Continuous Trade-Offs: Developing a Mixed Costing Methodology for CVD Prevention Care in a Low Resource Setting

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ABSTRACT

There is a lack of disease-specific costing analysis in low- and middle-income countries, despite the need for such data for efficient allocation of scarce resources. The main challenges to costing include poor financial and clinical data systems and lack of time and resources to carry out comprehensive patient-level analysis. This study develops the optimal methodology for guideline-based cardiovascular disease prevention care in a primacy healthcare center in rural Nigeria. Clinical pathways were used to identify the cost items, which were then valued using a combination of bottom-up micro-costing with top-down and gross-costing approaches. The resulting mixed methodology showed that bottom-up micro-costing could be used for several cost items including personnel, consumables, and medical equipment based on available cost and patient utilization data. More feasible approaches were needed for drugs and non-medical equipment. The methodology was applied to hospital data to give an illustration of cost estimates derived from the methodology. The study concludes that a mixed methodology allows flexibility in data sources and gives patient-level cost estimates relevant for local decision-making. Using this approach can provide a valuable tool in assessing disease-specific costs for LMIC hospital settings where there are various levels of data accuracy.

INTRODUCTION

Cost analyses of hospital services can be used to identify how many resources are required to provide a specific service; identify cost drivers for budgeting and other purposes; and assess comparative efficiencies between services (Mills, 1990a; Barnum and Kutzin, 1993; Shepard, 2000; Conteh and Walker, 2004; Mogyorosy and Smith, 2005; Adam and Evans, 2006). In the cost assessment of individual healthcare services, costs are calculated by multiplying the quantities of relevant cost items by the unit costs of those cost items (Drummond and Schulper, 2005). To identify cost items, micro-costing or gross-costing approaches can be used. Under micro-costing all cost items are identified, while under gross-costing cost items are identified at an aggregated level (e.g. inpatient day). Secondly, cost items are valued either using bottom-up or top-down approaches. The decision between a bottom-up or top-down valuation of resources is determined by the relevant decision questions, perspective and data availability (Magyorosy and Smith, 2005). Bottom-up approaches value cost items based on individual patients' resource use directly leading to patient-specific cost estimates. Bottom-up approaches rely on comprehensive patient and personnel activity data to determine the costs of actual resource use of a representative sample of patients and are difficult to implement in a setting with poor financial and clinical data systems (Drummond and Schulper 2005; Mogyorosy and Smith, 2005; Tan et al., 2009a). Top-down approaches value cost items using comprehensive sources, such as large (national) datasets, leading to cost estimates for the average patient (Brouwer et al., 2001). This approach is often taken for budgetary or other management considerations for larger units within a hospital (Tan et al., 2009a). The combination of the bottom-up approach and micro-costing is considered to result in the most accurate cost estimates because all cost items are identified and valued at the most detailed level. However, it is time and resource consuming and is not economically sensible in many organizations, especially those in low resource settings.

Hospital costing in low- and middle-income country (LMIC) settings has been the subject of research for over two decades (Mills 1990a; Trisolini et al., 1992; Conteh and Walker, 2004). However, the focus of analysis has been mostly on (vertical) health programs, which do not have joint costs to share with other services or are provided at the community level with

minimal overhead costs to consider (Conteh and Walker, 2001). Of the studies that have analyzed costs at the hospital level, the focus has been on facility or department level costs using the hospital perspective (Trisolini et al., 1992; Lewis et al. 1996; Flessa and Dung, 2004; van der Plaetse et al., 2005; van Booth, 2008; Sarowar 2010). Given this focus, the most common methodology used is step-down allocation (Trisolini et al, 1992; Flessa and Dung, 2004; van der Plaetse et al. 2005; van Booth, 2008), which assesses aggregated "cost centers" (e.g. pediatrics department) and takes a top-down approach to valuing resource use. Other studies have used activity based costing (ABC; Walters et al., 2001), which can be bottom-up or top down. The main feature is the use personnel time as the principle means to assign costs, including overhead and other indirect costs (Walters et al., 2001). Thus, knowledge on disease-specific costs at the hospital level is lacking, along with any consensus on the optimal methodology to apply to such cost analyses. The main limitation in LMIC cited by studies includes poor financial and patient utilization data, which are vital requirements for costing studies, especially more detailed bottom-up and micro-costing studies (Trisolini et al, 1992; Lewis et al. 1996; Flessa and Dung, 2004; van der Plaetse 2005; van Booth, 2008; Sarowar, 2010).

Recognizing the differences in approaches and specific constraints of LMIC, the WHO developed a step-by-step manual for hospital managers to undertake cost analyses of hospital services in low resource settings (Shepard, 2000). The manual does not prescribe a specific methodology, acknowledging instead the variations in relevant decision questions, perspective and data availability. The manual also recognizes that different cost items may require different levels of analysis. Consistent with recommendations from the NHS Costing Manual guidelines and the US Veterans Affairs guidelines, the prescription of a mixed approach to account for missing data or when data collections requires various approaches may be the optimal approach (Mogyorosy and Smith, 2005; Shepard, 2000). A mixed approach is thus study specific; the application of different approaches depends most especially on the data availability of the particular study. Such a mixed approach needs further testing in LMIC.

The present study aims to develop and apply a mixed costing methodology to measure the costs of providing internationally recognized guideline-based cardiovascular disease (CVD)

prevention care in a primary healthcare center in rural Nigeria. CVD prevention focuses on treating the main modifiable risk factors, such as hypertension and diabetes mellitus (DM), of CVD and is a main tool for managing the encroaching epidemic. The World Health Organization (WHO) estimates that mortality due to CVD will double between now and 2030 in Sub-Saharan Africa (WHO, 2005a). CVD is a growing concern among LMIC due to the increasing share of disability-adjusted life-years (DALYs) and quality-adjusted life-years (QALYs) lost (WHO 2005a; Kone, 2010). Furthermore, treatment options in LMIC are limited due to financial constraints and lack of skills and assets. Despite these warnings and the growing prevalence of chronic diseases in the region, knowledge of non-communicable disease management is lacking in comparison to more traditional communicable-disease counterparts such as malaria and HIV/AIDS (Kone, 2010). Knowledge on costs of CVD prevention care is valuable for cost effectiveness analyses of CVD prevention care.

Following a description of Ogo Oluwa Hospital (OOH), the provider implementing the methodology, this article will describe the costing methodology developed for the setting. The principle results include itemized descriptions of each cost item and its measurement, followed by an application of the methodology using preliminary data from OOH to give illustrative cost estimates of CVD prevention care. The article concludes with a discussion on the possibilities and limitations of using a mixed methodology for disease-specific costing and gives further recommendations for hospital planners and managers undertaking similar studies in LMIC.

METHODS

Setting

OOH is a rural, private hospital serving a patient population of 9500 patients, almost all of whom are registered with the Hygeia Community Health Plan (HCHP), a subsidized private insurance scheme operated by a number of local and international agencies (Hendriks, 2010). The most prevalent medical problems found in the target communities, such as hypertension and DM, are covered through the HCHP insurance package. In addition to providing access to care for patients through the insurance package, the HCHP program performs upgrading of all clinics participating in the program, implements guidelines, assists the health care providers in

improving financial and administrative management in the clinic and monitors and evaluates these processes. Before the start of the HCHP program, health centers and hospitals lacked standardized CVD prevention treatment guidelines, leading to inconsistent treatments and consequently, potential financial and delivery inefficiencies (Hendriks, 2010). Under the prospective observational research project QUality Improvement Cardiovascular Care Kwara-I (QUICK-I), both the operational and financial feasibility of providing standard CVD preventive care according to international guidelines will be assessed in Kwara State, Nigeria (Hendriks, 2010).[1] In order to assess financial feasibility, the QUICK-I study first requires a methodology that can measure the range of costs incurred by the clinic and the insurance program of prevention treatment per patient per year (Hendriks, 2010). Typical of low resource settings, OOH has suboptimal cost-accounting systems and limited capacity to undertake a full cost analysis, requiring a mixed costing methodology to work within these constraints.

Developing the Costing Methodology

Clinical pathways for hypertension and DM under the standardized CVD prevention care guidelines adopted by the QUICK-I study were used to identify all relevant cost items (Figure 1).[2] According to the guidelines, each patient presents for an initial diagnostic visit for consultation, drug treatment, and screening for additional cardiovascular risk factors and target organ damage. There are 9 CVD-related tests performed once per year on each hypertensive or diabetic patient as part of CVD prevention care guidelines. Blood tests include: glucose, total cholesterol, triglycerides, potassium, HDL cholesterol, and creatine. Urine tests include: urine dipstick to screen for proteinuria and glucosuria and a urine test for microalbuminuria. The last diagnostic test is an electrocardiogram (ECG). During follow-up visits, patients receive counseling and drug treatment by doctors, and further testing as required. These cost items consist of direct (personnel, drugs, consumables and medical equipment) and indirect cost items (non-medical equipment, building and overheads). Inpatient care costs are excluded from the present illustrative analysis as CVD prevention care is normally provided on an outpatient basis.

[1] See Appendix 1 for QUICK-I project design.
[2] See Appendix 2 for full clinical pathways.
[3] See Appendix 2 for full literature sources for international guidelines for CVD care that were used to arrive at the clinical pathway. Sources include:

The various levels of data sources available through OOH and HCHP required using a mix of bottom-up micro-costing and other more feasible approaches to assess the cost items. Data sources for cost items varied between hospital specific and international cost data. Patient utilization data was available through the QUICK-I study and HCHP databases.

Indirect costs were calculated using a mark-up percentage method, which allocates costs to the direct costs by raising the direct costs by a mark-up percentage. The mark-up percentage was determined by dividing the total hospital direct costs with the total hospital indirect costs.

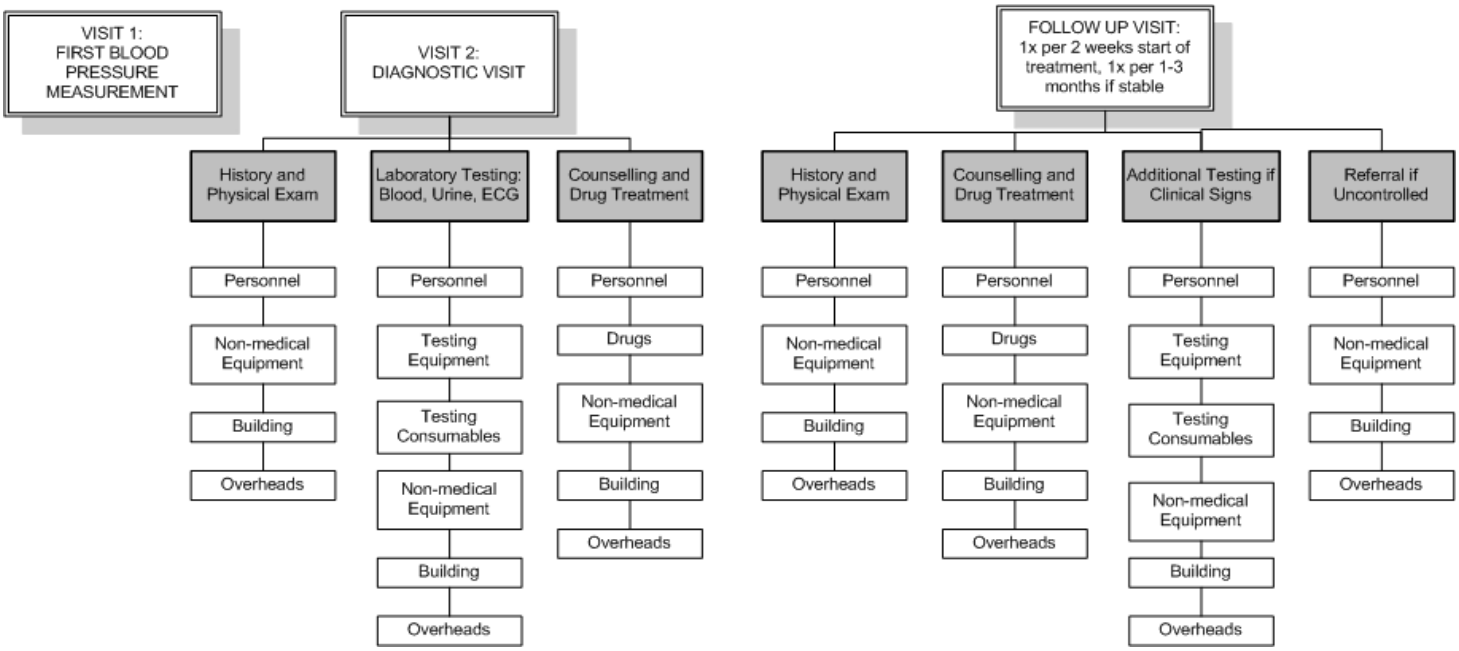

Figure 1. CVD prevention care clinical guidelines, based on international sources [3]

[3] The QUICK-1 study identifies several sources for international guidelines for CVD care that were used to arrive at the clinical pathway. Sources include:
[a]World Health Organization, 2007a. *Prevention of Cardiovascular Disease. Guidelines for assessment and management of cardiovascular risk.* [online] Geneva: WHO Press. Available at:
[b]World Health Organization, 2007b. *Prevention of cardiovascular disease: pocket guidelines for assessment and management of cardiovascular risk:(WHO/ISH cardiovascular risk prediction charts for the African Region).* [online] Geneva: WHO Press. Available at:
[C] National Institute of Health and Clinical Excellence, 2011. *NICE Pathways for Hypertension management and Preventiong type-2 diabetes.* [online] Available at:
http://pathways.nice.org.uk/pathways/hypertension; http://pathways.nice.org.uk/pathways/preventing-type-2-diabetes/preventing-type-2-diabetes-overview [Accessed 11 January 2011]

Applying the costing methodology

The OOH administration and QUICK-I researchers developed several templates to track hospital expenditures and activities to supply the relevant data for costing CVD care. Additionally, the QUICK-I study and HCHP databases, along with hospital inventories provided data on individual patients' utilization data regarding nature of visits, test performed, and prescribed drugs. Monthly hospital inventories provided aggregated costs of drugs and non-CVD related medical equipment, and itemized costs for medical equipment, consumables and indirect cost items. Hospital administration data also provided data for total hospital costs, which were needed to calculate the mark-up percentage. For resources for which data sources were unavailable, international sources were consulted or manufacturers directly contacted. This case study uses cost and utilization data from March and April 2011, with supplementing data from previous months to account for missing data in order to illustrate the application of the developed methodology. The data applied to the methodology comes from preliminary data under the QUICK-I study and thus the results presented do not represent the true costs of providing CVD care in OOH. All cost estimates are given in real-term 2011 US dollars, converted from Nigerian nairas using the average exchange rate for the 2-month period (Central Bank of Nigeria, 2011).[4]

RESULTS

Developing the Costing Methodology

1. Personnel

Data on personnel time for consultations and drug counseling was obtained from Doctor's Activity Log forms, which tracked all patient-related activities performed in a week. Doctors logged in the time spent per day with patients, indicating the various services provided (e.g. consultation, counseling, drug treatment, ward rounds), which were verified through interviews. The hospital reserves one day per week to CVD care. The average time per CVD

[4] Salaries, price lists for drugs, consumables, medical and non-medical equipment were quoted in 2011 Nigerian nairas. Several non-CVD related medical equipment items were quoted in 2010 nairas and were adjusted to 2011 nairas using the Nigerian inflation rate of 10.2%.
Source: Trading Economics, 2012. *Nigerian Inflation Rate.* [online] Available at: http://www.tradingeconomics.com/nigeria/inflation-cpi [Accessed 10 January 2012]

patient was calculated by dividing the hours by the number of patients for the specific CVD care day. The average number of minutes spent per patient was the reference measurement for personnel time for hypertension and DM care. Personnel time for laboratory technicians was assessed using the same method, with specific minutes spent per patient for blood, urine, and ECG testing.

2. Drugs

According to the current practice in OOH, CVD patients receive drug treatment and counseling each month for the 12 months of the study. The aggregated wholesale prices for CVD related drugs were divided by patient utilization data in order to calculate the average patient costs per year. The hospital pharmacy keeps an inventory of the number of prescriptions filled, which were used to verify the data from the utilization databases.

3. Medical Equipment

There are three high-value machines used for CVD-related diagnostic testing (i.e. Reflotron machine, ECG machine, microalbuminuria), which perform nine CVD related tests. The Reflotron machine performs six CVD related blood tests, the ECG and microalbuminuria machines each perform one test each, and the urine dipstick does not require a machine. While medical equipment is provided free of costs by the HCHP program to the hospital, the equipment depreciation and maintenance costs were included in the total cost CVD care, not just costs borne by the hospital alone since even donated items have opportunity costs.

Annuitized capital costs for these machines were calculated including depreciation and purchasing value. This was based on useful life years of equipment and Nigerian interest rates. Manufacturers were directly contacted to obtain the purchasing value for CVD-related medical equipment. Remaining information was found using several international data sources. The IMF interest rate of 14% for Nigeria was assumed due to the volatility of the local interest rates in Bacita. Utilization rates were obtained from the QUICK-I study and HCHP databases tracking guideline-based CVD care. The annuity rate of each machine was divided by the number of tests performed per year by that machine in order to obtain the unit cost of each CVD-related equipment.

In addition to CVD-related equipment costs, the major fixed assets in OOH include several high-value non-CVD related medical (e.g. ultrasound machine) and non-medical equipment. For non-CVD related care, hospital records only have a lump sum purchasing price so finding depreciation values for each piece of equipment was not possible. The IMF interest rate of 14% was also applied to the lump sum, and the annuity rate was divided by the total number of hospital days per year. The hospital does not have the utilization data for non-CVD patients to give a more accurate account of the unit costs of non-CVD related medical equipment. For non-medical equipment, purchasing prices and number of items were provided by hospital administration inventories. Data from WHO-CHOICE, a project focused on assessing the cost-effectiveness of several healthcare interventions, provided the durable life-years for non-medical equipment in Sub-Saharan Africa (WHO, 2005b).

4. Consumables

Laboratory and medical consumables used for conducting CVD related tests includes consumables for the Reflotron machine, for urine sampling, and for medical consumables for ECG machine. Unit costs per tests were calculated by dividing the monthly wholesale prices of each item with the number of tests performed per month, which were cross-checked with personnel activity logs and patient utilization databases.

5. Building

Depreciation was calculated using the same method for equipment depreciation with an assumed building lifetime of 20 years. Building costs were calculated by assuming annual building maintenance cost, which the hospital administration tracks on a monthly basis, equal 2% of the infrastructure value. The sum of the building and building maintenance costs comprised the total cost of the building.

6. Overheads

Overheads include: administrative personnel; general non-lab consumables (e.g. stationary) that are not itemized in hospital invoices; ICT, maintenance, security services; training; and entertainment and welfare activity services. Additionally, costs of medical equipment such as scales, centrifuges, stethoscopes and height meters cannot be allocated to

particular services alone so are instead designated as general overhead equipment shared by all services. Annual hospital administration data provided the information on these cost items.

Applying the costing methodology

This costing methodology was applied to preliminary OOH data to give approximated annual per patient costs of guideline-based CVD prevention care. For the two-month period, the total direct costs for the whole hospital were $67742 and indirect costs were $9049 (Table 1). Indirect costs thus constitute 13% of the total costs for the two-month period. This is the mark-up percentage by which guideline-based CVD prevention care must be increased.

Table 1. Total Hospital Costs (2011 USD)

Direct All-Hospital Costs		**67742**
Patient Care	65253	
CVD Medical Equipment	509	
Other Medical Equipment	1980	
Indirect All-Hopsital Costs		**9049**
Overheads	6374	
Building	2675	

Guideline-based CVD Patient Care Costs

The total cost of providing guideline-based CVD prevention care per patient per year is estimated to be $102 (Table 2). Drugs comprise the largest share of costs, followed by consumables, personnel and equipment. Each patient presenting for a diagnostic visit or a follow up receives drug treatment leading to the large share of overall costs. Equipment and consumables related to lab testing together comprise the next largest share of costs. Equipment costs vary widely with the Reflotron machine to perform the CVD related blood test having the largest purchasing price at $7828, followed by the ECG and microalbuminuria machines, which cost $4566 and $1135, respectively. However, the higher volume of tests performed by these machines leads to only a small share of overall costs. Finally, personnel

costs are divided between doctors performing consultations and laboratory personnel performing tests. Due the small number of laboratory personnel, salaries of all laboratory scientists, technicians, and assistants were aggregated.

Table 2. Total Per Patient Costs of Guideline-based CVD Care (USD)

1. Personnel	**12.09**
Doctors	10.87
Laboratory	1.22
2. Drugs	**47.42**
3. Consumables	**26.35**
4. Equipment	**4.11**
5. Building	**3.46**
6. Overheads	**8.19**
TOTAL	**102.41**

DISCUSSION

The present study aimed to develop and apply a mixed costing methodology to measure the costs of providing internationally recognized guideline-based CVD care in a low resource secondary hospital in Nigeria. In developing a costing methodology, ultimately the optimal approach is one that conforms to the relevant decision questions, perspective and data sources (Magyorosy and Smith, 2005; Shepard, 2000). The relevant decision questions were to inform decision making on financing and delivery inefficiencies, suitability of insurance reimbursements and the current and alternative benefits package. These decision questions led to a provider perspective where only the costs incurred by the hospital were considered for the study. Several levels of data sources were available through the hospital and the HCHP insurance program. Thus, the optimal approach was a study-specific mixed costing methodology that combined different approaches to identify and measure cost items relevant for CVD care.

Firstly, the mixed costing methodology used a clinical pathway identification of cost items. Given the provider objective to assess the costs of providing guideline-based care, using the clinical pathway indicated a clear outline of the hospital services (i.e. consultation, drug treatment, laboratory testing) where costs are incurred. This is a novel approach for disease-specific costing that allows comparison with cost estimates in other settings that may be following the same guidelines. The pathway approach also allows calculating costs for different scenarios. For instance, under the QUICK-I study, testing for patients is done frequently, up to the standards of high-income countries. However, WHO guidelines allows for less testing in lower resource settings, so costs can be recalculated by adjusting the frequency of tests (WHO, 2007b). Furthermore, clinical pathways provide a valuable comparator to actual practice in those settings where guidelines are not being followed.

After cost items were identified, there was continuous tradeoff between more accurate bottom-up micro-costing and more feasible approaches to measure these items. The choice of one approach over the other especially depended on the available data and data collection capabilities of the setting, which is the most important limiting factor in LMIC setting.

The bottom-up micro-costing approach was appropriate for personnel, consumables and equipment costs due to the availability of data sources such as personnel activity logs and interviews, itemized hospital inventories and the HCHP patient utilization databases. Micro-costing was feasible for these items due to small number of equipment and consumables used in CVD testing and the comprehensive data on patients' resource use, overcoming the main disadvantage of the method. Furthermore, micro-costing is recommended for those cost items that comprise a large share of total costs, for which lab testing (equipment and consumables) costs has the second highest share. Personnel time was determined using activity logs and followed up by interviews, which are practical techniques for LMIC (Conteh and Walker 2004). However, self-reported activity logs and interviews are second best to time and motion studies that can elicit personnel time with more accuracy, especially with regards to determining idle time personnel spend on activities other than direct patient care (Walters et al., 2001; Conteh and Walker 2004).

More feasible approaches were chosen for drug and non-CVD related medical equipment costs, which relied on aggregated hospital inventories. Hospital inventories did not keep itemized accounts of anti-hypertensive and anti-diabetes drugs and only had aggregated sums, which were then divided by patient utilization data from the HCHP databases. Gross-costing was done for non-CVD related medical equipment since patient utilization data was unavailable in addition to itemized costs in hospital inventories. The resulting average patient cost estimates may not represent actual resource consumption and is a compromise on accuracy. Since drugs comprise the largest share of total costs for CVD care, a bottom-up micro-costing methodology would be ideal in order to assign consumptions to individual patients and thereby get a more accurate cost estimate.

A mark-up percentage method was used to allocate indirect costs to direct costs due to the relative simplicity of the method. The mark-up percentage allocation method assumes a linear relationship between indirect and direct costs, making it a simple and feasible method for LMIC. However, this assumption often leads to an underestimation of indirect costs, as can be evidenced by the 13% share of total costs in the case study (Tan et al., 2009b). This may be especially true for a small, low resource hospital such as OOH in which overhead resources and personnel are stretched to cover all services, where there is no maintenance on equipment items, and building values are highly uncertain. Inaccurate estimates for these cost items depress the value of total indirect costs. Other methods for the allocation of indirect costs include: weighted service allocation, and allocation by hourly rate or inpatient day. Weighted service allocation calculates the relative cost of each patient by most accurately measuring actual resource use but is time-consuming (Tan et al., 2009b). It also produces similar cost estimates to hourly rate and inpatient day allocation, both of which were not appropriate for measuring indirect cost consumption for CVD care, which is done on an outpatient basis.

While the resulting cost estimates for CVD prevention care were illustrative and not meant to represent true cost estimates for OOH, they demonstrate that various approaches that conform to the setting could be combined to give the most comprehensive patient level cost estimate for local decision-making. In order to truly validate the mixed methodology, 1) the most up-to-date data from the QUICK-I study will have to be used and sensitivity analysis

done to test the results and 2) other methodologies be applied to the QUICK-I data to compare the resulting cost estimates and see how they differ. These were beyond the scope of this article and are areas for further research when more data is available.

The mixed costing methodology for CVD care presented here built on previous studies that have advocated a mixed methodology for hospital services. Sarowar et al. (2010) used a combination of micro-costing and more feasible approaches to assess pregnancy-related costs for a secondary hospital is Bangladesh. Similar to our study, bottom-up micro-costing was used to calculate direct cost items but then allocated these to the maternity and labor ward per patient bed-day. Similar challenges were also identified, such as accounting for donated items and aggregated drug costs. Other LMIC studies that have focused on hospital services have also had challenges with data accuracy and availability, but have adopted top-down and gross-costing approaches, such as step-down allocation (Trisolini et al, 1992; Lewis et al. 1996; Flessa and Dung, 2004; van der Plaetse et al., 2005; van Booth, 2008). The choice of these approaches depended also on the relevant decision questions, which focused on larger “cost centers”, rather than disease-specific services as done with the case study on CVD care. Thus, the current study differs principally in its objective to measure the costs of treating one set of diseases rather than costs incurred according to hospital department(s).

The illustrative case study for guideline-based CVD care in OOH highlights the possibilities of using a mixed costing methodology in a low resource setting. Low resource settings need not automatically apply standard top-down and gross-costing approaches exclusively due to (the assumed) lack of data sources and concern about feasibility. Instead, mixing bottom-up micro- costing and other approaches can give patient level cost estimates for any array of hospital services. Secondly, the flexibility of a mixed methodology allows using all available data sources at the local level and ensures that cost estimates are useful for local decision-making. This is vital if the aim of the study is to inform hospital planning and budgeting.

However, there are limitations to applying a mixed methodology. The case study demonstrates that that the setting must have a minimum standard of comprehensive patient

utilization data sources – as provided by the HCHP databases – in order to apply bottom-up approaches to valuing cost items. Secondly, the study-specific nature of a mixed methodology implies a compromise on generalizability to other settings because the focus is to achieve the most accurate cost estimates for the local decision-making.

The key lesson from this present study is that cost analysis for hospital services at the patient level are possible in low resource settings despite trade-offs between data accuracy and feasibility to carry out the study. Furthermore, the dual threat of managing emerging non-communicable diseases in LMIC on the one hand and efficiently allocating constrained resources on the other indicates that cost analyses for hospital services are also necessary. The study highlights several areas for further investigations and challenges researchers and planners to consider the specific nature of healthcare costing in LMIC.

Firstly, this study focused on costing hospital services for a chronic disease group that will pose an increasing threat to LMIC populations and healthcare systems. Since 2000, the WHO has indicated the necessity to close the knowledge gap on the cost-effectiveness of non-communicable disease prevention and treatments services in LMIC (WHO, 2005a). The present study contributes to closing this gap by developing a mixed costing methodology that can be applied in low resource settings as a first step to conduct cost-effectiveness analyses. Further research is needed using both the mixed costing and other methodologies for CVD and other chronic diseases posing a financial and medical burden to LMIC healthcare systems.

Secondly, this study uses the novel approach of a clinical pathway identification of cost items. Especially for chronic diseases, which are managed rather than cured, clinical pathways are useful to identify the actual cost items. This technique can be recommended for its applicability to any setting, chronic disease group and feasibility in LMIC.

Lastly, mixing bottom-up micro-costing with more feasible approaches helps to minimize concerns about data accuracy and feasibility. While local data can be inconsistent or inadequate, there are possibilities to create templates, conduct interviews, and tailor existing hospital data sources to conduct patient-level analysis. This is particularly true for those settings under community-based or other insurance schemes, which have been proliferating in LMIC. Often insurance schemes have their own sets of data on patient utilization that can be a

crucial asset to apply bottom-up and micro-costing methodologies. A mixed approach also enables choosing between which cost items can be assessed using bottom-up micro-costing and which would be sufficiently assessed by simpler methods. Consistent with previous studies (Tan et al. 2009a), this study recommends applying micro-costing to those cost items that comprise a large share of total costs.

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APPENDIX 1

I. Overview of Hygeia Community Health Plan and QUICK-1 Project Design

Out of pocket payments constitute the majority of financing in Sub-Saharan Africa and contributes to the further impoverishment of those requiring medical care (WHO, 2005). Low cost insurance schemes alleviate health-related financial risks of low- and middle-income families (Hendriks, 2010). The Health Insurance Fund (HIF) is an international not-for-profit organization committed to the delivery of affordable quality private health insurance and healthcare services for low-and middle-income families. The HIF program is building a healthcare financing and delivery system that is centered around private health insurance. The HIF programs started in early 2007 in Nigeria in Lagos and Kwara State under the name of Hygeia Community Health Plan (HCHP). The implementation of the HIF program in Nigeria is carried out by PharmAccess Foundation and the local Health Maintenance Organization Hygeia Nigeria Ltd. Hygeia has contracted both private and public clinics to provide the care for the enrollees. The HCHP program provides access to care for patients, performs upgrading of all clinics participating in the program, implements guidelines, assists the health care providers in improving financial and administrative management in the clinic and monitors and evaluates these processes (Hendriks, 2010).

The Amsterdam Institute of Global Health and Development (AIGHD) is contracted by HIF to perform an independent impact evaluation of the HIF program though operational research. The QUICK-1 study is part of the impact evaluation and is carried out by AIGHD in collaboration with the University of Ilorin Teaching Hospital, Ilorin, Nigeria. The study takes place in Ogo Oluwa Hospital, a health clinic under the HCHP program that provides care to 9500 HCHP enrollees. From this patient population, 349 patients at risk for CVD (e.g. patients with hypertension, diabetes, renal disease or established CVD) are followed over the course of one year to measure the feasibility of providing international guide-lined based CVD prevention care. Primary end points of the study include: 1) quality score of CVD care based on UK NHS Quality and Outcome Framework; 2) range of costs of CVD care per patient per year, divided per category (e.g. consultation, drug treatment); and 3) net healthcare costs of CVD prevention care per QALY gained in community health insurance context. The QUICK I study started in June 2010, the last patient is expected to complete follow up in February 2012.

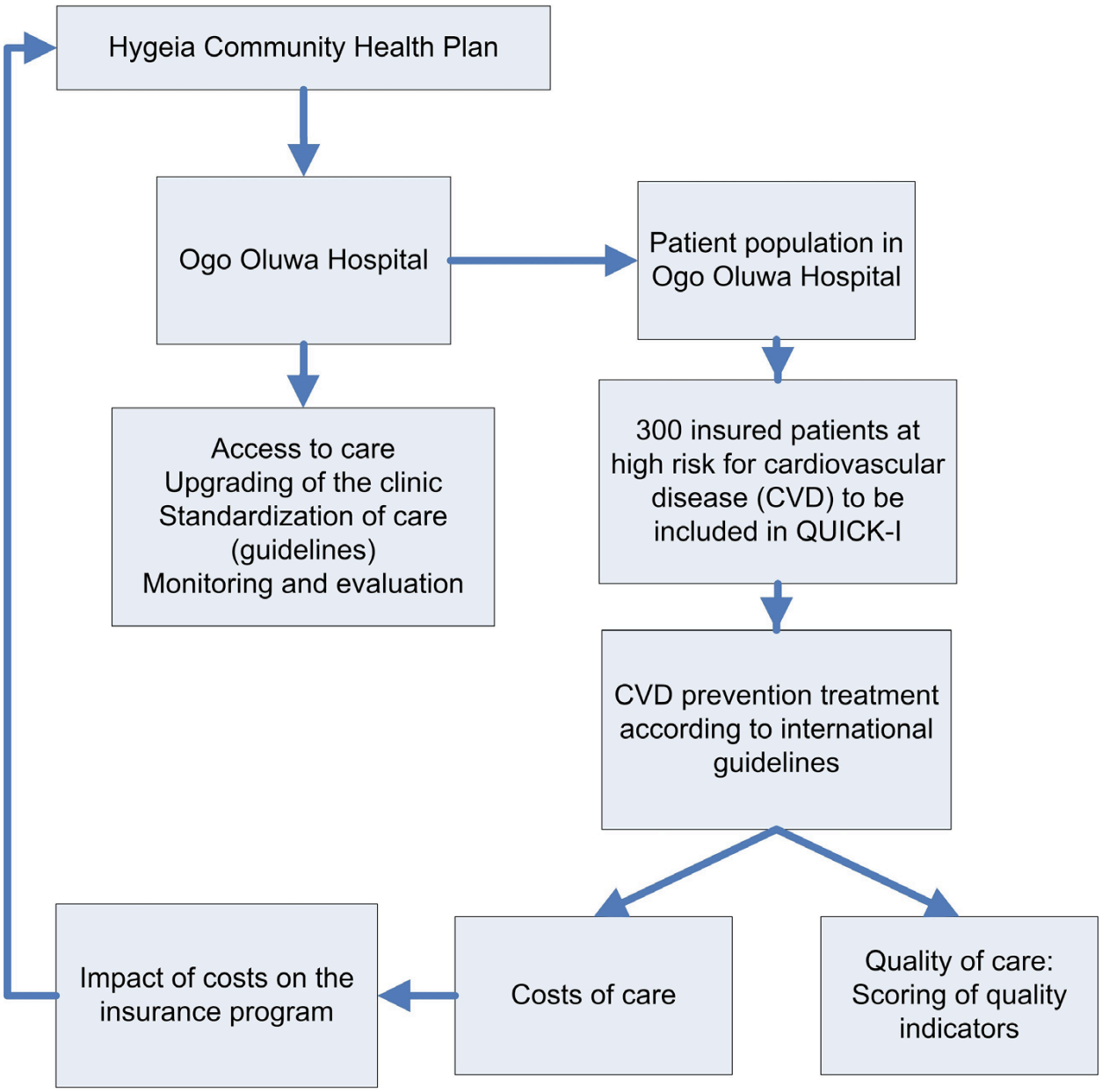

Figure 1. General Outline of Quality Improvement Cardiovascular Care (QUICK-1) within the Hygeia Community Health Plan . Source: Hendriks et al, 2010.

II. Cohort Inclusion Criteria

The following criteria were applied to obtain the cohort for the study. The total number of patients followed during the study period is 349.

Table 1 Inclusion and exclusion criteria for QUality Improvement Cardiovascular care Kwara-I

Inclusion criteria	1. ≥ 18 years of age
	2. Visiting the outpatient clinic/admitted to the clinic
	3. Enrolled in the Hygeia Community Health Plan
	4. At least one of the following:
	a. diagnosis of hypertension
	b. diagnosis of diabetes mellitus
	c. established cardiovascular disease (stroke, myocardial infarction, angina pectoris)
	d. diagnosis of renal disease
Exclusion criteria	1. Patients who are unwilling to provide consent for data collection
	2. All pregnant or lactating females
	3. All patients with suspected secondary hypertension
	4. Any person who is incapable of giving informed consent
	5. Patients who are not permanently residing in Kwara State*

*Patients who are not permanently residing in Kwara State are not eligible for the HCHP program.

Source: Hendriks et al, 2010

III. Study visits

Nurses will conduct study visits every 3 months with each patient, collecting the following information relevant for the primary endpoints of the QUICK-1 study in OOH.

Table 2 Data collection and investigations during each study visit

Month	0	3	6	9	12
Demographic data	X				
Socioeconomic data	X				
Co morbidities	X				
Cardiovascular risk factors	X		X		X
Transport costs	X	X	X	X	X
Drug use for cardiovascular disease (prevention) and side effects	X	X	X	X	X
Morisky adherence questionnaire [40]	X	X	X	X	X
Rose angina pectoris questionnaire [41,42]	X				
Quality of life using the 12-Item Short Form Health Survey (SF-12) [43]	X				X
Health care utilization and health care expenditures		X	X	X	X
Cardiovascular events		X	X	X	X
Physical Examination (height, weight, hip and waist circumference, blood pressure, heart rate)	X	X	X	X	X
Blood tests: (potassium, creatinine, lipid profile)	X				X
Blood tests: glucose	X	X*	X*	X*	X
Urine tests (microalbuminuria, proteinuria**)	X				X
Electrocardiogram	X				X

*Only for diabetic patients.

** Only if microalbuminuria test result is out of range at upper measuring range.

Source: Hendriks et al, 2010