

# **COSTS ASSOCIATED WITH PREOPERATIVE EVALUATION AMONG VASCULAR PATIENTS: TIKUR ANBESSA SPECIAIZED HOSPITAL**



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**Declaration**

I, Dr. KARENZI IRENEE DAVID, hereby declare that the Thesis:” **COSTS ASSOCIATED WITH PREOPERATIVE EVALUATION AMONG VASCULAR PATIENTS IN TIKUR ANBESSA SPECIALIZED HOSPITAL**”, is my original work and has not been presented for a degree in any other University. All sources and material used in the document have been duly acknowledged and cited properly.

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**Department of Surgery, Vascular Unity Approval**

The undersigned have examined the thesis report untitled” **Costs Associated with Preoperative Evaluation Among Vascular Patients in Tikur Anbessa Specialized Hospital**” presented by Dr KARENZI IRENEE David with registration umber GSR/0451/16, a candidate for the fellowship Certificate in Vascular and Endovascular Surgery and here certify that it is worthy of acceptance.

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## **Abstract**

### **Background**

Preoperative evaluation is essential for safe vascular surgery. However, routine tests can impose financial burden on patients, especially in resource-limited settings. This study aim was to assess preoperative evaluation in vascular patients with its associated direct patient costs and cost drivers in Tikur Anbessa Specialized Hospital (TASH).

### **Methods**

An institutional-based retrospective cross-sectional study was conducted for vascular patients operated from January 2022 to December 2024 at TASH, assessing costs associated with preoperative investigations among vascular patients. Data were collected from patients' records, and phone calls. National Institute for Health and Care Excellence (NICE) guidelines 2016 served as reference to characterize investigation tests. Costs were determined using TASH service fees and private center rates. Data were analyzed using SPSS version 21.

### **Results**

A total of 165 elective vascular surgery patients were recruited. Mean age was 49.6 years, 88 males, 77 females. Peripheral artery disease was the most common diagnosis (47.3%). The average hospital stay was 13.7 days. The mean total cost of preoperative investigations per patient was 9,717.40 ETB, average imaging cost: 8,797 ETB, laboratory tests cost was 1,328 ETB. CT scans (82.4%) and echocardiography (61.2%) were the most requested imaging. Notably, 20% of ECGs and 43.5% of echocardiograms were not clinically indicated. The mean cost of unindicated tests was 648.99 ETB per patient, with a maximum of 3,565 ETB. Advancing age, having comorbidity, diagnosis type, procedure type and increasing hospital stay, were significantly associated with higher investigation costs. Over 61.3% of patients reported that the cost of investigations was unaffordable to them.

### **Conclusion**

Preoperative evaluation in vascular surgery at TASH is characterized by excessive use of routine and advanced investigations, some of which lack clinical indication. These practices contribute to substantial patient expenses, primarily through out of pocket payment. There is also gap in providing some necessary investigation tests. A large proportion of imaging tests were done in private centers which imposed financial burden to vascular patients. Developing and implementing evidence based testing guidelines could limit the cost and bridge the gap observed.

## **Abbreviations and Acronyms**

|                 |                                             |
|-----------------|---------------------------------------------|
| <b>TASH:</b>    | Tikur Anbessa Specialized Hospital          |
| <b>ASA:</b>     | American Society of Anesthesiologists       |
| <b>PAC:</b>     | Pre anesthesia checkup                      |
| <b>SPSS:</b>    | Statistical Package for the Social Sciences |
| <b>ETB:</b>     | Ethiopian Birr                              |
| <b>USD:</b>     | United States of America Dollars            |
| <b>CT Scan:</b> | Computed tomography scan                    |
| <b>MRI:</b>     | Magnetic resonance imaging                  |
| <b>ECG:</b>     | Electrocardiography                         |
| <b>ECHO:</b>    | Echocardiography                            |
| <b>PT:</b>      | Prothrombin time                            |
| <b>aPTT:</b>    | Activated partial thromboplastin time       |
| <b>INR:</b>     | International normalized ration             |
| <b>L.E:</b>     | Lower extremity                             |
| <b>U.E:</b>     | Extremity                                   |
| <b>C.I:</b>     | Confidence Interval                         |
| <b>COR:</b>     | Crude Odd Ratio                             |
| <b>AOR:</b>     | Adjusted Odd Ratio                          |

## **I. Introduction**

### **I.1. Back ground**

Pre-operative evaluation or pre-operative check-up is the pre requisite for preparing a patient for surgery. It is described as the clinical evaluation step that precedes the administration of anesthetics for surgical and non-surgical procedures. It must consider data from many sources including preoperative tests. (1) Pre-operative evaluation may include routine tests and indicated tests. The American Society of Anesthesiologists (ASA) Task Force on Pre anesthesia checkup (PAC), defines routine tests as those done in the absence of any specific clinical indication or purpose, while indicated tests are those done for specific clinical purpose or indication, like confirming a clinical diagnosis or assessing the severity and progress of disease.

Patients with peripheral arterial disease has increased risk of postoperative major cardiovascular complications like myocardial infarction, heart failure, arrhythmias and stroke. For this reason, preoperative evaluation aim is to reduce mortality related to those complications even though there is no standardized approach of preoperative workup for those patients.(2) Major Adverse cardiovascular events are defined as acute myocardial infarction, decompensated heart failure, stroke or malignant arrhythmias which are unstable ventricular or supraventricular arrhythmias. The incidence of these complications range from 5%-15% in patients with peripheral arterial diseases in post-operative period. Characteristics of patients and pathophysiology of atherosclerosis and hemodynamic instability, bleeding, cross cramping of major arteries, thromboembolic and reperfusion phenomena increase the risk of Major Adverse Cardiovascular Events.(3)

Preoperative cardiac evaluation and risk stratification in surgical patients and especially in vascular surgery should be performed by any practicing Surgeon. Due to the systemic nature of atherosclerosis and similarities in pathophysiology and risk factors of both vascular and cardiac disease processes, most vascular patients suffer from cardiac disease.(4) Preoperative laboratory investigations are considered as an important element of pre-anesthesia evaluation to determine the fitness for anesthesia and surgery. Few decades ago this practice was closely surveyed due to its low input and high added cost. It was found that performing routine screening tests in otherwise healthy patients is of little value in detecting diseases and in changing the anesthetic management



or outcome. A large number of investigations which are costly to pursue, often detect minor abnormalities of no clinical relevance, may be risky to patients and may cause unnecessary delay or cancellation of surgery. Selective testing reduces cost without sacrificing safety or quality of surgical care.(5)

Advances in technology and introduction of multiple laboratory tests, few decades ago, led to increase in number of ordered tests thinking that asymptomatic diagnosis will optimize care and reduce medical cost but more testing can lead to increased number of abnormal results leading to additional unnecessary workup with increase in medical cost with possibility to increase morbidity from more medical interventions. Preoperative testing should base on targeted history and physical exam for patient comorbidities and types of surgery planned.(6)

Vascular surgery procedures are grouped in three categories according to the likelihood of developing perioperative major adverse cardiac events (MACE); those are: high risk procedures with risk >5%, Intermediate risk ones (1%-5%) and low risk procedures which risk is <1%. Preoperative cardiac evaluation is based on above mentioned categories.(7)

Effective preoperative evaluation of vascular patients includes Cardiac, respiratory system, renal, metabolic, coagulation, blood group and cross matching and specialists input. The prevalence of cardiovascular disease in vascular patients is 25-60%, for smoking it is 35-85% and coexistence of respiratory disease counts 10-50% in vascular patients. The prevalence of renal system dysfunction accounts 4-13%. (8) There is large variations in length of hospital stay mainly due to practice patterns than severity of diseases and interventions that can decrease length of stay in hospital can results in cost savings.(9)

Indiscriminate preoperative tests ordering was found to be a problem that affect many surgical procedures worldwide with estimated direct cost more than 18 million USD. Un-indicated or routine tests may also add on cost of health and surgical care in general. Routine tests requested in preoperative work up is still common and leads to substantial excess cost for surgical patients. Economic analysis suggests that preoperative workup guidelines can reduce the cost of preoperative investigations(10)

## **I.2 Statement of the Problem**

Many patients with cardiovascular diseases need surgical treatment even though they present with many comorbidities that predispose them to perioperative adverse events. Preoperative preparation of these patients requires different clinical investigations that might increase the cost of care and for some patients, safe and timely surgery may not be affordable. For patients coming for elective surgery in TASH, 30% of preoperative laboratory tests were provided routinely and its related cost was not studied. To the best of my knowledge, the total cost of pre-operative investigations and their key cost drivers for vascular patients receiving surgical care at TASH was not studied.

## **I.3. Significance and Rationale of the Study**

Understanding the cost related to preoperative investigations for vascular patients and unnecessary increments will lead to development and implementation of evidence based guidelines with aim to enhance the cost-effectiveness of vascular surgery care at TASH. It will also incite improvement in preoperative investigations by decreasing cost related to unnecessary tests also by addressing gaps in preoperative tests. As vascular patients need a large number of preoperative tests, this study aimed to assess in details, the preoperative investigations and associated costs for vascular patients at TASH.

This study provided primary data on cost estimation of preoperative investigations needed for patient who came for vascular surgery. This study also highlighted the gap in preoperative evaluation of these patients so that many more quality improvement projects may be developed based on data from this study.

This study aimed to assess the total direct cost incurred by patients for preoperative investigation tests prior to undergoing vascular surgery. Specifically, this study sought to characterize the profile of preoperative investigations commonly performed for these patients and estimate the total and average direct costs related to the above mentioned investigations at Tikur Anbessa Specialized Hospital (TASH) and in private health facilities. Additionally, this study provides insight about the routine preoperative tests performed and their associated financial burden on patients.

## **I.4. Research Questions**

What are the average costs (patient costs), of preoperative investigation for vascular patients in TASH?

What is the cost of routine tests for preoperative workup in vascular patients?

## **II. Literature review**

In study done in Caribbean tertiary care teaching hospital found that 64% of preoperative investigations were considered to be unnecessary and the total amount spent those tests was 44,664 USD, it was estimated to 178,488 USD annual cost that counted 59% of total preoperative investigations.(11)

Alazzawi et al. in 2012 investigated the costs and benefits of pre-operative blood tests in orthopedic trauma patients with an ASA score 1. Based on 127 patients, they found that pre-operative lab testing and abnormal results did not change the patients' treatments or clinical decisions(12)

A study done by Alison W. Vogt et al. concluded that an average of 72.5% of tests done by surgeons' requests were considered not indicated by the anesthesiologists and that their hospital could have saved \$80,000 by eliminating un-indicated preoperative tests for the 5100 patients seen in preoperative clinic annually.(13)

Comprehensive geriatric assessment before vascular surgery was found to be cost effective compared to standard preoperative care by reducing post-operative complications and length of hospital stay that led to cost saving.(14)

A retrospective review found that judicious preoperative blood grouping and cross- match could save significant amount, as many patients did not require transfusions despite undergoing major surgeries. Rationalizing the preoperative blood group and cross- match policy could lead to cost savings without affecting patient care.(15)

Literature shows that 60-70% of preoperative test requested before general surgery were not really required. Indiscriminate tests ordering affects around > 30 million procedures and estimated direct cost of 18 million USD. The added cost of un-indicated tests counts around 13.9% of total investigation cost, this means that routine tests done in preoperative period leads to excess of cost of care.(16)

Magnetic resonance angiography can be cost effective alternative to conventional angiography for patients with limb threatening peripheral vascular diseases, if its accuracy for inflow evaluation reaches a certain threshold.(17)

Replacing Doppler ultrasound with contrast-enhanced magnetic resonance angiography (MRA) for the initial imaging tests for patients with peripheral vascular disease reduces the need for additional imaging tests, but MRA cost is higher than ultrasound.(18)

In a study assessing the necessity of multiple preoperative investigations found that 2/3 of investigations were not needed, leading to unnecessary costs. Limiting preoperative tests to those favored by clinical indications, can lead to significant cost savings without compromising the quality and safety of care.(19)

The imaging request CT and MR were increased considerably from 1995 to 2010 and 10-30% of imaging tests are done for inappropriate indications which increase cost, waiting time and unnecessary patient exposure to radiations and can lead to missed diagnosis with its clinical consequences.(20)

In patients undergoing peripheral vascular procedures, preoperative risk stratification by selective noninvasive stress imaging has been shown to reduce costs significantly. This approach minimizes the economic impact of initial diagnostic testing while maintaining patient outcomes.(21)

According to Marcello, annual routine preoperative investigation cost counted > 30 billion USD in United States and 60% of the tests were found to be routine and they would be eliminated without affecting quality surgical care for patients.(22)

According to Alex et al., routine preoperative tests in low risk procedure are common and costly, echo counting 47.8% of the total cost. To address the burden of low value preoperative tests ,it is needed to develop quality monitoring measures and identify the root cause.(23)

Even though preoperative investigations are important asset in surgery and anesthesia planning, 60-70% of preoperative laboratory tests are unnecessary, so evidence based recommendations on preoperative investigations are needed in resource limited settings. Selective laboratory requests

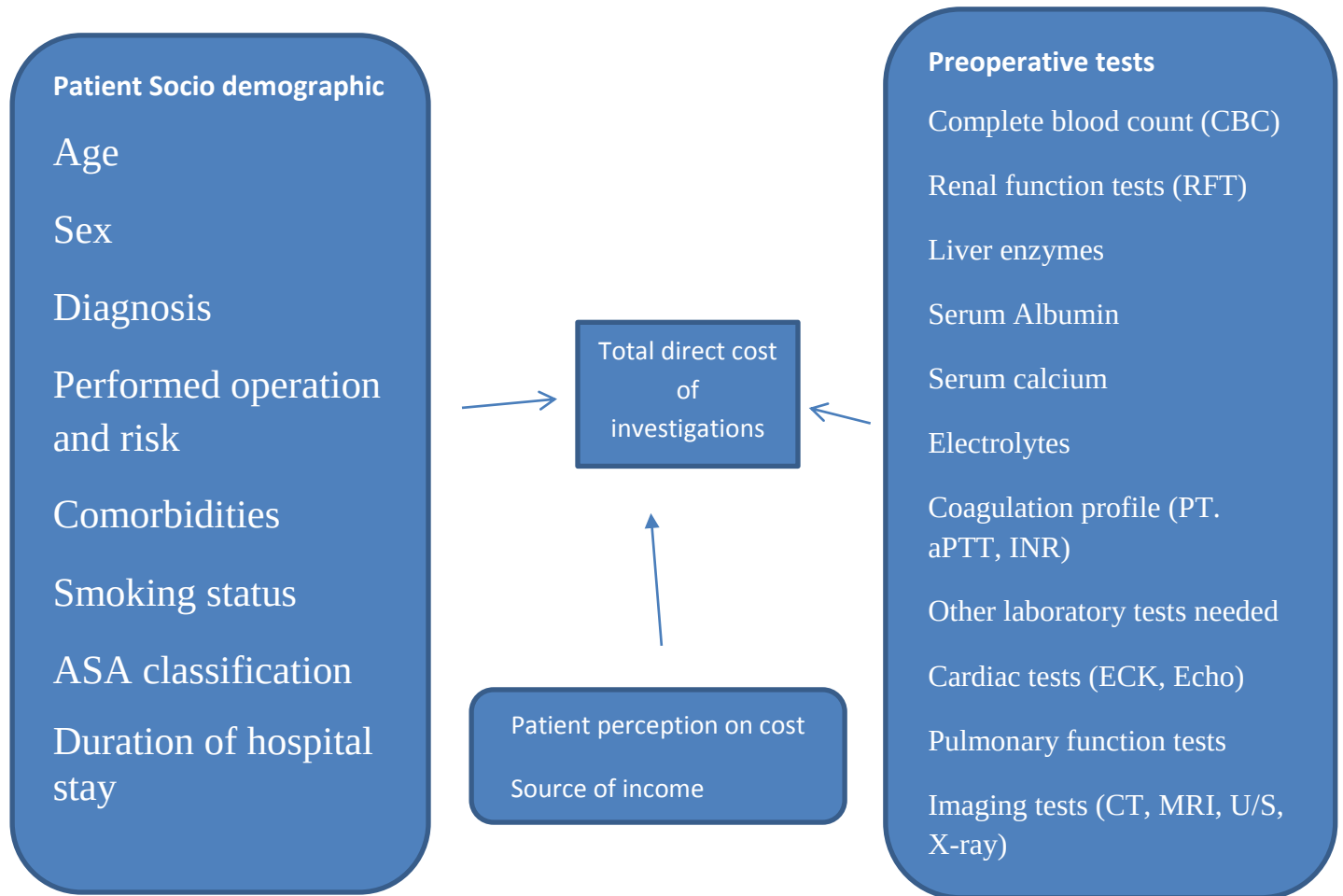
reduce the number and cost of investigations. Preoperative tests should be guided by clinical evaluation and comorbidities. (12)

In a cross sectional study done in Gondar University hospital in 2019 found that 13.89% of the total cost of preoperative investigations were attributed to routine tests.(24)

Recent study done in TASH on preoperative investigations for elective surgery found that 31.3% of test were not indicated, and concluded that unnecessary preoperative tests are prevalent and there is low adherence to NICE recommendations among Surgeons and surgical residents compered to Anesthesia team.(25)

Selective preoperative screening for vascular patients may improve 5-year survival and be cost-effective. Neither routine noninvasive testing nor routine angiography appears to be cost-effective compared with other accepted medical therapies.(26)

### III. Conceptual Framework



## **II. Objectives**

### **II.1. General objective**

To assess the preoperative evaluation and related costs among vascular patients who underwent surgery in TASH from January 2022 to December 2024.

### **II.2 Specific objectives**

To determine types of preoperative investigations in vascular surgery patients and existing gaps at TASH

To assess the direct patients' costs of investigations including routine tests

To estimate economic burden of investigations

## **III. Methods and Materials**

### **III.1. Study description**

This was an Institutional based retrospective cross-sectional study that assessed the profile of preoperative investigations in vascular patients, costs and key cost drivers related to investigation tests of vascular patients in the vascular surgery unit of TASH.

### **III.2. Study design**

The study design was retrospective.

### **III.3. Study setting**

The study was conducted in TASH which is Ethiopian largest specialized public hospital. It is the main referral center for vascular surgery in the country. In 1998, the hospital was given to Addis Ababa University by the ministry of health to serve as the main teaching hospital. The hospital offers diagnosis and treatment for approximately >500000 patients per year. It receives patients referred from across the country. TASH is selected for this study because it is the main referral center for vascular surgery in Ethiopia. Patients seeking vascular surgery care are evaluated, investigated and booked for surgery in referral clinic by a surgical team led by a consultant vascular surgeon. Patient information is kept in a file (electronic and/or hard copy). Investigation tests were done in hospital and some others were provided by private centers outside TASH.

Health care cost in hospital is covered by health insurance or out of pocket money.

#### **III.4. Source Population**

All vascular patients admitted with confirmed surgical diagnosis and operated with preoperative evaluations in their medical records.

#### **III.5. Study Population and Procedure**

Those patients who were admitted with confirmed surgical diagnosis and operated with preoperative investigation tests, from Jan 2022 to December 2024

Some of the patients admitted for elective surgery were evaluated in pre-anesthesia clinic on the day of admission and all underwent pre surgical evaluation in surgical ward, one day before operation. Comprehensive history and physical examination is done for every patient, imaging, laboratory tests and others special tests were requested and recorded in patient file before surgery. Above tests were done in the hospital but a portion of them was done in private centers.

#### **III.6. Inclusion and Exclusion Criteria**

##### **Inclusion Criteria**

All patients who were admitted and evaluated for elective surgery in vascular unit from 2022 to 2024. All information regarding preoperative evaluation and the direct medical costs that patients paid in TASH and private health facilities, for preoperative investigations, was collected.

##### **Exclusion criteria**

- Patients in the above-mentioned population whose data on preoperative investigations was missing in file and electronic medical record, were excluded from the study.
- Patients operated on emergency basis without time for preoperative investigations were excluded from the study.
- Patients operated as day cases.

#### **III.7. Sample Size determination**

Data from the registry revealed 240 cases as the total population of patients operated in vascular unit per year. the acceptable precision for this research is 0.05. With these values the sample size was calculated using Yamane formula:  $n = \frac{N}{1+N(E)^2}$  with n: sample size, N: finite population, E:



level of significance (0.05 for this study). Accordingly, the sample size was 165 including 10% non-response rate.

### **III.8. Sampling Technique**

A random sampling technique by Microsoft excel was used to recruit patients in this study. Medical record numbers (MRN) were retrieved from Operating room registry and were entered in excel; a random list was generated and 165 MRNs were obtained randomly and corresponding files were searched from archives. For each MRN, corresponding file was missing or incomplete, it was replaced by another MRN with complete file on the random list.

### **III.9. Data Collection and Quality Assurance**

Data collection tool was developed based on similar studies and it was tested. Patients details and clinical data were retrieved from patient's medical records and cost information was collected from hospital service fees. For tests done in private centers, providing centers were contacted to have information on the cost of each investigations and patients were called by phone and provided information on amount they paid. Patients also were asked their perception on the cost, source of income and their monthly income. Electronic medical record and patient's files were check for prescribed investigations. Data were kept in password protected excel form and was analyzed by SPSS version 21.

Evidence based recommendations on ordering preoperative investigations for elective surgery was used to for each investigation and to denote indicated and non-indicated tests and to classify risk of surgery. National Institute of Care for Excellence (NICE) guidelines 2016 (United Kingdom) was referred to as the recently updated guideline for preoperative investigation for non-cardiac surgery.

For every recruited patient, the direct cost (patient cost) of investigation was calculated as well as the duration of hospital stay. Information provided by patients on cost was cross checked with responsible providing centers. Data collection team was recruited and trained on the research protocol to maximize data quality. Data collection team comprised of health professionals only. Pre designed data collection form was used to collect all needed information and the data was entered in excel dataset for data cleaning before analysis.

### **III.10. Study Variables**

#### **Dependent Variables**

Total Direct cost of preoperative investigations

Investigation tests as cost generating

#### **Independent Variable**

Age

ASA classification

Admission Diagnosis

Type of Operation:

Having comorbidities (Diabetes mellitus, Hypertension, Heart disease, Pulmonary disease, other)  
or not

Smoking status: previous smoker, active smoker

Alcohol intake

Payment mean (Health insurance or Out of pocket money)

### **III.11. Ethical consideration**

Ethical clearance (**DOS/REC/143/2025/2027**) was obtained from School of Medicine, Collage of Health Science Addis Ababa University Institutional Review Board, Department of Surgery.

### **III.12. Operational definition**

**Preoperative evaluation:** laboratory and imaging and other special tests done for the patient planned for surgery from the time of elective admission till the time of entering in operating room.

**Direct Total cost:** amount of money a patient paid to the hospital or another health care facility for **preoperative evaluation** excluding other expenses like transport, meal, ...

**Affordability:** the capacity of a patient to pay for the tests without financial difficulty.

**NICE:** Guidelines used to assess relevancy of preoperative investigations for non-cardiac surgery the lastly updated in 2016.

**Routine tests:** investigation tests provided without clinical indication, for the patient booked for surgery. Referring to NICE guidelines 2016.

**Indicated tests** investigation tests provided with clinical indication for patients being prepared for surgery referring to NICE guideline 2026.

## **IV. Results**

### **IV.1. Socio-Demographic Characteristics and Diagnosis profile**

The study analyzed 165 vascular patients with a mean age of 49.6 years, comprising 88/165(53.3%) males and 77/165 (46.7%) females, the majority were from Addis Ababa, Oromia, and Amhara regions. Peripheral Artery Disease (PAD) was the most common diagnosis (78/165; 47.3%), followed by carotid disease (33/165; 20%) and various aneurysms (25/165; 15.1%). Many 69.7 were paying by out of pocket money. 65.9% among the called patients had a monthly salary. The average hospital stay was 13.7 days. Among the 165 patients evaluated, (16/165 9.7%) were former smokers, (3/165;1.8%) were active smokers, and (146/165; 88.5%) had never smoked. 69 patients (41.8%) had at least one comorbidity, while (96; 58.2%) had none. Preoperative ASA classifications revealed that most patients were class I to III (Table 1-2).

### **IV.2. Profile of all investigations**

In general, preoperative investigations in vascular patients comprised Imaging, laboratory test and cardiac evaluation tests. No Pulmonary function tests reported in this study. CT scan was the most commonly provided imaging test (136/165, 82.4%), followed by ultrasound 74.5%. CBC was the most common laboratory test (100%), followed by renal function tests (RFT), electrolytes 97% and Liver function tests (LFT). Serum albumin and calcium were less frequently provided. (Table 3)

#### **IV.2.1. Imaging and cardiac tests Investigations**

For 82.4% of patients, computed tomography(CT) scans were done with average cost of 8,355 ETB. For all CT scans done,78.2% of them were done in private facilities. Magnetic resonance imaging (MRI) was done in 2.4% of the patients (mean cost 9,750 ETB) exclusively in private centers; 74.5% of patients had ultrasounds (mean cost 523 ETB) with 69.9 % done in TASH. Electrocardiography (ECGs), with average cost 513 ETB, were performed for 72.7% of cases, with 70.3% requested by surgeons and 20% done without clinical indication.

Echocardiography, average cost: 732 ETB, was performed for 61.2% of patients, with nearly equal distribution between TASH (32.1%) and private health facilities (29.1%). 43.5 % of

Echocardiograms were done without indication. Chest X-rays were performed for 20% of the cases and was done in hospital. (Table 4).

**Table 1: Characteristics of patients**

| Variables          |                  | Findings                    |
|--------------------|------------------|-----------------------------|
| Age                |                  | Mean 49.6 (Min 17 & Max 87) |
| Gender             | Male             | 88/165 (53.3%)              |
|                    | Female           | 77/165 (46.7%)              |
| Smoking status     | Never smoked     | 146/165 (88.5%)             |
|                    | Stopped smoking  | 16/165 (9.7%)               |
|                    | Active smoking   | 3/165 (1.8%)                |
| Alcohol intake     | No               | 152/165 (92.1%)             |
|                    | Yes              | 13/165 (7.9%)               |
| Comorbidities      | No               | 96/165 (58.2.0%)            |
|                    | Yes              | 69/165 (41.80%)             |
| Payment mean       | Health insurance | 50/165 (30.3%)              |
|                    | Out of pocket    | 115/165 (69.7%)             |
| ASA classification | ASA I            | 63/165 ( 38.2%)             |
|                    | ASA II           | 45/165 (27.3%)              |
|                    | ASA III          | 53/165 (32.1%)              |
|                    | ASA V            | 4/165 (2.4%)                |
| Hospital stay      |                  | Mean: 14 days               |
| Source of income   | Salary           | 83/124 (66.9%)              |
|                    | Family support   | 23/124 (18.5%)              |
|                    | Self-employees   | 10/124 (8.1)                |
|                    | Other            | 8/124 (6.5)                 |

**Figure2: Average costs of investigation according to types of diagnosis**

| <b>Type of Diagnosis</b>                    | <b>Frequency (%)</b> | <b>Average Cost (ETB)</b> |
|---------------------------------------------|----------------------|---------------------------|
| Aortic Aneurysm                             | 9/165 (5.4%)         | <b>10858.9</b>            |
| Aneurysm of lower extremities               | 9/165 (5.4%)         | <b>10117.2</b>            |
| Aneurysm of Upper Extremities               | 7/165 (4.2%)         | <b>8223</b>               |
| Carotid diseases                            | 33/165 (20.0%)       | <b>8885</b>               |
| Peripheral artery disease lower extremities | 78/165 (47.3%)       | <b>11866.2</b>            |
| Upper extremities artery diseases           | 4/165 (2.4%)         | <b>11737.5</b>            |
| Vascular malformations                      | 7 /165 (4.2%)        | <b>8566</b>               |
| Venous diseases                             | 13/165 (7.9%)        | <b>4191</b>               |
| Others                                      | 5/165 (3.1%)         | <b>9048</b>               |

**Table 3: Profile of investigations**

| <b>Investigation</b> | <b>Done</b> | <b>Frequency</b> | <b>% done in private</b> |
|----------------------|-------------|------------------|--------------------------|
| CT scan              | Yes         | 136(82.4%)       | 78.2%                    |
|                      | No          | 29(17.6%)        |                          |
| MRI                  | YES         | 4(2.4%)          | 100%                     |
|                      | NO          | 161(97.6%)       |                          |
| ULTRASOUND           | YES         | 123(74.5%)       | 30.1%                    |
|                      | NO          | 42(25.5%)        |                          |
| ECG                  | YES         | 120(72.7%)       | 38.3%                    |
|                      | NO          | 45(27.3%)        |                          |
| ECHOCARDIOGRAM       | YES         | 101(61.2%)       | 47.5%                    |
|                      | No          | 64(38.8)         |                          |
| CXR                  | Yes         | 33(20.0%)        | 0.0%                     |
|                      | No          | 132(80.0%)       |                          |
| PFTs                 | Yes         | 0(0%)            | 0.0%                     |
|                      | No          | 165(100%)        | 0.0%                     |

| <b>Investigation</b> | <b>Done</b> | <b>Frequency</b> | <b>% done in private</b> |
|----------------------|-------------|------------------|--------------------------|
| CBC                  | Yes         | 165(100%)        | 0.0%                     |
|                      | No          | 0 (0%)           |                          |
| Blood Group          | Yes         | 158(95.8%)       | 0.0%                     |
|                      | No          | 7(4.2%)          |                          |
| RFT                  | YES         | 163(98.8%)       | 4.8%                     |
|                      | NO          | 2(1.2%)          |                          |
| Electrolytes         | Yes         | 160 (97%)        | 2.4%                     |
|                      | No          | 5(3.0%)          |                          |
| Calcium              | Yes         | 10(6.1%)         | 30.0%                    |
|                      | No          | 155(93.9%)       |                          |
| Albumin              | Yes         | 18(10.8%)        | 16.7%                    |
|                      | No          | 147(89.2%)       |                          |
| Coagulation          | Yes         | 147(89.1%)       | 78.9%                    |
|                      | No          | 18(10.9%)        |                          |
| HIV Tested           | Yes         | 20(12.1%)        | 0.0%                     |
|                      | No          | 145(87.9%)       |                          |
| LFTs                 | Yes         | 159(96.4%)       | 0.0%                     |
|                      | <b>No</b>   | <b>6(3.6%)</b>   |                          |

**Table 4. Imaging investigation of patients, costs and proportion done at private centers**

| <b>Investigation</b> | <b>% of patients with Investigations done</b> | <b>%of Investigations done in private</b> | <b>Average Cost in ETB</b> | <b>% of patients: Investigation was done not indicated</b> |
|----------------------|-----------------------------------------------|-------------------------------------------|----------------------------|------------------------------------------------------------|
| CT Scan              | 82.4%                                         | 78.2%                                     | 8,500                      | 0.0%                                                       |
| MRI                  | 2.4%                                          | 100%                                      | 9,750                      | 0.0%                                                       |
| Ultrasound           | 74.5%                                         | 30.1%                                     | 523                        | 0.0%                                                       |
| Chest X-Ray          | 20%                                           | 0%                                        | 80                         | 0.0%                                                       |

| <b>Investigation</b>    | <b>% of patients with Investigations done</b> | <b>% of Investigations done in private</b> | <b>Average Cost in ETB</b> | <b>% of patients: Investigation was done not indicated</b> |
|-------------------------|-----------------------------------------------|--------------------------------------------|----------------------------|------------------------------------------------------------|
| <b>ECG</b>              | <b>72.7%</b>                                  | <b>38.3%</b>                               | <b>513</b>                 | <b>20%</b>                                                 |
| <b>Echocardiography</b> | <b>61.2%</b>                                  | <b>47.5%</b>                               | <b>732</b>                 | <b>43.5%</b>                                               |

#### **IV.2.2. Pulmonary Function Test (PFT)**

Pulmonary function tests were not performed for any of the patients in our sample. This suggests a gap in pulmonary system evaluation of vascular patients.

#### **IV.2.3. Laboratory Investigations**

##### **Complete Blood Count (CBC)**

CBC tests were provided in all patients and were routinely provided without indication in 15 (9.1%) patients. The majority of CBC requests were made by surgeons (78.8%). All CBCs were provided by TASH, with a consistent cost of 50 ETB per test.

##### **Blood Group Determination**

Blood Group Determination test was done in 95.8% (158/165) of cases. The test was indicated in 148 patients (89.7%). A small portion (4.2%) did not have this test done. Surgeons and anesthesiologists were responsible for requesting these tests and all of them were provided by TASH. The mean cost was about 30 ETB.

##### **Renal Function Test (RFT)**

Majority of patients, 98.8% (163/165), were tested. RFT was not indicated in 14.5% of all patients. The tests were primarily provided by TASH (94.5%), with a small portion done at private centers (4.8%). The cost for RFT varied widely, ranging from 100 to 800 ETB, with a mean cost of 130.57 ETB.



### **Electrolytes Panel (sodium, potassium and chloride)**

Electrolyte testing was performed in 97% of patients. Although the test was indicated in about 68% of the cases, a notable 32% received it routinely. Most requests came from anesthesiologists (61.8%), while surgeons requested (35.8%). TASH provided nearly all tests (97.6%). The mean cost was 447.19 ETB.

### **Calcium Test**

Only 6.1% of patients (10 out of 165) had serum calcium level tested, despite being indicated in 28% of patients. A significant proportion of calcium testing was done at TASH (70%), and 30% in private facilities. The average cost was 213.75 ETB. The low rate of provided serum calcium compared to indication explains the gap.

### **Serum Albumin**

Despite being indicated in (89/165; 53.9%) of patients, it was provided in only (18/165; 10.9%) of all patients. However routine requests were 4.8%. Most albumin tests were provided by TASH (83.3%) and a small proportion done by private institutions. The average cost was 102 ETB, with a common charge of 50 ETB. There was a gap in requesting serum albumin levels compared to clinical indications.

### **Coagulation Profile**

A coagulation profile was done for 89.1% of patients, with 86.1% having a clinical indication. The primary providers were anesthesiologists (61.8%) and surgeons (27.9%). Tests were mainly done at private facilities (78.9%). The average cost was 508.76 ETB.

### **HIV Test**

Only 12.1% of patients underwent HIV testing, all of which were performed at TASH and provided free of charge. There was a lack of testing in the remaining 87.9% of patients.

### **Liver Function Test (LFT)**

LFTs were widely provided, done in 96.4% of patients, despite being clinically indicated in only 12.7% of cases. Mainly they were requested by Surgeons, 88.5% of all LFT orders. Nearly all tests were performed at TASH, with costs averaging 150 ETB (Table 5).

**Table 5. Laboratory Investigations of patients, average costs and proportion done at private centers**

| Investigation       | % of patients who had investigation done | % of patients who had investigation done in private | Average Cost in ETB | % of patients from whom Investigations done not indicated |
|---------------------|------------------------------------------|-----------------------------------------------------|---------------------|-----------------------------------------------------------|
| PFT                 | 0%                                       | 0%                                                  | -                   | -                                                         |
| CBC                 | 100%                                     | 0%                                                  | 50                  | 9.1%                                                      |
| Blood Group         | 95.8%                                    | 0%                                                  | 30                  | 6.1%                                                      |
| RFT                 | 98.8%                                    | 4.8%                                                | 130.57              | 14.5%                                                     |
| Serum Electrolytes  | 97%                                      | 2.4%                                                | 447.19              | 30.9%                                                     |
| Serum Calcium       | 6.1%                                     | 1.83%                                               | 213.75              | 0 %                                                       |
| Serum Albumin       | 10.9%                                    | 1.82%                                               | 102                 | 4.2%                                                      |
| Coagulation Profile | 89.1%                                    | 70.3%                                               | 508.76              | 7.9%                                                      |
| HIV Test            | 12.1%                                    | 0%                                                  | 0%                  | -                                                         |
| LFT                 | 96.4%                                    | 0.0%                                                | 150                 | 82.4%                                                     |

### **Other Laboratory Investigations**

Roughly 47.3% of patients received additional laboratory investigations such as inflammatory markers, hepatitis viral markers, etc. The cost of these tests ranged from 30 to 285 ETB, with a mean of 124.59 ETB.

### **IV.3. Investigation Costs**

The mean total cost of imaging investigations was approximately 8,797 ETB, reflecting use of advanced or private imaging services. Laboratory investigations cost an average of 1,328 ETB. The average cost of investigations per patient was 9,717.40 ETB with a median of 10,130 ETB.

### **IV.4. Affordability and Socioeconomic Factors - Financial Burden of Investigations**

All 165 patients were called and 124 were found and answered phone calls, (76; 61.3%) of them stated the cost of investigations was not affordable, while only 38.7% were able to afford it without financial difficulties. Some patients 66,9% were having salary (government or private sector) as source of income, or family assistance (18.5%). Others were having some business or no occupation. The average monthly income was approximately 9,748 ETB, and the median income was 8000 ETB.

### **IV.5. Gaps in Investigations**

Our study analyzed disparities between what investigations were clinically indicated and what were provided for vascular patients in this study. Substantial gaps between indicated and requested investigations among vascular patients was observed for serum calcium, pulmonary function tests (100% not done) and serum albumin (89.5% not done). HIV screening was also missing in 87.9% despite being free of charge.

### **IV.6. Cost of Unindicated Investigations**

Investigations tests ordered routinely without clinical indications contributed to total cost of all tests. More considerable expense was found with echocardiography, with a mean cost of 197.52 ETB and 26.7% of patients undergoing this test without clinical indication. Total cost of non-indicated Investigation test was averaged at 648.99 ETB per patient, with the highest reaching 3,565 ETB.

**Table 7 – Cost of requested test without indication based of NICE guideline**

| <b>Test Type</b>           | <b>% Not Indicated</b> | <b>Total Cost (ETB)</b> |
|----------------------------|------------------------|-------------------------|
| <b>ECG</b>                 | 20.0% (24/120)         | 20051.4                 |
| <b>Echocardiography</b>    | 43.5% (44/101)         | 32208                   |
| <b>CBC</b>                 | 9.1% (15/165)          | 750.75                  |
| <b>ABO-Rh</b>              | 6.1% (10/159)          | 300.30                  |
| <b>RFT</b>                 | 17.1% (24/140)         | 3,649.80                |
| <b>Electrolytes</b>        | 31.6% (51/161)         | 22,948.85               |
| <b>Calcium</b>             | 0% (0/10)              | 0                       |
| <b>Albumin</b>             | 44.4% (8/18)           | 849.75                  |
| <b>Coagulation Profile</b> | 8.8% (13/148)          | 5,430.15                |
| <b>LFT</b>                 | 85.0% (136/160)        | 20,101.92               |
| <b>Total</b>               |                        | 106,675                 |

#### **IV.7. Hospitalization Costs**

The average cost of hospital stay in average was 2,906 ETB. Around 30% of patients had zero out-of-pocket expense for hospitalization.

#### **4.8 Associations Between High Cost of Investigations and Patient Variables**

Considering high cost of investigations as the one above the median cost; in the bivariate logistic regression analysis examining factors associated with the outcome, several variables demonstrated statistically significant associations at the  $p < 0.2$  threshold. Age was significantly associated with the outcome ( $p < 0.001$ ), with an odds ratio (OR) of 1.039 (95% CI: 1.019–1.059), for one increase the 3.9% increase of total cost. Diagnosis types were significant, including PAD ( $p = 0.001$ , OR = 37.263), vascular malformations ( $p = 0.017$ , OR = 9.000), aneurysms ( $p = 0.062$ , OR = 18.000),

and upper extremity arterial disease ( $p = 0.089$ , OR = 36.000), all showing strong associations with high cost. Procedure risk was highly significant; high-risk ( $p = 0.001$ , OR = 9.488) and intermediate-risk procedures ( $p = 0.001$ , OR = 13.222) were both associated with increased odds. Among procedure types, aneurysmorrhaphy ( $p = 0.013$ ), aortic surgery ( $p = 0.001$ ), other procedures ( $p = 0.026$ ), primary amputation of the lower extremity ( $p = 0.013$ ), and revascularization ( $p = 0.003$ ) showed elevated risk of high cost, with odds ratios ranging from 7.15 to 66. Hospital stay duration was significantly associated with the outcome ( $p = 0.001$ , OR = 1.076; 95% CI: 1.032–1.123). Comorbidity prevalence was also a strong predictor ( $p = 0.000$ , OR = 3.615; 95% CI: 1.833–7.128). Variables such as alcohol use, smoking status, ASA Class did not show significant associations ( $p > 0.2$ ) and were excluded from further consideration (Table 8).

**Table 8. Bivariate logistic Regression Analysis between patient Variables and high cost of investigations**

| Variable                 | P value | COR    | 95% C.I         |
|--------------------------|---------|--------|-----------------|
| Age                      | < 001   | 1.039  | 1.019 – 1.-59   |
| <b>Diagnosis type</b>    |         |        |                 |
| Aneurysm                 | 0.062   | 18.000 | 2.012 - 161.044 |
| Carotid Disease          | 0.133   | 7.800  | 0.903 - 67.378  |
| Other                    | 0.001   | 8.000  | 0.530 - 120.649 |
| PAD                      | 0.021   | 37.263 | 4.543 - 305.666 |
| Upper extremity diseases | 0.089   | 36.000 | 1.710 - 757.790 |
| Vascular malformations   | 0.017   | 9.000  | 0.717 - 113.016 |
| <b>Procedure risk</b>    |         |        |                 |
| High risk                | 0.001   | 9.488  | 2.627 - 34.270  |
| Intermediate risk        | 0.001   | 13.222 | 3.087 - 56.635  |
| <b>Procedure type</b>    |         |        |                 |
| Aneurysmorrhaphy         | 0.013   | 44.000 | 2.193 - 882.660 |
| Aortic Surgery           | 0.001   | 66.000 | 5.226 - 833.557 |
| Carotid surgery          | 0.075   | 7.150  | 0.822 - 62.180  |

| Variable                       | P value | COR    | 95% C.I         |
|--------------------------------|---------|--------|-----------------|
|                                |         |        |                 |
| Other                          | 0.026   | 11.846 | 1.337 104.991   |
| Primary amputation L.E         | 0.013   | 44.000 | 2.193 - 882.660 |
| Revascularization              | 0.003   | 25.143 | 3.047 207.460   |
| Hospital stay                  | 0.001   | 1.076  | 1.032 1.123     |
| <b>Presence of comorbidity</b> | <0.001  | 3.615  | 1.833 7.128     |

Multivariate logistic regression analysis, several variables were significantly associated with increased odds of high total cost of investigation. Advancing age was independently associated with increased cost (AOR = 1.032, 95% CI: 1.011–1.053,  $p = 0.002$ ). Patients diagnosed with Peripheral Artery Disease (PAD) had a markedly higher likelihood of incurring high costs (AOR = 28.109, 95% CI: 3.362–234.996,  $p = 0.002$ ), as did those with Upper Extremity vascular disease (AOR = 29.342, 95% CI: 1.344–640.652,  $p = 0.032$ ), and aneurysms (AOR = 15.569, 95% CI: 1.711–141.662,  $p = 0.015$ ). Among procedure types, aortic surgery (AOR = 51.731, 95% CI: 3.995–669.844,  $p = 0.003$ ), Aneurysmorrhaphy (AOR = 33.131, 95% CI: 1.585–692.382,  $p = 0.024$ ) were all strongly associated with high costs. Additionally, longer hospital stay (AOR = 1.065, 95% CI: 1.022–1.110,  $p = 0.003$ ) and the presence of comorbidities (AOR = 3.194, 95% CI: 1.586–6.433,  $p = 0.001$ ) were significant independent predictors of increased investigation-related expenses (Table 9).

**Table 9. Multivariate Logistic Regression**

| Variable                          | p-value      | AOR           | 95% CI                 |
|-----------------------------------|--------------|---------------|------------------------|
| <b>Age</b>                        | <b>0.002</b> | <b>1.032</b>  | <b>1.011 – 1.053</b>   |
| <b>Diagnosis Type</b>             |              |               |                        |
| • <b>PAD (Peripheral)</b>         | <b>0.002</b> | <b>28.109</b> | <b>3.362 – 234.996</b> |
| <b>Procedure Type</b>             |              |               |                        |
| • <b>Aortic Surgery</b>           | <b>0.003</b> | <b>51.731</b> | <b>3.995 – 669.844</b> |
| • Other Procedures                | 0.027        | 12.002        | 1.328 – 108.463        |
| • <b>Primary Amputation (L.E)</b> | <b>0.024</b> | <b>33.131</b> | <b>1.585 – 692.382</b> |
| • Revascularization               | 0.007        | 18.871        | 2.236 – 159.245        |

| Variable                    | p-value      | AOR          | 95% CI               |
|-----------------------------|--------------|--------------|----------------------|
| <b>Procedure Risk</b>       |              |              |                      |
| • High Risk                 | 0.002        | 7.571        | 2.045 – 28.022       |
| • Intermediate Risk         | 0.002        | 10.119       | 2.287 – 44.760       |
| <b>Hospital Stay (days)</b> | <b>0.003</b> | <b>1.065</b> | <b>1.022 – 1.110</b> |
| <b>Comorbidity Presence</b> | <b>0.001</b> | <b>3.194</b> | <b>1.586 – 6.433</b> |

## V. Discussion

This study highlighted the investigations ordered for preoperative vascular patients and the associated costs. The burden of routine preoperative investigations is amplified by limited public resources and out-of-pocket payments (30). In this study, out of pocket expenditure was 69.7%. This is greater than the estimation found in studies done in Ethiopia that shows: one-third of total health expenditures comes from out of pocket payments, with inadequate financial protection for surgical patients (28,29). Mollalign et al. reported that 13.9% of the preoperative cost burden in Gondar was due to unnecessary tests (24), while a recent study at TASH found that around 30% of tests ordered preoperatively lacked clinical indication (25).

In this study, imaging tests increased the total cost. CT scans and echocardiography followed by excessive routine laboratory tests. Notably, while some investigations like pulmonary function tests (PFTs) and serum albumin and calcium were underutilized despite clinical indication, others were performed excessively. PFTs, which were not requested, highlight a gap in preoperative evaluation. These patterns are concerning given that only a small proportion of the results influence patient management, consistent with findings by Lakomkin et al. and Admass et al. (12,16). Pollard et al. previously demonstrated that arranged outpatient preoperative evaluations could reduce hospital length of stay and cost without compromising care quality (9).

The analysis of preoperative evaluation in vascular patients at TASH revealed excessive utilization of investigations and unneeded costs driven by routine testing. Nearly all patients underwent basic labs (e.g., 100% had CBC, 98.8% RFT, 97% electrolytes), and a majority received imaging (CT 82.4%, ultrasound 74.5%, ECG 72.7%). However, many tests lacked clear indications, such as

20.0% of ECGs and 43.5% of echocardiograms and a proportion of laboratory tests were not clinically justified. Some global studies reported wasteful preoperative testing in preoperative patients. A study done in Caribbean found that 64% of tests were routinely requested, resulting in major financial losses (11). Lakomkin et al. found that routine preoperative laboratory tests in orthopedic trauma patients did not affect treatment outcomes (12). Similarly, Vogt et al. and Obasuyi and Antwi-Kusi showed that over 70% of tests ordered by surgeons were deemed not indicated, contributing to significant cost burdens (13).

In this study, CT scans were the single investigation most likely to increase total cost and were largely performed at private centers. This aligns with literature noting the high costs of advanced imaging (17, 18). Rubin et al. found that 10–30% of imaging tests were done without clinical justification, leading to unnecessary radiation and costs (20). Shaw et al. demonstrated that selective preoperative stress testing can significantly reduce costs in vascular procedures (21). In the United States, routine preoperative testing is estimated to cost over \$30 billion annually (22). Harris et al. reported similar findings within the Virginia health system, where nearly half of preoperative test costs were from low-value care (23). However, in our study, the imaging investigations were done with clinical indication. Even though they were indicated, they still raised financial burden to the patients as more than half of our study participants mentioned that investigations were not affordable. This could be attributed to the high cost of imaging services in private centers, the limited availability of imaging investigation tools and also to the relatively low income of studied patients.

With regards to laboratory investigations, while routine tests like CBC and Blood Group typing were almost universally indicated and inexpensive, other tests showed overuse. Electrolyte panels were performed in 97% of patients, despite being clinically indicated in 68% of cases while tests like LFTs were widely overused. These findings are consistent with Admass et al., who found that 60–70% of routine laboratory tests were not clinically indicated and contributed to elevated healthcare costs (16). Akula and Vijaynagar similarly reported the potential for substantial savings by limiting routine laboratory tests (15). Although not all patients in our study got tested for HIV, studies show the impact of early HIV testing in order to prevent complications in elective surgery patients (31).



This study also quantified the financial burden of unindicated preoperative investigations, revealing a substantial avoidable cost to patients. On average, patients incurred 648.99 ETB in routine test-related expenses. The largest contributors were echocardiography and electrolyte panels, followed by LFTs and ECGs. International data estimate that up to 60–70% of routine preoperative tests are not clinically necessary and lead to excessive costs without improvement in patient outcomes (13,16,19,22). Prior studies have also reported high rates of test overuse: a study in Gondar attributed 13.9% of investigation costs to unindicated testing (24), and another at TASH found that routine tests were done for over 30% of elective surgery patients. (25) Given the out of pocket expenditure burden (28, 30), also considering low income of the patients in general, these avoidable costs likely exacerbate cost of surgical care and may lead patients to catastrophic health expenditure.

The analysis of patient variables in our study showed significant factors associated with increased investigation costs: Advancing age (AOR = 1.032, 95% CI: 1.011–1.053,  $p = 0.002$ ), presence of comorbidities (AOR = 3.194, 95% CI: 1.586–6.433,  $p = 0.001$ ) were independently associated with high cost, having peripheral artery disease (PAD), aneurysms were likely to incur high cost. Aortic surgery (AOR = 51.731, 95% CI: 3.995–669.844,  $p = 0.003$ ) and aneurysmorrhaphy (AOR = 33.131, 95% CI: 1.585–692.382,  $p = 0.024$ ) were strongly associated with high cost. Prior findings reported that older vascular patients, often having multiple risk factors, require more extensive preoperative evaluation (3,4). Literature support that comorbid conditions are drivers of increased testing and healthcare utilization (6,7). Longer hospital stay (AOR = 1.065, 95% CI: 1.022–1.110,  $p = 0.003$ ) was significant predictor of increased investigation cost.

In this study, the mean monthly income was calculated: 9,748 ETB whereas the average cost of preoperative investigations per patient was 9,717.40 ETB, which could highlight the potential impoverishment that a vascular patient would face if he is likely to undergo surgery.

## **VI. Conclusion and Recommendations**

### **VI.1. Conclusion**

This study has demonstrated that preoperative investigations in vascular surgery at TASH are characterized by high costs compared to the patients' ability to pay. Certain laboratory tests were frequently ordered without clinical indication, resulting in significant direct costs to patients and many of them already face substantial financial vulnerability. Pre-operative tests should be ordered based on patient history, comorbidities and physical findings to avoid financial risk that can result from routine tests. By implementing this, it is possible to preserve healthcare resources and protect vascular patients from catastrophic health expenditure in TASH. These findings are not only relevant for TASH but also offer important insights for broader surgical systems across low- and middle-income countries facing similar challenges.

### **VI.2. Recommendation**

#### **To the hospital:**

TASH should develop protocol guiding for pre-surgical investigations for vascular patients in order to reduce the amount of costly routine tests.

TASH should explore the factors influencing high rate of investigation tests being provided by private centers.

A prospective study is needed to investigate contributing factors of requesting routine preoperative investigations for vascular patients. A cost effectiveness of preoperative investigations done for vascular patients is also needed.

#### **To the Ministry of Health**

Persuade the private health facilities to reduce the costs of investigation tests for the vulnerable patients.

Partner with private facilities so that community health insurance can cover expensive tests done outside TASH.

## **VII. Strength of the Study:**

It provided primary data on investigation costs for vascular patients undergoing surgery and it can serve as reference for further studies in this field and highlighted room for improvements.

#### **VIII. Limitations of the Study:**

Being a retrospective study some data were missing in patients records and through phone call response rate was 75%

During calling of patients they might be recall bias while providing information

This was a single center study, the results may not be generalized in the whole population

There is paucity of local similar studies that could be compared to our findings.

Some patients 'files were not found in archives

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## ANNEX

### 1.Data collection form

#### Patients Details

| CODE: | Age | Sex | Address | Diagnosis | ASA classification |
|-------|-----|-----|---------|-----------|--------------------|
|       |     |     |         |           |                    |

Admission date:

Operation date:

Discharge date:

Alcohol use: Yes / No

Smoking history

| Active smoker |    | Stopped smoking |    | Never smoked |    |
|---------------|----|-----------------|----|--------------|----|
| YES           | NO | YES             | NO | YES          | NO |

Operation done:

| High risk | Intermediate risk | Low risk |
|-----------|-------------------|----------|
|           |                   |          |

Comorbidities

| Diabetes | Hypertension | Heart diseases | Other |
|----------|--------------|----------------|-------|
|          |              |                |       |

Imaging Tests, Providing centers and Cost in Ethiopian Birrs (ETB)



|                                                           |                                                                                           |                      |                      |                         |                   |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------|----------------------|-------------------------|-------------------|
| <b>Test done</b>                                          | Yes                                                                                       | No                   |                      | <b>Providing Center</b> | <b>Cost (ETB)</b> |
| <b>CT Scan</b>                                            |                                                                                           |                      |                      |                         |                   |
| <b>MRI</b>                                                |                                                                                           |                      |                      |                         |                   |
| <b>Ultrasound</b>                                         |                                                                                           |                      |                      |                         |                   |
| <b>Chest X- ray</b>                                       |                                                                                           |                      |                      |                         |                   |
|                                                           | <b>Cardiac Evaluation</b>                                                                 |                      |                      |                         |                   |
| <b>Test</b>                                               | <b>Indicated</b>                                                                          | <b>Not Indicated</b> | <b>Requesting Dr</b> | <b>Providing center</b> | <b>Cost(ETB)</b>  |
| <b>ECG</b>                                                |                                                                                           |                      |                      |                         |                   |
| <b>Echo</b>                                               |                                                                                           |                      |                      |                         |                   |
|                                                           | <b>Cardiologist Consultation needed (Yes/No)</b>                                          |                      |                      |                         |                   |
| <b>Respiratory evaluation</b>                             |                                                                                           |                      |                      |                         |                   |
| <b>Pulmonary function tests</b>                           |                                                                                           |                      |                      |                         |                   |
|                                                           | <b>Renal Function test, electrolytes and Coagulation profile and Serology and Albumin</b> |                      |                      |                         |                   |
| <b>Renal function:</b><br>Urea, Creatinine                |                                                                                           |                      |                      |                         |                   |
| <b>Electrolytes:</b><br>Sodium,<br>Potassium,<br>Chloride |                                                                                           |                      |                      |                         |                   |
| <b>Calcium</b>                                            |                                                                                           |                      |                      |                         |                   |
| <b>Magnesium</b>                                          |                                                                                           |                      |                      |                         |                   |
| <b>Serum Albumin</b>                                      |                                                                                           |                      |                      |                         |                   |

|                                                         |                    |                                              |                         |                       |  |
|---------------------------------------------------------|--------------------|----------------------------------------------|-------------------------|-----------------------|--|
| <b>Coagulation profile:</b><br><br><b>PT, aPTT, IRN</b> |                    |                                              |                         |                       |  |
| <b>Other test</b>                                       |                    |                                              |                         |                       |  |
| <b>HIV test</b>                                         |                    |                                              |                         |                       |  |
| <b>Others</b>                                           |                    |                                              |                         |                       |  |
| <b>Patients' Call</b>                                   |                    |                                              |                         |                       |  |
| <b>Imaging test providing facility</b>                  | <b>Amount Paid</b> | <b>Cost Affordable:</b><br><br><b>Yes/No</b> | <b>Source of Income</b> | <b>Monthly income</b> |  |