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Research Article

SHORT-TERM TREATMENT WITH UNFRACTIONATED HEPARIN OR ENOXAPARIN AMONG PATIENTS ADMITTED WITH ACUTE MYOCARDIAL INFARCTION IN A TERTIARY CARE CENTRE – A COST MINIMIZATION ANALYSIS

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ABSTRACT

Objective: To estimate the direct medical cost associated with unfractionated heparin (UFH) and enoxaparin among hospitalized patients with acute myocardial infarction (AMI) in a tertiary care center.

Methods: The present cohort study was conducted among hospitalized patients treated with UFH or Enoxaparin for AMI in a tertiary care center. Costs of the drugs, supplies for administration, and costs of laboratory test monitoring were added to calculate the total medical cost. The researchers assumed other costs were equivalent between the two groups.

Results: Researchers included 100 patients aged 40–88 years, admitted with AMI, with a mean age of 67.10±10.89 years. Moreover, they treated 66 patients with UFH and 34 with enoxaparin. The mean duration of hospital stay in the UFH group was 4.36±2.3 and was 4.85±2.9 in the enoxaparin group (p=0.126). The mean direct medical cost per day was calculated as INR 435.05±50.002 for UFH and INR 926.03±81.462 for enoxaparin (p=0.166), while the direct medical cost considering the mean duration of use was INR 1897.50±1021.9 and INR 4547.79±2710.6, respectively, in both groups (p=0.000). The cost of laboratory monitoring was INR 677.27±218.94 with UFH and INR 308.82±51.45 with enoxaparin (p=0.000). The total cost, including laboratory monitoring, was INR 2574.77±1211.69 in the UFH group and INR 4856.62±2717.9 in the enoxaparin group.

Conclusion: Direct medical costs associated with UFH were lower than those of enoxaparin; hence, short-term treatment with UFH for AMI in hospitalized patients provided cost savings in a tertiary care hospital in South Kerala.

Keywords: Unfractionated heparin, Enoxaparin, Direct medical cost, Acute myocardial infarction.

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INTRODUCTION

Globally, cardiovascular diseases are among the top causes of morbidity and mortality. Acute myocardial infarction (AMI) is a critical and potentially life-threatening manifestation of coronary artery disease (CAD) [1]. The prevalence of coronary atherosclerosis is increasing due to risk factors such as changing lifestyles, increasing incidences of diabetes and high blood pressure, and family history of the disease [2]. Effective anticoagulation medication is a significant component of AMI treatment to prevent the development of blood clots and reduce the risk of future ischemic events [3].

Two common anticoagulants used in the treatment of myocardial infarction (MI) are low-molecular-weight heparin (LMWH), particularly Enoxaparin, and unfractionated heparin (UFH). UFH is a widely used anticoagulant that has been in use for decades. Although it is fast-acting and reversible, it has unpredictable pharmacokinetics, which necessitate frequent monitoring. An adverse drug reaction such as thrombocytopenia, is also commonly observed with UFH [4,5]. LMWH, like enoxaparin are favored for its predictable anticoagulant effects, lower risk of side effects, and convenient administration without frequent dose adjustments [6,7]. Studies have shown that enoxaparin is as effective as or more effective than UFH in lowering the risk of repeat ischemic events in patients with non-ST-elevation MI (NSTEMI) [8,9]. In addition, another trial showed that enoxaparin produced comparable clinical outcomes to UFH in patients receiving an early invasive strategy, with a bias toward reduced mortality [9].

Past studies demonstrated that enoxaparin thromboprophylaxis possessed therapeutic benefits, including reduced adverse events, major bleeding, and hospital deaths, resulting in reduced overall hospital costs than UFH. However, its higher cost of purchase is also a concern, particularly in resource-constrained healthcare environments such as Kerala [10,11]. Cost-minimization analysis (CMA) is a pharmacoeconomic technique that compares two or more treatments with identical clinical efficacy and identifies the least expensive [12]. Both enoxaparin and UFH are effective in the treatment of AMI, so a CMA can assist us in identifying how we can reduce our expenditure on healthcare without compromising on the outcomes [7]. Research has indicated that although UFH might be less expensive in terms of direct cost, the costs of constant monitoring, increased length of hospital stay, and increased risk of complications might offset its initial cost benefit [10].

The goal of this study is to compare the short-term treatment costs of UFH versus LMWH (Enoxaparin) in patients with AMI at a tertiary care center in Kerala using a cost-minimization approach [13]. The outcomes of cost analysis will give doctors and policymakers valuable data to assist them in making decisions on how to diagnose and treat clinical disorders in a cost-saving manner [14,15].

METHODS

This prospective cohort study at the cardiology department of a tertiary care center in South Kerala examined the extra cost of treating AMI patients with either UFH or Enoxaparin.

Inclusion criteria

Both male and female patients with an age of more than 18 years, diagnosed with AMI–either ST-elevation MI (STEMI) or NSTEMI–and who received either UFH or enoxaparin during their hospital stay were included in the study.

Exclusion criteria

Patients were excluded from the study if they met any of the following criteria:

- Contraindications to receive anticoagulant medication
- Received both UFH and enoxaparin during hospitalization
- Had severe renal impairment (estimated glomerular filtration rate <30 mL/min/1.73 m^2)
- Had insufficient cost data or were lost to follow-up.

Study period

The research was conducted over a period of 3 months.

Sample size

The required sample size was calculated as 96 using the formula:

$$N=Zalpha^2PQ/d^2$$

Where:

- P=93.3% [16]
- Zalpha=1.96
- d=5%

Data collection method

Informed consent was obtained from all participants. The study focused on direct medical spending from the healthcare system's perspective, which included the costs of drugs, supplies, and laboratory monitoring.

- Drug costs: Calculated based on the total dosage administered to each patient
- Supply costs: Included items necessary for administration, such as syringes, infusion sets, and IV catheters
- Laboratory monitoring costs: Comprised the cost of tests required to monitor the anticoagulant medication. For monitoring anticoagulant effects, activated partial thromboplastin time (aPTT) is used for UFH, and anti-Xa assay is used for enoxaparin. The average direct medical cost per patient was calculated for both groups receiving UFH and Enoxaparin.

Data entry and analysis

Data management was done using Microsoft Excel. Descriptive statistics summarized patient demographics and clinical data. Continuous variables like cost differences were compared using independent t-tests or Mann–Whitney U tests. Categorical data were analyzed with Chi-square tests.

Cost analysis

A CMA was conducted assuming both treatment options have equivalent effectiveness.

Ethics approval

The research was approved by the Institutional Ethics Committee (IEC) before starting (Reference number: IRB/10/01/2023). Participants gave signed informed consent, and the study followed ethical guidelines to protect patient privacy.

RESULTS

The mean age of 100 patients who took part in the research was 67 (67.10) years. The distribution of gender in LMWH and UFH groups was not statistically significant (Fig. 1) (2=1.32, p=0.2). There was also the same proportion of males and females in both groups.

When comparing the risk status of patients (between those in both groups) with regard to smoking and non-smoking, as shown in Fig. 2, no significant distinction was detected between the proportion of smokers and non-smokers in the UFH group and that in the LMWH group.

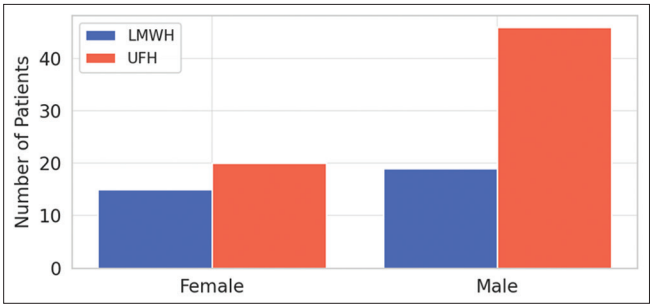

Fig. 1: Distribution of patients by gender in the low-molecular-weight heparin and unfractionated heparin groups

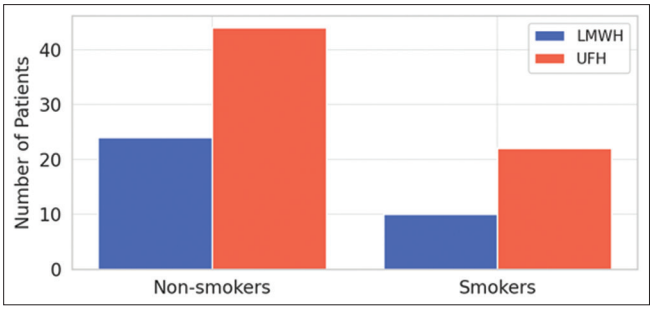

Fig. 2: Distribution of smokers and non-smokers in the low-molecular-weight heparin and unfractionated heparin groups

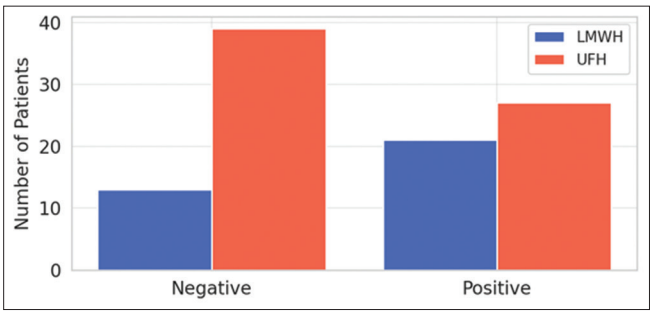

Fig. 3: Distribution of patients with a family history of coronary artery disease in the low-molecular-weight heparin and unfractionated heparin groups

As shown in Fig. 3 comparing the proportion of patients with a family history of CAD between the two groups showed no significant difference (x 2(Chi squire value) = 3.92, p =0.047).

Among patients' risk factors for CAD such as high blood pressure, diabetes, and dyslipidemia, the rate of patients with diabetes was notable (x 2(Chi squire value) (× 2=3.92, p=0.047)). The proportions of the other two categories, hypertension, and dyslipidemia, were not significantly different from each other.

As shown in Fig. 5 most of the patients (27 in the LMWH group and 38 in the UFH group) had STEMI (χ^2=3.79, p=0.051).

Patients in the UFH group had an average hospital stay of 4.36 days (±2.3 days), compared to 4.85 days (±2.9 days) for the enoxaparin group (p=0.126).

Table 1 shows the direct medical expenditures of UFH and enoxaparin therapy for patients with AMI. The enoxaparin group had far higher average direct medical costs, laboratory costs, and overall treatment costs while they were in the hospital.

Table 1: Comparison of direct medical costs between the UFH and LMWH groups

Cost analysis	UFH Mean±SD (INR)	LMWH (enoxaparin) Mean±SD (INR)	p-value
Mean direct medical cost/day	435.05±50.002	926.03±81.462	0.166
Mean direct medical cost during hospital stay	1897.50±1021.9	4547.79±2710.6	0.000*
Laboratory cost	677.27±218.94	308.82±51.45	0.000*
Total cost	2574.77±1211.69	4856.62±2717.9	0.000*

*Significant. SD: Standard deviation, UFH: Unfractionated heparin, LMWH: Low-molecular-weight heparin

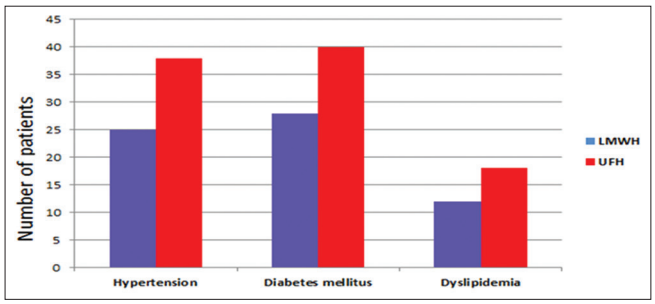

Fig. 4: Distribution of risk factors for coronary artery disease in the low-molecular-weight heparin and unfractionated heparin groups

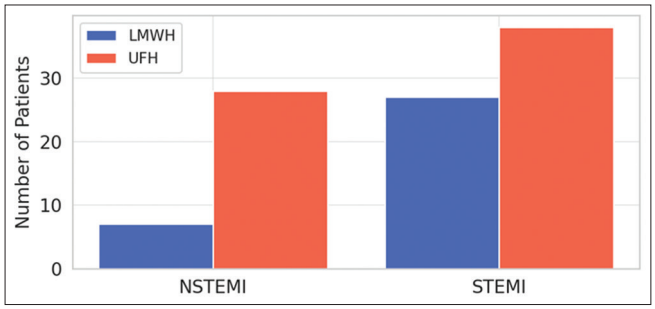

Fig. 5: Distribution of diagnosis in the low-molecular-weight heparin and unfractionated heparin groups

DISCUSSION

This cost minimization analysis compared the direct medical costs of using UFH and LMWH: Enoxaparin in a short-term period in patients admitted to a tertiary care facility with AMI. The patients in this study had a mean age of 67.1 years. This is higher than the mean age in earlier Indian studies [17,18]. Differences in risk factors and access to healthcare across India may explain this. Previous studies have looked at risk factors for CAD. These include smoking history, family history of AMI, and other health conditions such as hypertension, diabetes, and high cholesterol [18]. In this study, risk factors were generally distributed similarly between the two treatment groups, except for diabetes mellitus, which was more common in the UFH group.

Study results indicated both medications played a significant role in treating AMI. However, UFH had a lower cost. This gap is especially important in healthcare settings where resources are limited. Cost-efficient treatments are needed to improve patient care and clinical outcomes. This study showed that the difference in the direct medical costs between UFH and enoxaparin was statistically significant, and enoxaparin is nearly twice as expensive as UFH. This was mainly because the cost of purchasing enoxaparin remained very high, even though the cost of laboratory monitoring decreased significantly. The literature contains a lot of information regarding enoxaparin as an anticoagulant that has improved pharmacokinetic predictability, reduced interpatient variability, and fewer side effects compared to UFH [3].

The duration of hospital stay was similar between the two groups, even though enoxaparin required less laboratory monitoring of aPTT. This could be due to the influence of other variables, including the baseline characteristics of the patient, differences in the medications they were using concurrently, and the hospital policies on treatment. The judgment of the doctor, the availability of beds, and the arrangements of care after discharge are other factors that could have influenced the length of stay of a person in the hospital. These factors might have affected the likelihood of enoxaparin leading to shorter hospital stays [19]. This study found that the anticipated advantage of reduced hospital stays with Enoxaparin does not necessarily translate into cost savings in clinical practice.

Although enoxaparin has some pharmacological advantages, its higher price remains a significant factor limiting its popularity, especially in regions with limited medical budgets. The cost of Enoxaparin mainly comes from its purchase price, along with added costs for administration and monitoring, which can drive up its overall cost for healthcare institutions [20]. Previous studies [8,9] have also found that the price of enoxaparin is not always justified when UFH is a viable alternative. In this study, the cost disparity highlights the need to choose anticoagulants carefully to balance clinical outcomes and cost-effectiveness.

CONCLUSION

This study's results show that UFH is a better way to save money on anticoagulation for AMI patients than enoxaparin, without substantially changing how long they remain in the hospital. These results have essential implications for healthcare policymakers, hospital managers, and clinical practitioners in places with limited financial resources that need wise allocation. Using low-cost treatment alternatives like UFH, healthcare systems can expand access to cardiovascular care, reduce financial burden, and help ensure equitable care for all. To make AMI treatment strategies sustainable and effective across various hospital settings, decision-makers should include pharmaco-economic factors in evidence-based guidelines, institutional protocols, and national healthcare policy frameworks.

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AUTHORS' CONTRIBUTIONS

All of the writers may have contributed to the research article and also edited it. All writers have authorized the final version.

CONFLICTS OF INTEREST

Nil.

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