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A STUDY ON CARDIOTHORACIC VASCULAR DEPARTMENT IN A TERTIARY CARE TEACHING HOSPITAL WITH SPECIAL FOCUS ON COSTING OF PROCEDURES

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ABSTRACT

The prevalence of non-communicable diseases (NCDs) is increasing alarmingly across the globe and the burden of the disease was higher in developed countries. The incidence is increasing in developing and the underdeveloped countries owing to lifestyle changes and stress. (Cardiovascular disease incidence and prevalence statistics in the world and India to be included here) Even though it is more common in the urban population, the prevalence in the rural population is also increasing. Cardiac catheterization is an important procedure in the diagnosis and management of coronary artery disease and other cardiovascular disorders. Accurately understanding the cost of healthcare delivery important in the management of costing challenges facing the health care services in the current scenario. Unit cost calculation and activity based costing information improves the knowledge regarding the organization

process and about unused capacity resources, so that managers can make decisions regarding use of resources. Calculation of accurate unit costing of Coronary artery bypass grafting (CABG), Aortic valve replacement (AVR) and Mitral valve replacement (MVR) is beneficial to improve the efficiency of the cardiology department.

Activity based costing was used to find out the unit cost of coronary angiography and coronary angioplasty, with the cost drivers like, Direct costs, Indirect costs.

The results of the study provide improved understanding about the organizational process of the cardiac Cath lab. The study also gives cost information of the most common services in the cardiac oath lab which will be helpful for future decision making regarding pricing of services. This will improve cost awareness among professionals in the field of healthcare and help the hospital managers to provide healthcare services at least possible cost, maintaining high level of quality.

This study will be useful to understand the operations and financial impact in setting up and running of a cardio thoracic vascular surgery department. This study was conceptualized to analyze the unit cost per procedure of Coronary artery bypass grafting (CABG), Aortic valve replacement (AVR) and Mitral valve replacement (MVR) and make recommendations for enhancing the functional efficiency of the CTVS department by effective cost control. This study will definitely help to provide scientific information on attaining high standards of efficiency in CTVS procedures by minimizing the wastage, optimizing the resources, providing effective cost control and enabling high standards of quality.

Key words: CARDIOTHORACIC VASCULAR, Coronary artery bypass grafting (CABG), Aortic valve replacement (AVR) and Mitral valve replacement (MVR), cost analysis

INTRODUCTION:

Cardiovascular disease

Cardiovascular disease (CVD) is a class of diseases that involve the heart or blood vessels. Cardiovascular disease includes coronary artery diseases (CAD) such as angina and myocardial infarction (commonly known as a heart attack). Other CVDs include stroke, heart failure, hypertensive heart disease, rheumatic heart disease, cardiomyopathy, heart arrhythmia, congenital heart disease, valvular heart disease, carditis, aortic aneurysms, peripheral artery disease, thromboembolic disease, and venous thrombosis.

The underlying mechanisms vary depending on the disease. Coronary artery disease,

stroke, and peripheral artery disease involve atherosclerosis. This may be caused by high blood pressure, smoking, diabetes, lack of exercise, obesity, high blood cholesterol, poor diet, and excessive alcohol consumption, among others. High blood pressure results in 13% of CVD deaths, while tobacco results in 9%, diabetes 6%, lack of exercise 6% and obesity 5%. Rheumatic heart disease may follow untreated strep throat.

It is estimated that 90% of CVD is preventable. Prevention of atherosclerosis involves improving risk factors through: healthy eating, exercise, avoidance of tobacco smoke and limiting alcohol intake. Treating risk factors, such as high blood pressure, blood lipids and diabetes is also beneficial. Treating people who have strep throat with antibiotics can decrease the risk of rheumatic heart disease. The use of aspirin in people, who are otherwise healthy, is of unclear benefit.

Cardiovascular diseases are the leading cause of death globally. This is true in all areas of the world except Africa. Together they resulted in 17.9 million deaths (32.1%) in 2015, up from 12.3 million (25.8%) in 1990. Deaths, at a given age, from CVD are more common and have been increasing in much of the developing world, while rates have declined in most of the developed world since the 1970s. Coronary artery disease and stroke account for 80% of CVD deaths in males and 75% of CVD deaths in females. Most cardiovascular disease affects older adults. In the United States 11% of people between 20 and 40 have CVD, while 37% between 40 and 60, 71% of people between 60 and 80, and 85% of people over 80 have CVD. The average age of death from coronary artery disease in the developed world is around 80 while it is around 68 in the developing world. Disease onset is typically seven to ten years earlier in men as compared to women.

Global facts Sheet.

CVDs are the number 1 cause of death globally: more people die annually from CVDs than from any other cause. An estimated 17.7 million people died from CVDs in 2015, representing 31% of all global deaths. Of these deaths, an estimated 7.4 million were due to coronary heart disease and 6.7 million were due to stroke.

Over three quarters of CVD deaths take place in low- and middle-income countries. Out of the 17 million premature deaths (under the age of 70) due to non-communicable diseases in 2015, 82% are in low- and middle-income countries, and 37% are caused by CVDs. Most cardiovascular diseases can be

prevented by addressing behavioral risk factors such as tobacco use, unhealthy diet and obesity, physical inactivity and harmful use of alcohol using population-wide strategies.

People with cardiovascular disease or who are at high cardiovascular risk (due to the presence of one or more risk factors such as hypertension, diabetes, hyperlipidemia or already established disease) need early detection and management using counseling and medicines, as appropriate.

WHO Response.

Under the leadership of the WHO, all Member States (194 countries) agreed in 2013 on global mechanisms to reduce the avoidable NCD burden including a "Global action plan for the prevention and control of NCDs 2013-2020". This plan aims to reduce the number of premature deaths from NCDs by 25% by 2025 through nine voluntary global targets. Two of the global targets directly focus on preventing and controlling CVDs.

Global action plan for the prevention and control of NCDs 2013-2020

The sixth target in the Global NCD action plan calls for 25% reduction in the global prevalence of raised blood pressure. Raised blood pressure is the leading risk factor for cardiovascular disease. The global prevalence of raised blood pressure (defined as systolic and/or diastolic blood pressure more than or equal to 140/90 mmHg) in adults aged 18 years and over was around 24.1% in men and 20.1% in women in 2015. The number of adults with raised blood pressure increased from 594 million in 1975 to 1.13 billion in 2015, with the increase largely in low- and middle-income countries.

Reducing the incidence of hypertension by implementing population-wide policies to reduce behavioural risk factors, including harmful use of alcohol, physical inactivity, overweight, obesity and high salt intake, is essential to attaining this target. A total-risk approach needs to be adopted for early detection and cost-effective management of hypertension in order to prevent heart attacks, strokes and other complications.

The eighth target in the Global NCD action plan states at least 50% of eligible people should receive drug therapy and counselling (including glycaemic control) to prevent heart attacks and strokes. Prevention of heart attacks and strokes through a total cardiovascular risk approach is more cost-effective than treatment decisions based on individual risk factor thresholds only and should be part of the basic benefits package for pursuing universal health coverage. Achieving this target will require

strengthening key health system components, including health-care financing to ensure access to basic health technologies and essential NCD medicines.

In 2015, countries will begin to set national targets and measure progress on the 2010 baselines reported in the "Global status report on non-communicable diseases 2014". The UN General Assembly will convene a third high-level meeting on NCDs in 2018 to take stock of national progress in attaining the voluntary global targets by 2025.

Cost-Benefit Considerations: Over the years, traditional catheterization laboratories have gained a highly regarded reputation for excellence in physiologically oriented and anatomically precise diagnosis. These laboratories provided major research advances as well as catheter-based therapies. Their safety record was excellent even for very sick patients, who received care with a very favorable cost-benefit ratio. In fact, these factors led to the conclusion in at least one report6 that catheterization laboratory evaluation of the middle-aged man with chest pain was the most efficient initial step in management of such patients.

REVIEW OF LITERATURE

Review of literature is important for developing a broad conceptual context into which a problem will fit. It is only within such a context that the findings of a project can make a contribution to a body of knowledge. The more one's study is linked with other research, the more of a contribution it is likely to make. A very important role of the literature review is to suggest ways of going about the business of conducting a study on a topic of interest.

CABG

The arteries that bring blood to the heart can get clogged at times with plaque (an accumulation of cholesterol, fat and other substances) that prevents the blood to flow smoothly. Coronary artery bypass surgery or simply CABG is a surgical procedure that is used to bypass blood through those clogged arteries to improve the flow of blood and oxygen in the heart.

- Procedure

CABG is performed in two ways: the "off-pump" and the "on-pump".

In "off-pump" the surgery is performed on a beating heart whereas in "on-pump" the surgery is performed with the heart stopped. Arteries and veins from the other parts of the body are sewn to one of the coronary arteries and the other end is attached to the aorta (the largest artery in the body) to bypass the clogged arteries.

- When is CABG performed?

A CABG is performed on patients suffering from coronary artery diseases.

- Cost

The cost of CABG or bypass surgery starts from USD 4400 in India.

- Patient Stay

In hospital: Approximately a week in the hospital

In India: Around 2-3 weeks in India

Heart Valve Replacement

Heart valve replacement surgery is the replacement of one or more heart valves. It can be replaced with an artificial heart valve or a bioprosthesis, an alternative for valve repair.

- ProcedureThe valves are replaced either with a mechanical or a bioprosthetic valve. An open heart surgery is performed to replace the damaged valves. There are four procedures included in the heart valve replacement:

Aortic Valve Replacement

Mitral Valve Replacement

Tricuspid Valve Replacement

Pulmonary Valve Replacement

When is a valve replacement performed?

A valve replacement is performed when any of the four major valves of the heart (aortic, mitral, tricuspid and pulmonary) are damaged, that is, if there is a narrowing of the valve (valve stenosis) or if the valve is unable to close properly (valve incompetence or regurgitation or a leaky valve).

- Cost

The cost of a valve replacement starts from USD 6,500 in India.

- Patient Stay

In hospital: Around 10 days

In India: 2-3 weeks in India

- **Unit Cost of Medical Services at Different Hospitals in India**

Institutional care is a growing component of health care costs in low- and middle-income countries, but local health planners in these countries have inadequate knowledge of the costs of different medical services. In India, greater utilisation of hospital services is driven both by rising incomes and by government insurance programmes that cover the cost of inpatient services; however, there is still a paucity of unit cost information from Indian hospitals. In this study, we estimated operating costs and cost per outpatient visit, cost per inpatient stay, cost per emergency room visit, and cost per surgery for five hospitals of different types across India: a 57-bed charitable hospital, a 200-bed private hospital, a 400-bed government district hospital, a 655-bed private teaching hospital, and a 778-bed government tertiary care hospital for the

financial year 2010–11. The major cost component varied among human resources, capital costs, and material costs, by hospital type. The outpatient visit cost ranged from Rs. 94 (district hospital) to Rs. 2,213 (private hospital) (USD 1=INR 52). The inpatient stay cost was Rs. 345 in the private teaching hospital, Rs. 394 in the district hospital, Rs. 614 in the tertiary care hospital, Rs. 1,959 in the charitable hospital, and Rs. 6,996 in the private hospital. Our study results can help hospital administrators understand their cost structures and run their facilities more efficiently, and we identify areas where improvements in efficiency might significantly lower unit costs. The study also demonstrates that detailed costing of Indian hospital operations is both feasible and essential, given the significant variation in the country's hospital types. Because of the size and diversity of the country and variations across hospitals, a large-scale study should be undertaken to refine hospital costing for different types of hospitals so that the results can be used for policy purposes, such as revising payment rates under government-sponsored insurance schemes.

- **Variation in Hospital Costs, Payments, and Profitability for Cardiac Valve Replacement Surgery**

Expansions of insurance coverage under the Patient Protection and Affordable Care Act (PPACA) are to be financed partly through restrictions in Medicare payments, relative to expected trends in costs (Davis et al. 2010; Foster 2010; PricewaterhouseCoopers Health Care Research Institute 2010). Key empirical questions concern the extent of variance across hospitals in costs, payments, and contribution margins for privately insured patients; the magnitude of the differentials for Medicare and privately insured patients; and the influence of local market structure on hospital economic performance. Answers to these questions require data that permit detailed adjustments for patient characteristics such as comorbidities and complications; hospital characteristics such as procedure volume and input costs; and market characteristics such as the affiliation of individual hospitals with larger chains that negotiate on a unified basis with private insurers.

This paper analyzes the variance in costs, payments, and hospital contribution margins for 1,858 Medicare and privately insured patients undergoing one major surgical procedure, cardiac valve replacement surgery. Focus on a single procedure eliminates much of the case mix heterogeneity that challenges studies that use

the hospital as the unit of observation, and it permits further adjustments as to whether the patient received cardiac catheterization in addition to valve replacement and for other characteristics including age, comorbidities, complications, length of stay, and discharge destination.

- **The price of surgery: markup of operative procedures in the United States.**

The study sought to characterize and compare variability in pricing for commonly performed major surgical procedures across the United States.Medicare claims corresponding to eight major surgical procedures (aortic aneurysm repair, aortic valvuloplasty, carotid endartectomy, coronary artery bypass grafting, esophagectomy, pancreatectomy, liver resection, and colectomy) were identified using the Medicare Provider Utilization and Payment Data Physician and Other Supplier Public Use File for 2013. For each procedure, total charges, Medicare-allowable costs, and total payments were recorded. Among all providers, the median MR was 3.5 (interquartile range: 3.1-4.0). MR was noted to vary by procedure; ranging from 3.0 following colectomy to 6.0 following carotid endartectomy ($P < 0.001$). MR also varied for the same procedure; varying the least after liver resection (CoV = 0.24), while coronary artery bypass grafting pricing demonstrated the greatest variation in MR (CoV = 0.53). Compared with the national average, MR varied by 36% between states ranging from 1.8 to 13.0. Variation in MR was also noted within the same state varying by 15% within the state of Arkansas (CoV = 0.15) compared with 51% within the state of Wisconsin (CoV = 0.51).The study found that the significant variation was noted for the price of surgery by procedure as well as between and within different geographical regions. Greater scrutiny and transparency in the price of surgery is required to promote cost containment.

- **CTVS Surgeons Perform Innovative Heart Surgery.**

Austin, TX – September 28, 2010 Cardiothoracic surgeons at Cardiothoracic and Vascular Surgeons, P.A. (CTVS) now perform minimally-invasive heart surgery to treat heart valve defects. About 95,000 Americans undergo heart valve procedures each year for valve defects, complications caused by congenital defects, aging, deterioration, or an untreated infection. If left untreated, heart valve problems can lead to heart failure or life-threatening cardiomyopathy, a serious disease where the heart muscle becomes weakened and does

not function properly. Traditionally, surgeons perform heart valve procedures with "open chest" techniques where they divide the breastbone to reach the heart. Recovery time can take several weeks or months, and patients are left with a large scar down the middle of their chest. The surgery procedure lead to mitral valve and reached his heart through a smaller incision located at the ribcage, about two inches long. He then used special instruments, as well as cameras to operate on the heart through the smaller incision. The newer procedure is used to treat mitral valve disease, aortic valve disease, tricuspid valve disease, atrial septal defects and coronary artery bypass grafts.

- **The cost of open heart surgery in Nigeria**

The aim of this study was to determine the direct cost of OHS procedures in Nigeria. The Method was performed prospectively from November to December 2011.. These procedures were Atrial Septal Defect (ASD) Repair, Off Pump Coronary Artery Bypass Grafting (OPCAB) and Mitral Valve Replacement (MVR). Cost categories contributing to direct costs of OHS (Investigations, Drugs, Perfusion, Theatre, Intensive Care, Honorarium and Hospital Stay) were tracked to determine the total direct cost for the 3 selected OHS procedures.

Results: ASD repair cost $ 6,230 (Drugs $600, Intensive Care $410, Investigations $955, Perfusion $1080, Theatre $1360, Honorarium $925, Hospital Stay $900). OPCAB cost $8,430 (Drugs $740, Intensive Care $625, Investigations $3,020, Perfusion $915, Theatre $1305, Honorarium $925, Hospital Stay $900). MVR with a bioprosthetic valve cost $11,200 (Drugs $1200, Intensive Care $500, Investigations $3040, Perfusion $1100, Theatre $3,535, Honorarium $925, Hospital Stay $900).

Conclusion: The direct cost of OHS in Nigeria currently ranges between $6,230 and $11,200. These costs compare favorably with the cost of OHS abroad and can serve as a financial incentive to patients, sponsors and stakeholders to have OHS procedures done in Nigeria.

- **Comparison of the treatment practice and hospitalization cost of percutaneous coronary intervention between a teaching hospital and a general hospital in Malaysia: A cross sectional study.**

This cross-sectional study was conducted from the healthcare providers' perspective from January 1st to June 30th 2014. TH is a university teaching hospital in the capital

city, while GH is a state-level general hospital. Both are government-funded cardiac referral centers. Clinical data was extracted from a national cardiac registry. Cost data was collected using mixed method of top-down and bottom-up approaches. Total hospitalization cost per PCI patient was summed up from the costs of ward admission and cardiac catheterization laboratory utilization. Clinical characteristics were compared with chi-square and independent test, while hospitalization length and cost were analyzed using Mann-Whitney test. As per the methodology the mean hospitalization cost was RM 12,117 (USD 3,366) at GH and RM 16,289 (USD4,525) at TH. The higher cost at TH can be attributed to worse patients' comorbidities and cardiac status. In contrast, GH recorded a lower mean length of stay as more patients had same-day discharge, resulting in 29% reduction in mean cost of admission compared to TH. As per the finding from the study the high PCI consumables cost highlighted the importance of cost-effective purchasing mechanism. Findings on the heterogeneity of the patients, treatment practice and hospitalization cost between TH and GH are vital for formulation of cost-saving strategies to ensure sustainable and equitable cardiac service in Malaysia.

- **Pro: early extubation after cardiac surgery decreases intensive care unit stay and cost.**

The recurrent or new trends of early extubation after cardiac surgery are here to stay in the 1990s. The preoperative status does not necessarily predict the postoperative course and prolonged mechanical ventilation following cardiac surgery should not be uncritically considered as routine. All patients should be assessed for tracheal extubation at the earliest opportunity when the criteria are met in the ICU. Early extubation post-cardiac surgery does reduce ICU and hospital length of stay and costs. It also allows early ICU discharge and reduces case cancellations without any increase in postoperative complications and readmission. These studies have emphasized that the change in the process of care to early extubation can affect patient outcome as well as costs in cardiac patient care. The substantial difference in cost savings per cardiac case between "criteria discharge" and "actual discharge" points out the importance of the organization of the process of care being delivered. To achieve maximum cost benefit from early extubation in cardiac patients, the organization of the perioperative management of these patients must be optimized. This process of care includes

intraoperative anesthetic modification; organization of ICU and staff expertise; postoperative early extubation and management; acute pain service; ICU discharge policy; utilization of step-down unit and surgical ward; and communication among cardiac patient management teams (cardiovascular surgeon, cardiac anesthesiologist, ICU staff, nurses, respiratory therapists, physiotherapists, and social workers), which are all vital to the success of such a program.

Costing and Related Concepts.

Hospitals usually face challenges in tracking the cost incurred in service delivery. Hence development of proper cost information is essential for accurate pricing of services. Healthcare services should be provided at the least possible cost and at the best level of quality. Hence it is necessary to get correct information on the actual cost of the services provided. With the rising healthcare costs, hospitals should focus on improving their efficiency in service delivery. Cost analysis of a service is useful for understanding the various expenses incurred while running the service.

Cost

A cost is 'a resource sacrificed or forgone to achieve a specific objective'. 'It is usually measured in terms of the monetary amount that should be expended to procure goods or services. Costs can be actual or budgeted. Actual costs are historical costs which are already incurred whereas budgeted costs are future costs which are yet to be incurred. A cost object is 'anything for which a measurement of costs is desired

Costing

Costing 'the technique and process of ascertaining costs'. According to the Chartered Institute of Management Accountants (CIMA), cost accounting 'involves the classification recording and appropriate allocation of expenditure for the determination of the costs of products or services; the relation of these costs to sales values; and the ascertainment of profitability'.

Activity Based Costing (ABC) One of the earliest papers illustrating the use of Activity Based Costing was published by Cooper and Kaplan in the. journal 'Accounting Horizons' in 1992. Traditional costing methods use volume based methods to allocate costs to individual products. But in many cases, the resource demands are not always proportional to the volume of production. Activity based costing systems were developed so that organizations can directly link the costs of performing various activities to the products for which they are performed.

In ABC, 'resources are assigned to activities .and the activities are assigned to cost objects based on their use'. The basic concept is that activities utilizes resources to produce an output. Expenses should be segregated and matched to the resource consume activity. Compared to the traditional method, the ABC approach results in utilization of greater number of indirect cost pools and cost drivers in the expense allocation process. ABC can relate help relate costs to outcome and performance measures ABC can help the management in achieving cost efficiency without impact on quality. ABC is particularly suited to the complex healthcare delivery system.

Activity based resting in healthcare

Activity Based Costing saw its use in' the healthcare industry from the early l990.Because of the increased accuracy in allocating costs; ABC was used by more t n 20% of hospitals in the USA and Canada in the 1990s".An article published by: Baker JJ and Boyd GP in the Journal of . Healthcare Finance, gave an example of how the hospital used ABC in the cost analysis of the Operating room procedures. It explained how the management was able to benefit from the improved costing data and how it was 'utilised in the continuous quality improvement process". Canby IB used ABC in the cost analysis of the X-ray process in an outpatient clinic".

Laurila *et al* applied ABC in a paediatric radiological unit for costing of radiological procedures. They were able to obtain more detailed and precise costing information with ABC which enhanced departmental management and facilitated process improvement". .

In a study by Shander et al. the cost of blood transfusions .for surgical patients were calculated. using ABC in two US and two European hospitals. The improved costing data with ABC helped them conclude that the blood costs were underestimated. The detailed ABC-driven description of the various cost elements helped the administrators in evaluating and improving hospital processes".

- **Costing Hospital Surgery Services: The Method Matters**

The aim of this study was to assess the agreement between bottom-up and top-down unit costs of a large sample of surgical operations in a French tertiary centre.In the study two thousand one hundred and thirty consecutive procedures performed between January and October 2010 were analysed. Top-down costs were based on pre-determined weights, while bottom-up costs were calculated through an activity-based

costing (ABC) model. The agreement was assessed using correlation coefficients and the Bland and Altman method. Variables associated with the difference between methods were identified with bivariate and multivariate linear regressions. The correlation coefficient amounted to 0.73 (95%CI: 0.72; 0.76). The overall agreement between methods was poor. In a multivariate analysis, the cost difference was independently associated with age (Beta=−2.4; p=0.02), ASA score (Beta=76.3; p<0.001), RCI (Beta=5.5; p<0.001), staffing level (Beta=437.0; p<0.001) and intervention duration (Beta=−10.5; p<0.001). To conclude the ability of the current method to provide relevant information to managers, clinicians and payers is questionable. As in other European countries, a shift towards time-driven activity-based costing should be advocated.

- **Development of a practical costing method for hospitals.**

To realize an effective cost control, a practical and accurate cost accounting system is indispensable in hospitals. In traditional cost accounting systems, the volume-based costing (VBC) is the most popular cost accounting method. In this method, the indirect costs are allocated to each cost object (services or units of a hospital) using a single indicator named a cost driver (e.g., Labor hours, revenues or the number of patients). However, this method often results in rough and inaccurate results. The activity based costing (ABC) method introduced in the Mid 1990s can prove more accurate results. With the ABC method, all events or transactions that cause costs are recognized as "activities", and a specific cost driver is prepared for each activity. Finally, the costs of activities are allocated to cost objects by the corresponding cost driver. However, it is much more complex and costly than other traditional cost accounting methods because the data collection for cost drivers is not always easy. In this study, we developed a simplified ABC (S-ABC) costing method to reduce the workload of ABC costing by reducing the number of cost drivers used in the ABC method. Using the S-ABC method, we estimated the cost of the laboratory tests, and as a result, similarly accurate results were obtained with the ABC method (largest difference was 2.64%). Simultaneously, this new method reduces the seven cost drivers used in the ABC method to four. Moreover, we performed an evaluation using other sample data from physiological laboratory department to certify the effectiveness of this new method. In conclusion, the S-ABC

method provides two advantages in comparison to the VBC and ABC methods: (1) it can obtain accurate results, and (2) it is simpler to perform. Once we reduce the number of cost drivers by applying the proposed S-ABC method to the data for the ABC method, we can easily perform the cost accounting using few cost drivers after the second round of costing.

- **A modified method of activity-based costing for objectively reducing cost drivers in hospitals**.

. The authors aim to develop a method for objectively reducing the cost drivers used in the ABC method.In the ABC method, the cost driver is assigned for each activity. We assume that these activities and cost drivers are the best combination. Our method, that is cost driver reduction (CDR), can objectively select surrogates of the cost drivers for each activity in ABC from candidate cost drivers. Concretely, the total indirect cost of an activity is temporarily allocated to the medical services using each candidate of cost drivers. The difference between the costs calculated by each candidate and the proper cost driver used in ABC is calculated to evaluate the similarity by the evaluation function.We estimated the cost of laboratory tests using our method and revealed that the number of cost drivers could be reduced from seven in the ABC to four. Similarly, the results of cost estimation obtained by our method were as accurate as those calculated using the ABC.Our method provides two advantages compared to the ABC method: 1) it provides results that are as accurate as those of the ABC method, and 2) it is simpler to perform complicated estimation of hospital costs.

- **Activity-based analyses lead to better decision making.**

Activity-based costing (ABC) and activity-based management (ABM) are cost-management tools that are relatively new to the healthcare industry. ABC is used for strategic decision making. It assesses the costs associated with specific activities and resources and links those costs to specific internal and external customers of the healthcare enterprise (e.g., patients, service lines, and physician groups) to determine the costs associated with each customer. This cost information then can be adjusted to account for anticipated changes and to predict future costs. ABM, on the other hand, supports operations by focusing on the causes of costs and how costs can be reduced. It assesses cost drivers that directly affect the cost of a product or service, and uses performance measures to evaluate the financial or nonfinancial benefit an activity

provides. By identifying each cost driver and assessing the value the element adds to the healthcare enterprise, ABM provides a basis for selecting areas that can be changed to reduce costs.

- **Impact of standard procedures and clinical standards on cost-effectiveness and intensive care unit performance in adult patients after cardiac surgery.**

To investigate the impact of organizational procedures on intensive care unit (ICU) performance and cost-effectiveness after cardiac surgery. The Mesurements implied Demographic data, surgical procedures, length of ICU and hospital stay and hospital outcome were recorded. Severity of illness was assessed daily using Acute Physiology and Chronic Health Evaluation (APACHE II), Simplified Acute Physiology Score (SAPS II) and Organ Failure Score (OFS). Intensity of treatment and nursing care was monitored by the Therapeutic Intervention Scoring System (TISS). RIYADH ICU Program (RIP 5.0) was used to determine the relationship of observed to predicted mortality (standardized mortality ratio SMR) and the effective costs per survivor.SMR decreased continuously after the establishment of new management procedures while all other factors all other factors remained unchanged. Comparing outcome according to APACHE II on ICU admission demonstrated a significantly increased ICU performance in high risk patients with an APACHE II of 20-30 points ($p < 0.05$) while effective costs per survivor decreased significantly from DM 29,988 to DM 13,568 DM ($p < 0.05$).In conclusion Organizational changes can improve ICU performance and cost-effectiveness after cardiac surgery. The RIP may be used to monitor the clinical and economic effects of change

- **Estimating cost savings from regionalizing cardiac procedures using hospital discharge data**

We examined whether higher procedure volumes for coronary artery bypass graft (CABG) surgery or percutaneous coronary interventions (PCI) were associated with lower costs per patient, and if so, estimated the financial savings from regionalizing cardiac procedures. As per the study method Cost regressions with hospital-specific dummy variables measured within-hospital cost reductions associated with increasing hospital volume. We used the regression estimates to predict the change in total costs that would result from moving patients in low-volume hospitals to higher volume facilities.A 10% increase in PCI procedure

volume lowered costs per patient by 0.7%. For the average hospital performing CABG in 2000, a 10% increase in volume was associated with a 2.8% reduction in average costs. Despite these lower costs, the predicted savings from regionalizing all PCI procedures in the sample from lower to high-volume hospitals amounted to only 1.1% of the entire costs of performing PCI procedures for the sample in 2000. Similarly, the cost savings for CABG were estimated to be only 3.5%.The study found Higher volumes were associated with lower costs per procedure. However, the total potential savings from regionalizing cardiac procedures is relatively minor, and may not justify the risks of reducing access to needed services.

- **Comparison of Cost Structure, Package Rates and Financial Feasibility for Selected Surgeries Covered under Social Health Insurance Schemes**

To carry out a comparative analysis of the cost structure of the major procedures in the hospital covered under Yeshasvini and Kalaignar schemes; To compare the cost structure/s incurred by the hospital with the package rates approved by the schemes to evaluate the financial feasibility of the schemes across various departments of the hospital; and To suggest measures to reduce the costs of production for various procedures without negatively impacting the quality of care and, thereby, reduce the gap between the costs incurred by the hospital and the realization from the schemes. As per the study structure the cost incurred by the hospital in treating the patients covered under the two schemes—Yeshasvini and Kalaignar—for 210 surgical cases was analyzed. The costs of various resources on a per-patient basis including consumables, manpower, electricity, equipment, and use of facilities in and around the hospital were computed. Net realization by the hospital in the corresponding surgeries was computed by taking the approval amount (package rates) and total cost of care. The analysis was carried out for both the schemes by classifying data as 'cardiac' and 'non-cardiac' procedures. In general the results wasKalaignar scheme showed better cost recoveries than Yeshasvini scheme for similar types of cardiac and non-cardiac procedures. In all the cases studied, the major costs were attributable to cost of medicine and consumables and cost of manpower. The cost of medicine and consumables in cardiac and non-cardiac surgeries was 37 per cent and 29 per cent of the total cost, respectively. Manpower costs in the two types of surgeries were 42.5 per cent and 47.5 per cent,

respectively. Net realization for all surgeries studied, showed that cardiac cases gave a better cost recovery than non-cardiac categories. It was observed that only 4 of the 12 surgical procedures studied posted earnings more than the total cost indicating low financial viability for the hospital.

- **The reduction in hospital stay and costs in the care of patients with congenital heart diseases undergoing fast-track cardiac surgery**

To assess the care provided to patients with congenital heart diseases and ischemic heart diseases undergoing cardiac surgery according to the fast-track recovery protocol compared with those undergoing the conventional procedure. The transfer of patients from one hospital unit to another was assessed for 175 patients, 107 (61%) men and 68 (39%) women, with ages ranging from 0.3 to 81 years. For the result it was evident that he discharge rate from the different hospital units per unit of time of the patients with congenital heart diseases treated according to the fast-track recovery protocol compared with that of patients conventionally treated was as follows: a) 11.3 times faster than the discharge rate of patients treated according to the conventional protocol, in regard to the time spent in the operating room; b) 6.3 times faster in regard to the duration of the surgical intervention; c) 6.8 times faster in regard to the duration of anesthesia; d) 1.5 times faster in regard to the duration of perfusion; e) 2.8 times faster in regard to the stay in the postoperative recovery I unit; f) 6.7 times faster in regard to hospital stay (time period between hospital admission and hospital discharge); g) 2.8 times faster in regard to the stay in the preoperative unit; h) 2.1 times faster in regard to the stay in the admission unit after discharge from postoperative recovery; i) associated with reduced costs. The difference was not significant for patients with ischemic heart disease. The study found out a reduction in the length of hospital stay and costs for the care of patients undergoing cardiac surgery according to the fast-track protocol was observed.

METHODOLOGY:

It is a descriptive and observational study. The information for the study was obtained from records available in the cardiology department and by direct interaction with the staff. The staffing pattern and functioning of the department was assessed based on the documents available in the department. The analysis of unit costing of Coronary artery bypass grafting (CABG), Aortic valve replacement (AVR) and Mitral valve

replacement (MVR) was done considering the direct and indirect costs associated with the performance of the two procedures. Activity based costing was used for calculating the cost incurred for performing of CABG, AVR, MVR. The study was conducted from December 1st 2019 to December 31st 2019 and all the above mentioned procedures performed during this one month were considered for calculation of the cost.

RESULTS AND OUTCOME:

TOTAL COST OF PROCEDURES

Table 1: Total Cost of procedures for CABG/AVR/MVR

S. No.	Cost Head	CABG	AVR	MVR
1	Direct labor cost	8616	8616	8616
2	Indirect labor cost	800	800	800
3	General Stores Consumables	8232	15292.41	17566.21
4	Pharmacy Consumables	138.6	138.6	138.6
5	Sterilization of reusable consumables	244.4	244.4	244.4
6	linen(laundry and sterilization)	176	176	176
7	Pre procedure investigations	1891	1891	1891
8	Equipment Depreciation	916.8	916.8	916.8
9	Equipment maintenance	3006.27	3006.27	3006.27
10	Building Maintenance costs	31.92	31.92	31.92
11	Air conditioning costs	326.1	326.1	326.1
12	electricity costs	1512	1512	1512
13	Hospital stay costs	12680	12680	12680
	Total	38571	45631	47905
14	Administrative costs(5% of total cost)	1928	2281	2395
	Grand Total	40499	47912	50300

DISCUSSION:

Activity based costing was used to find out the unit cost for CABG, AVR and MVR. The total cost incurred for CABG, AVR and MVR was found to be Rs 40,499, Rs 47,912 and Rs 50,300 respectively. The main cost drivers identified were Hospital stay consisting of 31%, direct cost consisting 21% and consumables cost consisting 20% for CABG procedure. The main cost drivers for AVR procedure were identified as Consumables cost consisting of 31.9%, Hospital stay cost consisting 26% and direct labor cost consisting 17.9%. The major cost factors for MVR procedure consisted of 34% of Consumables cost, 26% of Hospital stay cost and 17% of direct labor cost. Whereas the minimum cost incurred for all three procedures are namely Building maintenance cost of 0.07%, Pharmacy consumable cost of 0.34% and linen cost of 0.43%.

SUMMARY AND CONCLUSION

There is increasing prevalence of cardiovascular disorders in the world, especially in Indian population and it causes significant morbidity and

mortality. Even though it is more common in the urban population, the prevalence in the rural population is also rising. CABG, AVR and MVR are important procedure in the intervention and management of cardio vascular disorders. Hence, CTVS department has an integral role in the management of patients with cardiovascular disorders. CABG, AVR, and MVR are three most common procedures done in the Department.

Accurately understanding the cost of healthcare delivery is important in the management of costing challenges facing the health care services in the current scenario. Unit cost calculation and activity based costing information improves the knowledge regarding the organization process and about unused capacity resources, so that managers can make decisions regarding best use of resources. Accurate unit costing of the procedures is beneficial to improve the efficiency of the cardio vascular surgery department.

This study was conducted with an aim to study the costing of procedures in CTVS department in a tertiary care teaching hospital. It is a descriptive and observational study. The objectives were to study the organization and staffing pattern: to study the policies, procedures and work flow; to calculate the cost incurred in performing CABG , AVR and MVR and to suggest recommendations if any.

The existing facilities in the CTVS were studied and were compared with standard guidelines. CTVS department of JSS Hospital was inaugurated on 24th July 2015. It has a total area of approximately 3824 square feet. An interdisciplinary team of cardiologists, cardiovascular surgeons, technicians and nursing staff work together for the efficient functioning of the CTVS department.

Procedures in the CTVS has evolved from purely interventional techniques to an array of modern life saving methods. The study of the yearly workload of the CTVS showed a constant increase in volume of cases in the CTVS. The CTVS architecture and services mostly comply with the NABH guidelines. Recommendations are given for further improvement.

Activity based costing was used to find out the unit cost for CABG, AVR and MVR. The total cost incurred for CABG, AVR and MVR was found to be Rs 40,499, Rs 47,912 and Rs 50,300 respectively. The main cost drivers identified were Hospital stay consisting of 31%, direct cost consisting 21% and consumables cost consisting 20%

for CABG procedure Whereas the least drivers identified were Building maintenance cost of 0.07%,pharmacy consumable cost of 0.34% and linen cost of 0.43%. The main cost drivers for AVR procedure were identified as Consumables cost consisting of 31.9%, Hospital stay cost consisting 26% and direct labor cost consisting 17.9% whereas the least were identified as Building maintenance cost of 0.07%,pharmacy consumable cost of 0.34% and linen cost of 0.43%. The major cost factors for MVR procedure consisted of 34% of Consumables cost, 26% of Hospital stay cost and 17% of direct labor cost Whereas the least was noted on Building maintenance cost of 0.07%, pharmacy consumable cost of 0.34% and linen cost of 0.43%.

The results of the study provide improved understanding about the organizational process of the cardio thoracic surgery department (CTVS). The study also gives cost information of the most common services in the CTVS which will be helpful for future decision making regarding pricing of services. This will improve cost awareness among professionals in the field of healthcare and help the hospital managers to provide healthcare services at least possible cost, maintaining high level of quality.

Susmita Chatterjee *et al* (2013) Unit Cost of Medical Services at Different Hospitals in India, https://doi.org/10.1371/journal.pone.0069728 . In this study, it is estimated operating costs and cost per outpatient visit, cost per inpatient stay, cost per emergency room visit, and cost per surgery for five hospitals of different types across India: a 57-bed charitable hospital, a 200-bed private hospital, a 400-bed government district hospital, a 655-bed private teaching hospital, and a 778-bed government tertiary care hospital for the financial year 2010–11. The major cost component varied among human resources, capital costs, and material costs, by hospital type. The outpatient visit cost ranged from Rs. 94 (district hospital) to Rs. 2,213 (private hospital) (USD 1=INR 52). The inpatient stay cost was Rs. 345 in the private teaching hospital, Rs. 394 in the district hospital, Rs. 614 in the tertiary care hospital, Rs. 1,959 in the charitable hospital, and Rs. 6,996 in the private hospital. The study results can help hospital administrators understand their cost structures and run their facilities more efficiently, and we identify areas where improvements in efficiency might significantly lower unit costs. The study also demonstrates that detailed costing of Indian hospital operations is both feasible

and essential, given the significant variation in the country's hospital types. Because of the size and diversity of the country and variations across hospitals, a large-scale study should be undertaken to refine hospital costing for different types of hospitals so that the results can be used for policy purposes, such as revising payment rates under government-sponsored insurance schemes. From the above study it shows the hospital stay cost and material cost plays a vital role in the total costing process for various procedures in private tertiary care hospital.

Alfredo Manoel da Silva Fernandes *et al* (2011) The reduction in hospital stay and costs in the care of patients with congenital heart diseases undergoing fast-track cardiac surgery, The study found out a reduction in the length of hospital stay and costs for the care of patients undergoing cardiac surgery according to the fast-track protocol was observed. In this background of study the length of stay counting for pre and post operation amounts to major cost driver factor which was evident.

RECOMMENDATIONS

In View of the observations made during the study the functioning of the CTVS department were according to the standard operating protocol maintained and assessed by the Hospital. The work efficiency and knowledge of the staffs pertaining to the departments work flow, scope of services, roles and responsibilities are highly appreciable. In order to maintain the same effectiveness and efficiency, it is highly recommended to induce further education and training for the staffs.

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