cost differential between options.[17,18]

Aim

The aim of this study is to analyze the drug usage and cost of drugs used in Coronary Artery Disease and Angioplasty patients

Objectives:

1. To ensure rational use of drugs.
2. Assess the appropriateness.
3. Comparing the cost-effectiveness of drugs used.

Methodology

Study Site: The study was conducted in Continental Hospital, Nanakramguda, Gachibowli, Hyderabad, Telangana, India

Study Duration: The study is conducted over a period of 6 months.

Study Design: This is an observational study

Sample Size: A total of 115 patients who were diagnosed with Coronary Artery Disease and angioplasty at Continental Hospital, who fulfilled the inclusion and exclusion criteria were included in the study

Study method: The data collection form was designed for the purpose of the present study. It comprises information about the study subject's data, including demographics, history of presents illness, past medical and medication history, social and family history, laboratory investigations, diagnosis, current medications prescribed, and a progress chart. Data relevant to the aims of the study were collected and recorded in the data collection form. Prescriptions were selected after application of inclusion and exclusion criteria. Data collected was fed in a spreadsheet (Excel sheet).

Study Criteria

Inclusion Criteria:

1. Subjects of both genders who were diagnosed with coronary artery disease and angioplasty.

Exclusion Criteria:

1. Neonates, Pediatrics, Pregnant women and Outpatients were excluded
2. Patients with other heart conditions.

Statistical Analysis

The data collected was analyzed using Statistical Analytical System (SAS) version 9.2 and 9.4 software, ANOVA test was applied to assess the cost difference of different classes of drugs used in coronary artery and angiography patients. Probability value obtained [P value] <0.5 was considered significant.

Results

1. SUBJECT CHARACTERISTICS

SUBJECT CHARACTERISTICS		FREQUENCY	PERCENTAGE
GENDER	MALE	84	73.04%
	FEMALE	31	26.96%
AGE RANGE (YEARS)	30 - 39	10	8.69%
	40 - 49	17	14.78%
	50 - 59	36	31.30%
	60 - 69	32	27.82%
	70 - 79	15	13.04%
	80 - 89	5	4.34%
LENGTH OF STAY	1 DAY	19	16.52%
	2 DAYS	17	14.78%
	3 DAYS	44	38.26%
	4 DAYS	21	18.26%
	5 DAYS	5	4.35%
	6 DAYS	2	1.74%
	7 DAYS	4	3.48%
	8 DAYS	1	0.87%
	9 DAYS	2	1.74%
COMORBIDITIES	HYPERTENSION	74	64.35%
	DIABETES MELLITUS	56	48.70%
	CAD	31	26.96%
	HYPOTHYROIDISM	16	13.91%
	HYPERLIPIDAEMIA	9	7.83%
	STROKE	4	3.48%
	CHRONIC KIDNEY DISEASE	3	2.61%
	ASTHMA	3	2.61%
	GASTRITIS	2	1.74%
	SPONDYLOSIS	2	1.74%
	OTHERS	22	19.13%

Out of 115 patients, 84 (73.04%) were male, and 31 (26.96%) were female, indicating a higher prevalence of male patients. The majority of patients fell into the 50-59 age group (31.30%), followed by 60-69 (27.82%). The least represented age groups were 80-89 (4.34%) and 30-39 (8.69%). The most common hospital stay duration was 3 days, with 44 patients (38.26%) staying for this period, while only a small portion stayed for 8 or 9 days (0.87% and 1.74%, respectively).Hypertension (64.35%) and Diabetes Mellitus (48.70%) were the most common comorbid conditions. Other notable conditions included Coronary Artery Disease (CAD) (26.96%), hypothyroidism (13.91%), and hyperlipidemia (7.83%).

2. DIAGNOSIS

DIAGNOSIS	FREQUENCY (N=115)	PERCENTAGE
CAD	27	23.48%
CAD SVD	11	9.57%
CAD DVD	8	6.96%
CAD TVD	12	10.43%
STABLE ANGINA	18	15.65%
UNSTABLE ANGINA	8	6.96%
NSTEMI	16	13.91%
STEMI	2	1.74%
ANTERIOR WALL MI	5	4.35%
INFERIOR WALL MI	3	2.61%
ANTEROLATERAL MI	2	1.74%
INFERILATERAL MI	1	0.87%
ACS	2	1.74%

CAD was the most frequent diagnosis (23.48%), followed by other types of CAD including single vessel disease (SVD) (9.57%), double vessel disease (DVD) (6.96%), and triple vessel disease (TVD) (10.43%).Angina was commonly seen, with Stable Angina (15.65%) and Unstable Angina (6.96%)% etc.

3. DRUGS PRESCRIBED

INDICATION	CLASS OF DRUGS	FREQUENCY	PERCENTAGE
CARDIOVASCULAR DRUGS	ANTICOAGULANTS	108	93.91%
	ANTIPLATELETS	93	80.87%
	ANTIHYPERLIPIDEMICS	93	80.87%
	ORGANIC NITRATES	54	46.96%
	BETA-BLOCKERS	40	34.78%
	CALCIUM CHANNEL BLOCKERS	33	28.70%
	ANTIANGINALS	31	26.96%
	DIURETICS	27	23.48%
	ANGIOTENSIN-II RECEPTOR BLOCKERS	22	19.13%
	ACE INHIBITORS	5	4.35%
	OTHERS	6	5.22%
OTHER THAN CARDIOVASCULAR DRUGS	ANTACIDS	86	20.98%
	HYPOGLYCEMICS	83	20.24%
	MULTIVITAMINS	54	13.17%
	ANALGESICS	40	9.76%
	ANTIEMETICS	37	9.02%
	NARCOTICS	31	7.56%
	ANTIBIOTICS	26	6.34%
	BRONCHODILATORS	18	4.39%
	THYROID AGENTS	13	3.17%
	CORTICOSTEROIDS	7	1.71%
	SYMPATHOMIMETICS	3	0.73%
	ANTIGOUT AGENTS	2	0.49%

Cardiovascular Drugs were the most frequently prescribed, with Anticoagulants being the highest prescribed class (93.91%), followed by Antiplatelets (80.87%) and Antihyperlipidemics (80.87%). Common Anticoagulants included Heparin (92.04%) and Enoxaparin (3.54%). Antiplatelets like Aspirin (47.06%) and Ticagrelor (33.16%) were frequently used.

4. DISTRIBUTION ACCORDING TO DRUGS AND COSTS COMPARISON

CLASS OF DRUG	DRUG NAME	FREQUENCY	PERCENTAGE	MEAN COST	STANDARD DEVIATION	P VALUE
ANTIANGINALS	IVABRADINE	15	32.61%	24.1	1.22	0.000
	NICORANDIL	13	28.26%	18.9	1.5	
	TRIMETAZIDINE	9	19.57%	10.04	5.4	
	RANOLAZINE	9	19.57%	16.044	0.66	
ORGANIC NITRATES	NITROGLYCERINE	48	88.89%	32.1	10	0.000
	ISOSORBIDE DINITRATE	4	7.41%	4.5	2.1	
	ISOSORBIDE MONONITRATE	2	3.70%	5.49	0	
ANTICOAGULANTS	HEPARIN	104	92.04%	190	95.5	0.000
	ENOXAPARIN	4	3.54%	641	127.4	
	APIXABAN	3	2.65%	53	13	
	DALTEPARIN	2	1.77%	600	130	
ANTIPLATELETS	ASPIRIN	88	47.06%	0.4	0.02	0.000
	TICAGRELOR	62	33.16%	34.5	9.8	
	CLOPIDOGREL	27	14.44%	10.46	6.2	
	TIROFIBAN	8	4.28%	7468.4	0	
	PRASUGREL	2	1.07%	31.1	0	
ANTIHYPERLIPIDEMICS	ATORVASTATIN	52	49.06%	35.7	17.5	0.000
	ROSUVASTATIN	50	47.17%	39.06	15.2	
	FENOFIBRATE	3	2.83%	21.37	0	
	EZETIMIBE	1	0.94%	17.9	0	
CALCIUM CHANNEL BLOCKERS	CILNIDIPINE	20	54.63%	10.8	2.8	0.000
	AMLODIPINE	11	28.95%	2.9	1.1	
	DILTIAZEM	4	10.53%	6.69	3.9	
	NIFEDIPINE	2	5.26%	3.88	0	
	BENEDIPINE	1	2.63%	11.83	0	

BETA-BLOCKERS	METOPROLOL	25	52.08%	6.14	3.06	0.000
	CARVEDILOL	12	25.00%	5.08	1.9	
	BISOPROLOL	6	12.50%	10.7	4.1	
	NEBIVOLOL	2	4.17%	6.5	3.4	
	LABETALOL	2	4.17%	227.57	0	
ACE INHIBITORS	RAMIPRIL	3	60.00%	7.34	1.6	0.000
	PERINDOPRIL	2	40.00%	4.85	0	
ANGIOTENSIN- II RECEPTOR BLOCKERS	TELMISARTAN	20	83.33%	7.7	1.8	0.000
	OLMESARTAN	3	12.50%	18.3	4.2	
	LOSARTAN	1	4.17%	4.5	0	
DIURETICS	FUROSEMIDE	17	48.57%	11.09	0	0.000
	TORSEMIDE	12	34.29%	5.09	0.8	
	SPIRONOLACTONE	4	11.43%	2.35	0	
	METOLAZONE	1	2.86%	29.42	0	
	EPLERENONE	1	2.86%	36.66	0	

The distribution of drugs prescribed for coronary artery disease patients showed significant variations in drug classes and costs. Commonly used drug classes included antianginals, anticoagulants, and antiplatelets. Mean costs varied notably across drugs, with the ANOVA test revealing statistically significant cost differences ($p < 0.05$), emphasizing financial considerations in CAD treatment.

5. PRESCRIBING INDICATORS

PRESCRIBING INDICATORS		**FREQUENCY**	**PERCENTAGE**
PRESCRIBED THERAPY	SINGLE DOSE	93	80.87%
	FIXED DOSE COMBINATIONS	22	19.13%
RUG COMBINATION	ATORVASTATIN+ASPIRIN	4	16.67%
	CLOPIDOGREL+ASPIRIN	3	12.50%
	ROSUVASTATIN+ASPIRIN+CLOPIDOGREL	3	12.50%
	METOPROLOL+TELMISARTAN	2	8.33%
	AMLODIPINE+ATENOLOL	2	8.33%
	ROSUVASTATIN+FENOFIBRATE	2	8.33%

	CLOPIDOGREL+ATORVASTATIN	1	4.17%
	ASPIRIN+CLOPIDOGREL+ATORVASTATIN	1	4.17%
	TORSEMIDE+SPIRANOLACTONE	1	4.17%
	ROSUVASTATIN+CLOPIDOGREL	1	4.17%
	ATORVASTATIN+CLOPIDOGREL	1	4.17%
	ROSUVASTATIN+ASPIRIN	1	4.17%
	AMLODIPINE+PERINDOPRIL	1	4.17%
	SACUBITRIL+VALSARTAN	1	4.17%
PRESCRIPTIONS WITH/WITHOUT GENERIC DRUGS	PRESCRIPTIONS WITH GENERIC DRUGS	99	86.09%
	PRESCRIPTIONS WITHOUT GENERIC DRUGS	16	13.91%

Single-dose therapies were the most common form of treatment (80.87%), and fixed-dose combinations accounted for 19.13% of prescriptions. Common drug combinations included Atorvastatin + Aspirin (16.67%) and Clopidogrel + Aspirin (12.50%). Generic drugs were prescribed in 86.09% of cases, while 13.91% of prescriptions were without generic drugs.

6. DRUGS PRESCRIBED AS PER WHO MODEL LIST OF ESSENTIAL MEDICINES – 22ND LIST (2021)

DRUG	FREQ.	%	DRUG	FREQ.	%
Acetylcysteine	18	15.65%	Escitalopram	1	0.87%
Adrenaline	1	0.87%	Fentanyl	30	26.09%
Antiarrhythmics	1	0.87%	Ferrous ascorbate	3	2.61%
Antibiotics	18	15.65%	Fexofenadine	1	0.87%
Anticoagulants	113	98.26%	Folic acid	5	4.35%
Antihyperlipidemics	52	45.22%	Formoterol	4	3.48%
Antiplatelets	27	23.48%	Hypoglycemics	37	32.17%
ARB’s	21	18.26%	Lactulose	10	8.70%
Beta-Blockers	44	38.26%	Magnesium	10	8.70%
Bronchodilators	13	11.30%	Ondansetron	36	31.30%
Calcium	9	7.83%	Organic Nitrates	4	3.48%
CCB’s	13	11.30%	Paracetamol	31	26.96%
Corticosteroids	11	9.57%	Potassium chloride	18	15.65%
Diuretics	21	18.26%	Thyroxine	13	11.30%
Dopamine	1	0.87%	Vitamins	24	20.87%

Among the 115 prescriptions analyzed, 113 (98.26%) contained anticoagulants, 52 (45.22%) included antihyperlipidemics, and 44 (38.26%) involved beta-blockers. Other prescribed drugs listed in the table were also in alignment with the WHO Model List of Essential Medicines – 22nd list (2021), ensuring adherence to essential medicine guidelines by physicians.

7. DRUGS PRESCRIBED FOR CAD AS PER EUROPEAN SOCIETY OF CARDIOLOGY (ESC) 2019 GUIDELINES

DRUGS AS PER ESC GUIDELINES	FREQUENCY	PERCENTAGE
ASPIRIN	88	76.52%
CLOPIDOGREL	27	23.47%
TICAGRELOR	61	53.04%
TIROFIBAN	6	5.21%
ENOXAPARIN	3	2.60%

Out of the 115 prescriptions analyzed, 93 (80.86%) adhered to the European Society of Cardiology (ESC) 2019 guidelines, while 22 (19.13%) did not comply. The study evaluated the appropriateness of cardiac medications prescribed to in-patients with coronary artery disease (CAD). The prescription rates for key medications were as follows: Aspirin (76.52%), Clopidogrel (23.47%), Ticagrelor (53.04%), Tirofiban (5.21%), and Enoxaparin (2.60%).

Discussion

Our study revealed that 73.04% of patients were male, with the most common age group being 50-59 years (31.30%). This is consistent with global trends in CAD, where males and older populations are more frequently affected, as reported by **Mohammed Mustafa**[19]who found similar demographic patterns with males comprising 70% of their study group, and a majority of patients being over 50 years old. The distribution of length of hospital stay, with most patients staying for 3 days (38.26%), is similar to findings from **Gaur A**[20] where the average length of stay for CAD patients was around 4 days, reflecting the need for close monitoring and early discharge in stable cases. The high incidence of comorbidities such as hypertension (64.35%) and diabetes mellitus (48.70%) aligns with the previous studies conducted by **Md Mustafa**[19] where patients with CAD werepresentedwith1and/ormorethan1comorbiditie s, where over 60% of CAD patients had hypertension and approximately 50% had diabetes, indicating these as significant risk factors for CAD.

Coronary artery disease (CAD) was the most common diagnosis (23.48%), which is consistent with the findings of **N Solanki et al**, [21] where CAD remained the leading cause of cardiovascular admissions.

In this study, the most frequently prescribed drugs for coronary artery disease (CAD) were **anticoagulants** followed by **antihyperlipidemics ,** anti-plateletics, organic nitates, **beta-blockers** etc. These results align with standard CAD treatment guidelines, as seen in prior studies like **Jorg Muntwyler et al**[22] Anticoagulants, particularly **heparin**, were commonly used, reflecting their key role in preventing thromboembolic events.

The **ANOVA test** showed a statistically significant difference in the cost of drugs prescribed for CAD, particularly with regard to anticoagulants, antiplatelets, and antihyperlipidemics. This is consistent with the study by **Singh et al** [23] , who reported similar findings in the cost variability between branded and generic drugs, especially with newer antiplatelets like **Ticagrelor**, which showed higher costs compared to older agents like **Aspirin** and **Clopidogrel**. The cost differences highlight the importance of selecting cost-effective treatment options, particularly in settings with limited healthcare resources.

Our study revealed that 80.87% of prescriptions were for single-dose therapy, while 19.13% involved fixed-dose combinations (FDCs). The most common FDCs were Atorvastatin + Aspirin and Clopidogrel + Aspirin, which is similar to findings from **Solanki N et al**[21] where FDCs were frequently prescribed in CAD management to improve adherence and clinical outcomes. These results underline the need for optimizing drug combinations to enhance therapeutic efficiency and reduce the pill burden for patients.
Our study found that 113 prescriptions (98.26%) included anticoagulants, and 52 (45.22%) contained antihyperlipidemics etc. The alignment of prescriptions with the WHO Model List of Essential Medicines (2021) highlights a strong adherence to evidence-based practice.

Among the 115 prescriptions analyzed, **93 (80.86%)** complied with the **European Society of Cardiology (ESC) 2019 guidelines**, while **22 (19.13%)** did not, highlighting the global challenge of full guideline adherence in real-world practice.

Conclusion

The global rising burden of cardiovascular-related illnesses has greatly increased morbidity and mortality rates worldwide. This study had given additional information on the pattern of drug use in the management of coronary artery disease and angioplasty. Most the drugs prescribed were by their generic name, indicating a trend towards cheaper prescribing. Prescribers in this institution had a good adherence to the European Society of Cardiology guideline, as evidenced by 80.86% prescription of drug was according to this standard, 19.13% of this population did not adhere to the stipulated guidelines.

By adhering closely to such guidelines, prescribers attained optimal prescription practice, considered an important part in ensuring rational drug use and optimizing patient outcomes. It also points out that a decrease in the total number of drugs further contributes to the efficacy of treatment and compliance of patients.

Systematic monitoring and strategies to improve patient adherence and rational prescribing will achieve optimization of therapeutic outcomes. Adherence to clinical guidelines ensures better management of cardiovascular diseases and finally improves the quality of life in patients. This study will serve as an informative guide to healthcare professionals on how to enhance prescribing practices and improve the care of patients.

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