

Research Article**UNIT COSTS AND ITS DRIVERS FOR DIABETES MELLITUS, TREATED IN EMERGENCY DEPARTMENT OF MUHIMBILI NATIONAL REFERRAL HOSPITAL IN DAR ES SALAAM TANZANIA****^{1,*} Millen Charles Ringo and ²Phare Mujinja**¹Emergency Department, Muhimbili National Hospital, Tanzania²Behavioral Sciences Department, Muhimbili University of Health and Allied Sciences, TanzaniaReceived 10th December 2021; Accepted 14th January 2022; Published online 28th February 2022

Abstract

Lack of economic evaluation of unit cost in delivery of hospital services in developing countries public hospitals has led to poor resource allocation.(1) This is mainly caused by unawareness of importance of unit costs, and lack of costing experts, lack of expertise in the use of information related to economic evaluation in operating public hospitals.(2) Objective was to evaluate the unit costs of Diabetes Mellitus treatment and drivers in Muhimbili National Hospital (MNH), Tanzania. A cross-sectional descriptive hospital-based (direct cost-provider perspective) study was carried out from July to Sept 2020 in Emergency Department of MNH. The study horizon and analytical horizon were both one year (January to December 2019). Costing of materials, diagnosis and invested time were estimated from patient's electronic files. Treatment information and analysis were done using Microsoft excel for quantitative data. Bottom up approach was used to arrive at the total and unit cost of the health condition. Estimated unit cost for treating diabetes mellitus was found to be TZS 272,831. Cost drivers includes high cost of some diabetic medications. Unit cost for providing treatment to diabetic patients at emergency department at Muhimbili national referral hospital is high. Purchasing relative cheaper anti diabetic medications. Annual unit cost studies should precede budgeting and pricing for services offered by the department. Prioritizing preventive services especially annual health checks could lower curative services costs significantly. Patients' perspective study will shed light on what is the cost bone by diabetic patients as they seek treatment at the department.

Keywords: Heterogeneous, History, Lucayos, Racism, Native.

INTRODUCTION

A unit cost analysis is one of the most useful yet underused tool: it takes into account all of the resources associated with providing a particular service and calculates how much it costs to provide that service (4)(7) (6). Cost-per-unit data can be highly useful when developing budgets, setting fees, planning for expansion or negotiating rates with health care insurers. Strategic information for service provision needs cost information as important part for planning. For efficiency measurement of a service provision, combination of unit cost of a service and measurement of service and measurement of its outcome are required to arrive at cost effective ratios. Quantities and types of resources spent on various groups or populations' information is also important in evaluating the equity of the services provided on the cost of services. It also provides the basis for estimating possible future resource needs. However, the number of cost studies and the reliable cost data produced, have been limited, especially in middle- and low-income countries (8). There is a limited number of researches across Africa that details unit cost as found in a systematic review only 42 (5%) of 1,047 records reviewed included in a full-text review reported primary cost data on HIV interventions in South Africa, with 71% of included papers covering ART (9) Esatoglu et al. evaluated the cost for three hospitals and showed that the total hospital costs comprised 70% direct staff costs and 7%-25% tools and equipment (7). In Rwanda a study found the cost of an STI visit at the health center was 2,779 FRW compared to the cost of the same service at the hospital costing 12\$ (6,440 FRW) at the time of study in 2007 540 FRW = 1\$US (10). There are different methods for studying unit cost where the commonest applied is top-down costing method.

Although the top-down costing method could be used for the allocation of average expenditures per inpatient served the total cost of resources/inputs used to treat a patient with a particular disease, regardless of the number of patients served, is not easily estimated by this method. Alternative method is bottom-up or resource costing which is always recommended for exploring the total costs of resources used in providing a service (11). The Bottom-up costing is cumbersome as it requires recording of every item of service that a patient receives, and changing them into costs. Bottom-up costing gives more accurate results, but the challenge is that it requires a large investment in terms of time and many types of resources. Literature shows that the bottom-up approach has been used to obtain the case specific unit costs on common diseases and validate the unit cost estimates produced through top-down costing method (12). This dissertation has adopted the bottom up approach as the intention is to get accurate results, furthermore, the study involves case specific unit cost of three diseases at emergency department are being studied namely Diabetes Mellitus. Furthermore, it is crucially important to understand how the costs are defined, classified and measured in service level given the financial constraints facing the health sector in amidst increased demand for health care in the country. Speaking of the rise in new diseases and higher cost of managing them including cost of protecting health care providers caring for such diseases, as well as treating providers infected with the infectious disease in line of duty. The cost information is beneficial to policy makers and planners and general public at large so as to make an effective and efficient use of resources including how much it costs to provide care to each client visiting each level of service including emergency department. More importantly the cost information would determine the costs for top most prevalent conditions seen in the emergency department which include diabetic mellitus.

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Evidence from a study on cost of providing emergency obstetric care in Tanzania's Kigoma region by Maro et al which aimed at looking at a comprehensive programmatic approach. The study considered all sources of financial and in-kind support over a 1 year period. Data were collected retrospectively and costs disaggregated by input, sources of support, programmatic activity, and patient type (nonsurgical, surgical patients, and among the latter patients undergoing caesarean sections). Results showed the median per patient cost across the six facilities was TZS 672,510 (13). This findings shows how high are costs of medical services regardless the medical specialty involved. In the same study in Kigoma, personnel and equipment purchases accounted for the largest proportions of the total costs, representing 32% and 28%, respectively. Average per patient costs varied by patient type; cost per nonsurgical patient was TZS 185,520, TZS 598,302 for surgical patients and TZS 987,894 for patients undergoing caesarean sections. Per patient costs also varied substantially by facility type: mean per patient cost at health centers was TZS 672,510 compared with TZS 391,911 at hospitals. It was concluded that the estimates could inform programme planning and highlight areas with potential scope for cost reductions (13). Not only do the policy makers need unit cost of treatment information but also public as evidenced by health services users who wanted hospital charges be easily available to patients an idea often referred to as "price transparency" (4). With limited resources the cost information is required to decide which interventions should be implemented. However, because resources are limited it is important to know whether the intervention gives good value for money; is it cost effective? (14) This dissertation seeks to find just that, are the cost incurred during treatment of Diabetes mellitus give good value for money?

Muhimbili National Hospital has the emergency department reports revealing that on average 16,964 clients are attended quarterly of which 20% are diabetic, 18% are hypertensive and 15%. Regarding patients' acuity, three categories are Queue 6.7%, Emergency 23.7% and 69.6% Priority (EMD, 2019). The research question for this dissertation asks 'What are the unit costs of treating Diabetes Mellitus and drivers in Emergency Department at Muhimbili National Hospital?' implementing this study will reveal what the department incurs as it treat the three diagnoses hence evaluate the best use of the limited resources. This was achieved by conducting a cross-sectional descriptive hospital-based (direct cost-provider perspective) where all costs used to treat individual patient were calculated by adding medications, investigations, procedures and personnel costs then divide by number of number of patients in each diagnosis to find the unit cost.

Problem Statement

Scanty information on economic evaluation especially estimation of the unit cost of delivery of service in Tanzania's public hospitals has led to poor resources allocation. This is mainly caused by unawareness of importance of unit costs, lack of health economists in health facilities and lack of expertise in use of economic evaluation information public hospitals. Most economic evaluation studies have focused on cost effectiveness of interventions, total cost of hospital inpatient care and inpatient costs. Some studies have focused on cost of an STI visit at the health center and compared with such visits in a hospital (3). There is a scanty knowledge on the unit cost of treatment in individual departments of the tertiary

hospital. Such studies are crucial in understanding the performance of such hospitals

With the onset of decentralized planning process in a number of low and middle income countries, there is a need for generating reliable estimates of unit cost for various services to aid in planning (5) to make the best use of limited resources (13). Muhimbili National hospital has not done any research that look on cost of treatment of particular condition in different departments. Hence, this study sought to fill this gap of cost information in the emergency Department by answering the question 'What are the unit costs of care for the most prevalent conditions and their drivers in Emergency Department of Muhimbili National Hospital?' Specifically, the study estimated the unit cost of major illnesses and injuries that are attended at the emergency department. These problems are diabetes mellitus. Information on the unit cost of inpatient and outpatient care is an essential element for costing, budgeting and economic-evaluation exercises (15).

Rationale

The results of this study may be used by Muhimbili National Hospital to understand the unit cost of these diabetes mellitus and the drivers that are associated with the cost. By understanding these they may be used for pricing services (fees). Also they form the base for allocating resources and soliciting funds for investors who may be willing to finance some services at the hospital.

Broad Objective

To find out the unit costs of treatment of Diabetes Mellitus and their drivers in Emergency Department in Muhimbili National Hospital

Specific Objective

- To determine the unit cost of treating diabetic patient at Emergency Department in Muhimbili National Hospital
- To determine the cost drivers for providing treatment to diabetic patients at the Emergency Department in Muhimbili National Hospital.

Overview of Treating Diabetes Mellitus

World Health Organization's 2019–2023 work plan states: 'one billion better protected from health emergencies, one billion enjoying better health and one billion benefiting from universal health coverage'(2) setting up an emergency department at the tertiary hospital confirms with the WHO plan since Emergency care and the emergency care system encompass an array of time-sensitive interventions to address acute illness and injury(12) in that all people needing emergency care must get it and in time so as to arrest the life threatening condition under-facing a person which comes at a cost. Reports from the emergency department of Muhimbili national hospital reveals that , diabetes mellitus and are the leading conditions seen in the department(16)these are presumed to be the most costly conditions treated at the department. Hence, unit costs that are important for resource allocation would assist in understanding how resources are used at a more detail level. Furthermore, service delivery could be linked to cost drivers, to services provided to help make the right decision in achieving cost savings, setting fees for

revenue recoveries. A randomized trial evaluating different health care strategies at public health centres in Dar es Salaam, Tanzania to determine the costs of providing antiretroviral therapy services to HIV-infected individuals presenting with advanced HIV disease found that the mean cost per patient over the first three months and over a one year period of follow up following ART initiation in the standard care arm were TZS 248,133 and TZS 614,535 respectively. The same study found that ART drugs, clinic visits and hospital admission constituted 50%, 19%, and 19% of the total cost per patient year, while diagnostic tests and non-ART drugs (co-trimoxazole) accounted for 10% and 2% of total per patient year costs. The incremental costs of the intervention to the health service over the first three months was TZS 136,821 (17).

Above findings echo results from a Tuberculosis treatment study which looked at Costs to Health Services and the Patient, the Systematic Literature Review study in Morogoro region in Tanzania, found Drug-Susceptible (DS) Tuberculosis (TB) Provider Costs DS-TB provider costs were positively correlated with GNI per capita ($r = 0.73$, $p < 0.001$) and that the mean DS-TB treatment costs per patient were 57 times higher in HICs TZS 33,994,221 than in LICs TZS 598,302. A high degree of variability was observed in income group cost values, with almost as large as the mean provider costs in HICs and larger for LICs. Hospitalization and Outpatient Care Across all 59 studies, accounted for 74 % of all DSTB provider costs Hospitalization accounted for 63 % in HICs (TZS 26,165,277), 51 % in LMICs (TZS 498,585) and LICs (TZS 296,832), but only 12 % in UMICs (TZS 881,220). Multidrug-Resistant-TB (MDR-TB) Provider Costs Mean provider costs were TZS 193,323,435 (TZS 150,352,365) for the ten included studies and far less for the seven UMICs at TZS 12,253,596 (SD TZS 7,930,980). (18) Another study on Cost-effectiveness of malaria intermittent preventive treatment in infants (IPTi) in Mozambique and the United Republic of Tanzania found the cost per clinical episode of malaria averted was TZS 3,640.83 (range: US\$ 0.8–4.0) in Ifakara and TZS 10,968.87 in Manhiça; the cost per DALY averted was TZS 8,580.3 in Ifakara and TZS 25,972.8 (range: US\$ 3.6–92.0) in Manhiça; and the cost per death averted was TZS 232,000 in Ifakara and TZS 698,250.9 in Manhiça (19).

Study to determine the Cost of Delivering Health Care Services in Public Sector Primary and Community Health Centres in North India found the overall annual cost of delivering services through public sector primary and community health facilities in three states of north India were INR 8.8 million (95% CI: 7,365,630–10,294,065) and INR 26.9 million (95% CI: 22,225,159.3–32,290,099.6), respectively. Human resources accounted for more than 50% of the overall costs at both the level of PHCs and CHCs. Per capita per year costs for provision of complete package of preventive, curative and promotive services at PHC and CHC were INR 170.8 (2.26\$) (95% CI: 131.6–208.3) and INR 162.1 (2.15\$) (95% CI: 112–219.1), respectively (20). Study on cost of antenatal care for the health sector and for households in Rwanda found the societal cost (household + health facility) of antenatal care for the four visits according to current Rwandan guidelines was estimated at TZS 371,040 in the private health facility and TZS 102,036 in public and faith-based health facilities. The first visit had the highest cost TZS 173,925 in private and TZS 48,699 in public and faith-based health facilities) compared to the three other visits. Drugs and consumables were the main input category accounting for 54%

of the total cost in the private health facility and for 73% in the public and faith-based health facilities (21). Above findings shows a number of studies have been done in the health sector on the unit cost of providing care for different diseases both in Tanzania and outside. Unit costs reported according to countries were TZS 248,133 in ART, TZS 296,832 for Tuberculosis and TZS 25,972.8 for Malaria in Tanzania; in Rwanda Ante Natal care in public hospital cost TZS 102,036 while in India it ranged between TZS 5,240.94 to TZS 4,753.95. Due to the fact that Emergency care is a right and therefore it must be provided regardless the patient's status of payment at the time of need, this study was enable public health providers be aware of the exact cost uncured during services provision so that even health care providers can make sound decision during services provision so sustainability can be ensured through effective and efficiency use of all resources

Background Information

The Emergency department at Muhimbili National Hospital (MNH) is a state of art department that is fully equipped and capable of handling critical cases for patients received from all across the country and beyond. Providing such care encompasses human resource which includes medical and supporting staff, medical and surgical supplies costs which are borne by the department. Cost of treatment relies on the concepts of appropriateness and efficiency in the production of the health care service, assuming a standard quality level of treatment as target across the department. (16) The identification and measurement of health care costs is therefore a crucial task to health services economic evaluation since unit costs differs from bills. While bills are what institutions charge customers for their services, cost refers to are the value of resources incurred by a hospital in providing patient care (4).

MNH Background Information and Hospital Cost

Quarterly reports for the year 2019 for the Emergency department of the tertiary hospital reveals that Emergency department attended an average of 16,964 clients of which 20% are diabetic. Attended patients acuties are Queue 6.7%, Emergency 23.7% and 69.6% Priority. Medical supplies and medications used quarterly, an average of total TSh. 180,000,000TSh and TSh. 125,000,000TSh are used respectively for care providing care to all patients during the quarter (16).

Cost of Diabetic Treatment

Person with diabetes was have a fasting blood sugar higher than 126 mg/dL. Since normal blood sugar levels sit between 70 and 99 mg/dl.(22) In the year 2018 diabetes treatment in United states of America was coasted an average of TZS 38,847,888 per annum.(23) Mutyambizi, C et al reviewed twenty six articles on cost of Diabetes Mellitus in Africa in the same year where results showed that annual national direct costs of diabetes differed between countries but ranged from \$3.5 billion to \$4.5 billion per annum. Indirect costs per patient were generally higher than the direct costs per patient of diabetes(24). In a search which yielded 584 abstracts, and 52 publications that were included in an analysis that studied articles from Asia and Latin America, and most focused on type 2 diabetes founded that per-visit outpatient costs ranged from under TZS 11,595 to over TZS 92,760.

Cost Drivers

Predictors of cost in the variation of acute treatment costs of in high-income countries studies included Injury Severity Score (ISS), surgical intervention, hospital and intensive care, length of stay, poly- and age (7). A major finding in study on the Hospitalization Costs of Diabetes and Complications in Zimbabwe, major findings were that the median cost and interquartile range (IQR) for patients with diabetes, TZS 2,305,086 mean TZS 3,058,761, was higher than patients with, TZS 1,760,121 mean TZS 2,119,566. Regarding sex differences, female patients aged below 65 years with diabetes had the highest estimated mean costs TZS 3,401,973, a significant finding showing female patients to be the significantly high in care costs.

The study titled 'Using Top-down and Bottom-up Costing Approaches in LMICs'. The study represents a Case for Using Both to Assess the Incremental Costs of New Technologies at Scale purposed to estimate the incremental costs of scaling-up novel technologies in low-income and middle-income countries is a methodologically challenging and substantial empirical undertaking, in the absence of routine cost data collection. Researchers here demonstrated a best practice pragmatic approach to estimate the incremental costs of new technologies in low-income and middle-income countries, using the example of costing the scale-up of Xpert Mycobacterium tuberculosis (MTB)/resistance to rifampicin (RIF) in South Africa. It was found that the unit costs measured using the different methods of bottom-up and top-down costing, respectively, are TZS 39,191.1 and TZS 77,686.5 for Xpert MTB/RIF, and TZS 14,609.7 and TZS 19,711.5 for microscopy (34).

There are several uses of economic evaluations including evidence for decision making where economic evaluations offer the researcher or analyst an additional piece of evidence to demonstrate to a decision maker that an activity is worth continuing, scaling up, or eliminating. Budgets are not limitless; economic evaluation allows the researcher or analyst to understand the relative value-for-money of a given activity in comparison with other activities. Economic evaluations provide an opportunity for obtaining convincing evidence for those who are not well-versed in global health. Economic evaluations provide cost data that are helpful for planning or scaling up a specific activity. It is rare that the unit cost of an intervention does not change when it is scaled up. Allocation. Economic evaluations assist decision makers to formulate their budgets to maximize impact on health outcomes (35). Several cost drivers have been identified by different studies including by deferent trusts as one aimed at making financial markets work for the poor such as titled 'health micro insurance scheme design and pricing – lessons from four countries Kenya, Ghana, Colombia and India' which highlighted Demographic drivers or Demographic features, Claims patterns, Causes of claims, Incidence trends, payment mechanisms and product design as the main cost drivers (36). Literature showed available studies on cost in different fields but limited studies focused on unit cost for non-communicable diseases at emergency setting. Since emergency department out to handle illness that occurs suddenly and yet costly, unit costs ought to be known and information shared among all stakeholders so as to ensure that the critical departments run effectively and efficiently. Provider's perspective on the unit cost was also found to be very limited. This study therefore

sought to fill the knowledge gap. The department has not as yet broken even with regard to revenues collected as compared to cost of running the department. These makes the department a conducive place to conduct the study so as find out what is the estimated cost for the treatment of the top three disease as a starting point so as to improve the financial performance of the department.

METHODOLOGY

Study Site

This study was conducted in the Emergency Department of Muhimbili National Hospital in Dar Es Salaam Tanzania. Muhimbili national hospital (MNH) is a public tertiary hospital, currently with 1500 bed capacity and attending around 1000 to 1200 out patients per week and admitting around 1,000 to 1,200 inpatients week. At emergency department average of 100 to 120 patients are attended per day of which 60% are admitted. Diabetic, patients are among the top three diagnoses that are treated at the department. Apart from providing health care services to patients from all parts of Tanzania, the department conducts teaching to students from medical colleges in the country and abroad. The department collaborates with different teaching institutions including Muhimbili University of Health and Allied Sciences (MUHAS). The site was selected because there is only one national referral hospital with state of art emergency department that has been running for ten years now. The existence of and experience of personnel's working in the department makes it the best available option for the study. Clients at the department pay for the services by different methods. These methods includes health insurance and out of pocket (user fees).

Study Design

A cross-sectional descriptive hospital-based (direct cost-provider perspective) study that was carried out from July to Sept 2020. It is a cross-sectional because we dealt with prevalent cases and aimed to get the snapshot of the 2019 attendance/visits for the studied diseases. The study horizon and analytical horizons were both of one year (from January to December 2019).

Data Collection Method

This is a study that employed a bottom up prevalence approach collecting cost information from patient's electronic files. Patients' files were used to provide cost information Medical stores department catalogue was used to provide the prices for different medicines, medical and surgical supplies used in the treatment of diabetes mellitus. Information was extracted from patients' files including diagnosis, medicines prescribed, medical and surgical supplies used by each selected patient. A bottom-up approach was employed to extract cost information that were incurred in providing care to patients; the input cost varied for the cases that were examined. The human resource costs and overheads were responsible for the large portion of the total costs (2). The total costs included all imputes that were ordered by prescribers and appeared in the orders column of patients' chart. Medications prescribed to all 150 diabetic patients as presented in the 'orders' and 'prescription summaries' columns of Wellsoft software. A count of doses prescribed were identified then total doses for each medication

made. Cost of each drug was identified then multiplied by total doses to get total cost for all drugs prescribed. Formula used was $Q \times P = TC$ where Q is Quantities; P is Price and TC is Total Cost. All costs are expressed in Tanzanian Shillings(TZS) where the exchange rate is 1\$= TZS 2,289 Unit costs were calculated by dividing the total costs in each disease by the number of patients studied under each diagnosis i.e. 150 for diabetes mellitus.

Study Population

The study involved patients who visited the Emergency Department from January 1st to December 31st 2019 presenting and diagnosed with diabetes mellitus, where the patients electronic files, which were in the Wellsoft system were used to provide study data of selected patients.

Sample Size Determination

Table 2. Shows the total number of patients for diseases and the samples that were randomly selected for the health condition. A sample of 150 patients files were sampled for diabetes mellitus. The sample was arrived at using the inclusion criterion that were used as a basis of selection. Electronic filing system was accessed after obtaining permission from system administrator and the patients' files were downloaded from the system for the year 2019 for all patients diagnosed of diabetes mellitus diagnose. Lists of all files in the year 2019 were developed as the sampling frame. These strictly included only all files that had complete records. The files were randomly selected. About thirty patients' files that met inclusion criterion in each quarter of the year were randomly selected for each diagnosis. This was done to take care of seasonality during the year.

Inclusion Criteria

All files of adult (above 18years of age) patients recorded with diagnoses of diabetes mellitus that were attended at the Emergency Department in the year 2019 (January to December) whose medical records were complete(with all records of a particular visit including time of arrival, all personnel names and credentials, time of departure, procedures done, medications issued, prescribed laboratory investigations results)recorded in the Wellsoft medical record system.

Exclusion Criteria

- Adult patients' files with incomplete information in the electronic files.
- Patients with co-morbidities

Data Collection Procedure

Cost data were collected from the emergency department annual reports generated from Wellsoft system made available as excel spreadsheets.

Costing Procedure

Wellsoft generated reports for the three diagnosed health problems and transferred to excel format for quantitative analysis.

The following costing principles were abided by:

1. The study was based on provider information, hence provider costs were extracted. These were data on that were incurred treating diabetes mellitus patients.
2. The unit of analysis is the health facility in this case Muhimbili National Hospital
3. The identified cost items involved included pharmaceuticals, diagnostic and procedures.
4. We measured cost items in its units (time-hours, personnel's wages, pharmaceutical quantities and diagnostics numbers)
5. We valued cost items in Tanzanian monetary value (shillings) as medium of exchange, which could be converted into USD using the 2019.
6. Uncertainty (sensitivity) analyses were done for each disease to determine some of the drivers of the unit cost (7)
7. Once cost centres were defined and their output determined, the input used to produce the output were defined, measured and valued. All input and their respective cost at a support centre were determined, and thereafter the annual cost of each type of input was calculated by multiplying the unit price by the number of inputs consumed in 2019. Finally, all calculated costs of input were summed to obtain the total cost of the input of the cost centres for 2019.
8. After cost of inputs for the year 2019 were estimated, they were divided by the number of output units provided by the cost centre to generate the cost per output unit cost for each cost centre.
9. We calculated the total cost for each direct care centre which included adding the total cost of the direct care centres with the relevant support centres and the relevant costs of the indirect care centres and the costs of their respective support services.
10. We calculated the unit costs for each care centre once the total cost of input during a given time period has been estimated, it were divided by the number of output units provided by the care centre to generate the cost per unit of output.
11. We calculated the total cost of providing services at a service site after the unit costs and overall costs have been calculated for each relevant care centre, these were added together to produce the total cost of providing the services at the relevant service site.(8)
12. We identified the cost drivers and conducted sensitivity analysis for each disease.

Data Collection Process

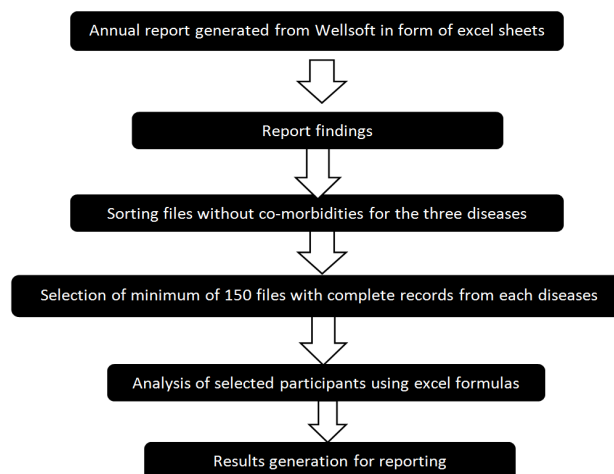


Figure 1. Data Collection Procedure

An excel sheet for data used for recording information extracted from patients electronic files. The columns constituted subtitles such as medications, laboratory investigations, and duration of treatment, personnel, total costs and unit costs. Rows was constitute diseases under study including Diabetes mellitus. Raw data tally sheets were used to count medications, lab investigations, time used by different cadres in the treatment provision, medical and surgical supplies used during patients treatment. Some of data sheets to be used for analysis of data collected includes individual diseases data sheets as elaborated below where the inserted tables' shows spaces for five patients, but the tools are well elaborated in the appendix where space for patients is shown in the data sheets. The buying prices of pharmaceuticals and supplies were adopted from Medical Stores Department (MSD) price list while personnels' salaries were extracted from Muhimbili national hospital salary scheme of service document. Personnel costs were calculated by determining the annual salary for each position for doctors, nurses, laboratory technicians and pharmacists. Thereafter the salaries portion were multiplied by the percentage of time dedicated to patients' treatment as determined by duration spent with the patient in the Wellsoft system (37).

Data Analysis

Microsoft excel software was used for the cost data. Summaries of cost items were done using an excel sheet consisting of columns with sub-titles including type of disease, total costs, total quantities, total costs divide by total quantities and unit cost. Rows were of a list of the diseases under study and beneath each disease specific costs items were listed such as unit cost lab, unit cost pharmacy, unit cost consultation and unit cost medical supplies. The direct costs of each diagnosis was then added to get the full cost. To calculate the unit cost the average cost method were used. For example, to find the unit cost per visit, the full cost of the emergency department were divided by the total number of each disease patient visits at the department during the whole year.(6) Salary scale reference sheet from public servants scheme of service were used to guide salaries of different health personnel working in the department (38).

Investigation Tools Validity and Reliability

The study tools to collect data have been used and verified in different published studies(39)(40)(41). Results of this study were reproduced using a similar methodology.

Ethical Issues

University research protocol were adhered to as advised including seeking ethical clearance from research governing boards in University and Muhimbili Hospital. Written permission for data collection were sought from hospital administration, specifically from directorate of research and publication as per stated procedures and shared with Emergency department head of department prior accessing the Wellsoft system for data retrieval. Confidentiality of patients' information were ensured at all time by adhering to department procedures for accessing the Wellsoft system which includes using assigned password to enter the system and not sharing the raw information to third party. The rest of the data was stored in a folder in a computer, which was by a password. Individual files used in the study were assigned a number that

was different from the medical records number. The medical record number was only known to Principal Investigator. The patients' files contained all retrospective data needed in this study

Study Limitations and Mitigation

The study was done on a conveniently sampled hospital, which happens to be the Referral Hospital, prices may be relatively higher compared to other hospitals in the country hence comparability to other hospitals in the country may not give a real picture of unit costs in other hospitals.

RESULTS

Introduction

The 2019 (January to December) data was collected from the Wellsoft system. This section therefore presents results of diabetes mellitus patients cost attended at the Emergency Department of Muhimbili National Hospital. The sample characteristics include demographic characteristics, illness status, length of stay, and cost of treating diabetes mellitus. Also costs drivers and sensitivity analysis are done.

Table 1. Financial Performance of Emergency Department

Head of account	FY2019/2020	FY2018/2019
Total Income (TZS)	6,529,757,035	7,952,328,721
Total Expenditure (TZS)	6,509,891,207	6,519,945,045
Surplus (TZS)	19,865,828	1,432,383,675

Table 2. Sample Size Determination

Diseases	Total	Selected	
		Number	Percentage
Diabetes Mellitus	830	150	18

Number and characteristics of the sample population

The Emergency department attended to 70,743 patients in 2019 calendar year about 22% of the total patient were diabetic patients. A total of 506 patients were selected for this study. Of the selected patients' files 18% of 830 diabetic patients' files. The selection was based on the data completion criteria. These files had complete data needed for cost analysis (Table 3).

Table 3. Patients of the diseases attended to in 2019

Disease	Total	Selected	
		Number	Percentage
Diabetes Mellitus	830	150	18

Table 4. Patients Demographic Characteristics

Age Groups	Diabetes Mellitus (N=150)	
	Number	%
18-25	4	3
26-35	9	6
36-45	22	15
46-55	36	24
56-65	35	23
66+	44	29
Total	150	100
Sex Males	80	53
Females	70	47
Total	150	100

Table 4. Shows 77% of diabetic patients and 80% of hypertensive patients were aged 46 years and above. About 53% and 49% of the patients were diabetes mellitus

The patients also were categorized as per severity of illness: those transferred to Intensive care unit (ICU) were categorized as severely sick, those admitted to general wards were categorized as moderately sick, while those discharged after being attended at emergency department as mildly sick. Results shows that; majority of patients with Diabetes Mellitus (58%) (Table 5). Severely sick patients are more likely to spend more time in the emergency department compared to the mildly sick ones. Furthermore, among selected patients, hypertensive patients spent more time seeking treatment (for up to twenty two hours) spent one and a half hours (Table 6).

Table 5. Patients Illness Severity Status

Diseases	Patients Illness Status						
	Severe	%	Moderate	%	Mild	%	Total
Diabetes Mellitus	14	9	49	33	87	58	150

Table 6. Average Length of Stay (ALoS) at Emergency Department Seeking Treatment (Duration)

ALoS	Diabetes Mellitus	
	Hours	Minutes
Maximum	19	21
Minimum	0	20
Mean	3	56

Total Cost of Treating Diabetes Mellitus

Medication, procedures including dressing diabetic wounds, investigations including point of care tests, supplies billed independently and medical personnel who attended to the 150 patients are summarized Table 7. The Table also shows that the total cost was TZS 31,266,091, where investigations were the largest cost; while supplies were the least cost. Inputs included medical personnel, medications, procedures conducted and supplies used. A total of TZS 42,288,797 was estimated as the total cost of treating 155 hypertensive patients where health personnel were the biggest cost, while supplies were the least cost as presented in Table 8.

Table 7. Estimated Cost of Treating Diabetic Mellitus Patients in TZS (BASE YEAR 2019)

SN	Description	Number	Unit price	Total cost
1	Personnels	607	9,666.68	5,867,677
	Medical Specialists	159	16,718.60	2,658,257
	Residents/Registrars'	158	8,881.45	1,403,269
	Nurses	290	6,406.66	1,857,932
2	Medications	443	4,951.45	2,193,492
3	Investigations	949	13,558.27	12,866,800
4	Procedures	189	53,010.58	10,019,000
5	Supplies	219	1,220.73	267,340
				31,266,091

Table 8. Unit Cost for Diabetes Mellitus

Unit cost for diabetes mellitus		
Total cost (a)	Sample (b)	Unit cost (a/b)
31,266,091	150	208,441

Personnel constituted the highest cost amounting to TZS 13,125,552 which were due to the length of stay patients spent in the department. The patients spent a longer average length of stay of up to more than twenty two hours in the department. The highest cost was estimated to be TZS 15,549,000. Medications prescribed to the patients had presented the lowest cost. Total cost however amounted to TZS 33,258,445.

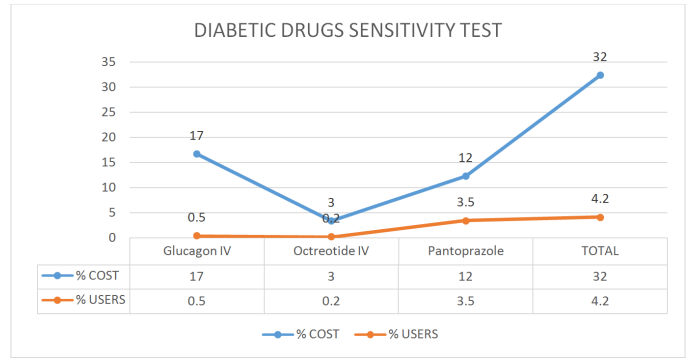


Figure 2. Sensitivity test on three diabetic drugs

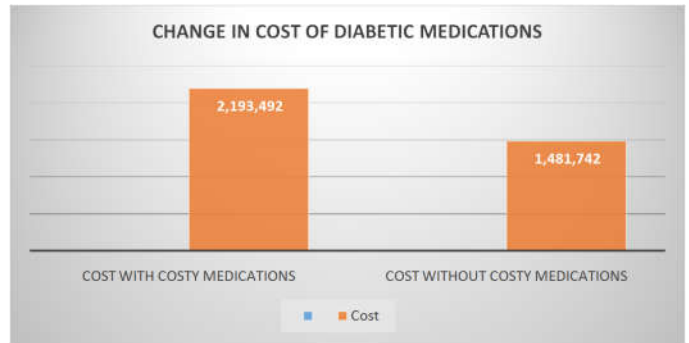


Figure 3. Change in cost of Diabetic Medications

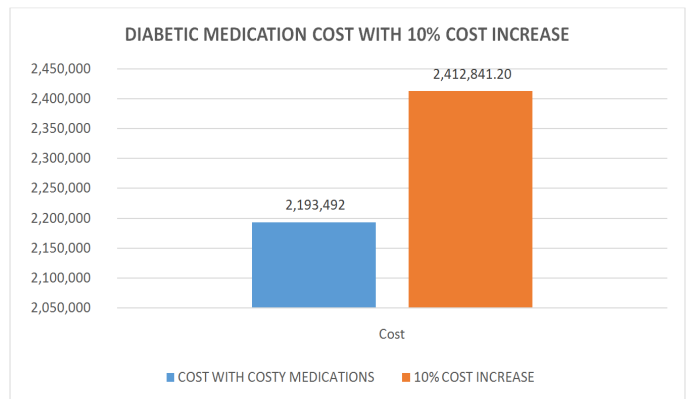


Figure 4. 10% increase in cost of diabetic medications

Unit Cost for Diabetes Mellitus

The cost of treating one diabetic patient per year at emergency department is estimated at TZS 208,441

Cost Driver: Sensitivity Analysis for Diabetes Mellitus

Intravenous medications used in the treatment of diabetes mellitus namely glucagon, octreotide and pantoprazole contributes 32% of the total medication costs for diabetes treatment in the emergency department however, three drugs were used by 4.2% of the all diabetic patients.

Pessimistic scenario: Total cost of diabetic medications amounted to TZS 2,193,492. If the most expensive drugs are excluded cost decreased to TZS 1,481,742 which is 32% reduction

Optimistic Scenario: Diabetic medications cost increase by 10% may result in TZS 219, 342/- additional total cost incurred by the department during care for the patients per year

seeking treatment due to various reasons such as system down time and long queues at payment outlets. This study demonstrates that with increased stay result is increased personnels cost of treatment bon by department. Since seeking development partners is one of the use of unit costs then presenting this data to stakeholders so as to seek their support and involvement in managing high costs of running the department will help ensuring sustainability of the department. To conclude, the department seem to be bearing high cost of service provision to customers at unawareness. Methods of cost containment exist but not implemented because budgeting and resources allocation activities are not preceded by unit cost analysis notwithstanding resources are very limited and the situation is not getting better. (42)

DISCUSSION

This study provides a provider perspective of the cost of managing diabetes. The public health implication of the study is to provide unit cost information for identifying areas for future intervention by policymakers using the unit cost approach during budgeting and resources allocation. Efforts were made in this study to include the relevant cost components related to managing diabetes mellitus which included medications, health personnel, investigations and procedures done to patients with Diabetes Mellitus. The study also assessed cost drivers for diabetes mellitus patients. The unit cost to treat Diabetes Mellitus patients in this study was found to be high. The per patient per year cost was estimated at to more than Tanzanian shillings two hundred thousand [1\$ =TZS2, 319 (2019)] The result corroborates other studies reported by Ernest Attuquaye Quayee et al, that analyzed the financial cost of diabetes mellitus in four cocoa clinics of Ghana found the mean annual financial cost of managing one diabetic case at the clinics was estimated to be US \$372.65 (45). Study done in Kenya by Robinson Oyando in 2019 reports that patient cost was US\$ 528.5. The cost driver for diabetes mellitus is cost of some intravenous medications that were used by small percentage of diabetic patients but constituted 32 % of the costly, hence purchasing alternative medications that are less costly will result in 32% cost saving

Limitations

Study was limited to data available in the Wellsoft system used by emergency department to document data regarding patients' treatment. Another limitation includes providers opinions shared during interviews. Due to non-perfect markets, costs are averaged (high or low) to ensure normalization. The quality of the electronic data may not be very accurate, however when entered in the system it is always verified. The study was done on a conveniently sampled hospital, which happens to be the Referral Hospital, prices may be relatively higher compared to other hospitals in the country hence comparability to other hospitals in the country may not give a real picture of unit costs in other hospitals.

Conclusion

The estimated annual unit costs of treating diabetes mellitus borne by emergency department is high across all diseases. The cost of treating one diabetic patient per year at emergency department at Muhimbili national referral hospital is high.

Recommendations

- Performing unit cost analysis and cost drivers prior budgeting will provide basis for pricing and resource allocation for the top ten conditions attended at the department
- The department should seek to implement interventions directed towards mitigating cost drivers so as to save operational costs
- The department may consider applying cost containment such as budget shifting, direct and indirect controls of supply, health technology assessment, pharmaceutical spending checks, emergency services policy review and conduct annual unit cost analysis prior budgeting and resource allocation for diabetic patients' treatment
- More research are advised including studies to explore patients perspectives regarding costs incurred as they seek treatments at the emergency department.

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