Unit Costs of Health Care Inputs in Low and Middle Income Regions

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Abstract

The Disease Control Priorities Project (DCPP) is a three-year effort to help inform disease control priorities in developing countries at a regional level using economic evaluation of specified interventions, an assessment of the size of the disease burden and consideration of how best to scale up interventions within a health system context. As part of the project a set of standardized regional unit costs have been estimated for a range of health care resource inputs. This Working Paper presents these data on the unit costs of health care inputs for the six low and middle-income World Bank regions. The aim is to provide DCPP chapter authors with a set of unit costs and ratios of relative costs for different regions in order that the same estimates and ratios are used in the analysis of a 'DCPP base case'. The objectives of this Working Paper are to: introduce and justify the approach taken to unit pricing for regions; provide preliminary results; illustrate how such information might be used; and discuss the pros and cons of the approach we have taken. In addition the paper explores some of the methodological issues around estimating costs and highlights where further research is required.

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1 INTRODUCTION

The Disease Control Priorities Project (DCPP) is a three-year effort to help inform disease control priorities in developing countries at a regional level using economic evaluation of specified interventions, an assessment of the size of the disease burden and consideration of how best to scale up interventions within a health system context. Maintaining comparability of costs across diverse regions and studies will be a key part in facilitating comparison across chapters and across the diverse range of diseases and interventions.

As part of the project, a set of standardized regional unit costs have been estimated for a range of health care resource inputs. The aim is to provide DCPP chapter authors with a set of unit costs and ratios of relative costs for different regions in order that the same estimates are used in the analysis of a 'DCPP base case'. It is also the intention that providing these data will facilitate examination and re-estimation of costs within chapters and by readers of the book, *Disease Control Priorities in Developing Countries*.

The objectives of this Working Paper are to introduce and justify the approach taken to unit pricing for regions; provide preliminary results; illustrate how such information might be used; and discuss the pros and cons of the approach we have taken.

1.1 Context

Economic evaluation, and particularly cost-effectiveness analysis (CEA), has gained credence in recent years as a policy tool relevant for decision-making at all levels. At the national level, for example, the British National Institute of Clinical Excellence publishes guidance about appropriate clinical care that is based partly on cost-effectiveness (National Institute for Clinical Excellence, 2001). CEA has also been used as part of the process for decision-making at the district level. For example, Finlay *et al* (1995) described a four year project based in two districts in Tanzania that set out to "test the hypothesis that burden of disease and cost-effectiveness analysis should provide the basis for health services planning in low income countries" (Finlay *et al.*, 1995 p1083). At a broader international level, cost-effectiveness analysis became a more visible tool for policy making following publication of the 1993 World Development Report (World Bank, 1993) and its companion volume on Disease Control Priorities (Jamison *et al.*, 1993).

The increasing demand, coupled with limited research resources and paucity of current evidence, for undertaking the economic evaluation of health interventions is creating pressure to use data from one setting in another (Walker and Fox-Rushby, 2000a). This pressure is felt at international, national and sub-national levels. However this has led to two major concerns. First, how should costs, effects and cost-effectiveness ratios be most appropriately transferred across settings? and second, to what extent are existing ratios comparable given the diverse methods employed in evaluations to date?

The pressure to transfer data on cost-effectiveness from one setting to another is not new and currently happens in a variety of ways. For example, economic evaluations undertaken alongside randomized clinical trials are often based on costs measured at one site and extrapolated to all other sites in the trial, often with no consideration of the external validity of the trial or its impact on actual costs in practice (Glick *et al.*, 2001). Costs measured outside trials are often 'top-down costings', reducing the ability to assess variation. Results of economic evaluations are often not subject to sensitivity analysis or considered in the light of: budget or resource constraints; scale of production; or basic contextual data such as time period and nature of provider units. Results are rarely presented in a way that allows costs, quantities, utilization, or effects to be disaggregated (Walker and Fox-Rushby, 2000b)

In practice, the presentation of cost-effectiveness results and the transfer of cost-effectiveness ratios from one setting to another imply that cost-effectiveness ratios are not subject to uncertainty, that results do not vary according to known or unknown factors, and that decision-making is not affected by the constraints of different contexts. Direct transfer of costs and cost-effectiveness results assumes that costs are the same across settings and, without dis-aggregate presentation of the results, cost-effectiveness ratios cannot be re-constructed for adaptation to different settings; thus, generalisability remains untested and untestable.

There are increasing concerns about the ability of global or regional analyses of cost-effectiveness to account adequately for local circumstances (Kumaranayake and Walker, (in press); Fox-Rushby and Parker, 1995) and a number of publications have highlighted problems faced in transferring results between settings (Mason, 1997; Drummond *et al.*, 1992; Spath *et al.*, 1999; Bryan and Brown, 1998). However, policy makers are often hindered in their decision making both by the paucity of available data and because of uncertainty on how results can or should be transferred between settings[1].

The paucity of data and lack of knowledge about whether and why cost-effectiveness/benefit ratios vary is a cause for concern. As Box 1 outlines, there are a range of potential causes of variation in cost-effectiveness ratios for the same intervention. Even without accounting for the impact of different budgets, all could potentially affect decisions about which kinds of interventions to fund. The potential bias and inefficiencies involved in transferring data without resolving our understanding of the causes of variation could not only introduce inefficient interventions and halt the provision of efficient interventions, but also harm a nation's health and welfare. Alternatively, variation within and between settings may not exist or may make little difference. It is therefore vital to assess how serious a problem this is and whether it leads to any systematic misallocation of resources.

[1] We are not implying that good decisions are not made with available evidence, just that there is little to guide decision-makers' understanding of the size and likelihood of alternative outcomes of their decisions with respect to actual average and incremental costs (or costs at differing levels of production) or effects of alternative interventions.

BOX 1: Factors that could account for differences in cost-effectiveness ratios for the same intervention

- demography / epidemiology of disease
- availability of health care resources
- variations in clinical practice
- incentives to health care professionals and institutions
- absolute and relative costs
- exact specification of the intervention
- scale of the intervention
- combinations of the intervention with other services
- methodological differences, including:
    - definition of cost
    - methods of identification, measurement and valuation of costs and benefits
    - discount rate
    - data availability
    - identification of the margin
    - choice of the comparison

The second major area of concern in the field of economic evaluation concerns the quality and comparability of current evidence. Growing recognition of the need for improved quality and for some 'standardization' in methods has led to a plethora of published guidelines and movement towards some consensus of what should be incorporated within any evaluation (Hjelmgren *et al.*, 2001). Of particular note are the guidelines developed by an expert group, The US Panel on Cost-Effectiveness in Health and Medicine. They recommended a series of standardized methods and positions to adopt for a 'reference case analysis' for any published paper. The details and specific recommendations are set out by Gold *et al.* (1996).

1.2 DCPP standardized unit costs

The second edition of DCPP is intended to update the first edition and to go beyond it in a number of important ways. In particular, a key aim is to ensure greater uniformity in the approach towards the applied cost-effectiveness analyses. Cost-effectiveness analysis as undertaken for DCPP is intended to be consistent with the methods of Gold *et al.* (1996), modified to assess large changes from the status quo as described in Jamison (2002). As part of this endeavor, the Project is providing DCPP chapter authors with a set of standardized unit costs for the six low and middle income World Bank regions (East Asia & Pacific, Europe and Central Asia, Latin America & Caribbean, Middle East & North Africa, South Asia and Sub Saharan Africa), to enable comparison across chapters.

A range of international datasets on costs or prices of inputs to health services already exist (see for example Adam *et al.*, 2003; Johns *et al.*, 2003; Hutton, 2001; Kumaranayake *et al.,* 2001; Schwartländer *et al.*, 2001). Probably the most ambitious dataset and set of estimations is that assembled by the Global Program on Evidence for Health Policy of the WHO (Adam *et al.*, 2003; Johns *et al.,* 2003). This work, known as WHO-CHOICE, started in 1998 with the development of standard tools and methods and represents the first systematic attempt to estimate unit costs at both the patient and program level for health interventions in all countries and regions of the world. This makes it possible to generate unit costs that are not only consistent across interventions within one country, but also allows for comparison across countries with similar determinants such as background epidemiology and socioeconomic factors, as well as estimating the cost of scaling up interventions to different coverage levels by varying capacity utilization. One key finding from this work is that unit costs of many health inputs vary substantially both between and within countries. This implies that basing cost-effectiveness studies for a region or country on the results of a study of a single facility, or even a small group of facilities, is likely to be misleading (Adam *et al.*, 2003).

MEDTAP International, in conjunction with a group of pharmaceutical companies, also embarked on a project in 1998 to collate a comparable set of unit cost data for health care resources in eight European and North American health systems and six disease areas (Hutton, 2001)[2]. The aim of this data set is to produce unit cost data for use in economic evaluations,with the objective of obtaining consistency within each country's list of resource items, given that economic evaluations are conducted on a country-specific

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[2] The countries are Canada, France, Germany, Italy, Spain, Sweden, UK and US. Diseases are Cancer, Cardiovascular disease, AIDS/HIV, Mental Illness, Alzheimer's disease and Stroke.

basis. Thus the intention is to produce data which are justifiable and acceptable to the audiences for economic evaluation in each country. Given that all the estimates are drawn from a small set of highly developed countries, the data are probably of less relevance to low and middle income settings. However, the process of drawing together the data has highlighted the areas where further work is required. In particular the developers argue that there is a need for better data on costs of diagnostic tests and this finding resonates with other efforts to establish the costs of laboratory services in developing countries (Liverpool School of Tropical Medicine, 2002).

In addition to cross-country datasets, there also exist numerous national datasets of unit costs within high income countries. The most comprehensive cost data come from the United States where efficiency concerns within the publicly financed Medicare program for the elderly led to new methods for measuring costs on a diagnosis basis (Glick *et al.*, 2001). In the United States, sources of cost data include: hospital charges adjusted using cost to charge ratios; data from internal hospital costing systems; diagnosis related group payments for hospitalizations (Department of Health and Human Services, 1991a); and resource-based relative value units for physician services (Department of Health and Human Services, 1991b; Hsiao *et al.* 1992). Data readily available in Europe include: the UK national reference costs dataset produced by the UK Department of Health (Department of Health, 2002); a comprehensive dataset on health and social care costs in the UK by Netten and Curtis (2002); data produced by the Healthcare Financial Management Association (2001) on UK health service costs; official data produced for German hospitals which give the relative scale of the costs of procedures (BPflV, 1998); inpatient hospitalization costs in France (Hopitaux de Paris, 1996); and diagnostic related group tariffs from the Italian National Health Service (Ministerio della Sanita 1997).

Datasets of costs in developing countries are harder to find and there is a heavier reliance on specific costing studies for particular diseases or hospitals. Barnum and Kutzin (1993) categorize hospital studies as 'step down' or cost finding analyses, and accounting statistics studies. The first group examines ex-post hospital expenditures in terms of different areas of hospital production. The second group relies on generally available hospital information reported to central or regional government. The former group is the most useful for costing hospital services as data routinely produced by hospitals are often too general and non-specific (Lewis *et al.*, 1996). Cost finding studies include those by Mills *et al.* (1989), Raymond *et al.* (1986), Russell *et al.* (1988), Valli *et al.* (1991) and Hongoro and McPake (2003). In each case the authors adopt a step-down methodology which allocates direct and indirect expenditures across cost centers. While such studies are able to distinguish where resources are distributed, they give no account of how resources are actually applied in practice (Lewis, 1996). The expenditures on producing the service are clear, but the actual cost of producing that service is less so. There are studies which document the actual costs of providing health services in developing country settings (see for example Fox-Rushby and Foord, 1993; Villar *et al.*, 2002 and Aikins *et al.*, 1998). However these are not usually nationally representative, are often for a limited number of interventions, and employ different costing methodologies (Walker and Fox-Rushby, 2000a). Nevertheless, taken together, these studies represent the best data currently available for developing countries and, outside of disease specific costing studies, there have been very few attempts at improving this methodology in a systematic way.

1.3 Current approaches to estimating unit costs

Given the lack of data, a key question for DCPP is how to transfer existing unit price estimates to those countries where there are little or no data. The various methods employed in the literature can be broadly divided into *econometric* approaches where costs are estimated from regression models, and *standardization* approaches where estimates are taken from the literature for one or more countries and are extrapolated to the other countries using a variety of methods.

There is a long history of econometric estimation of hospital costs (see for example, Feldstein, 1967, Lave and Lave 1970, Grannemann *et al.*, 1986; Wagstaff and Barnum, 1992; Bitran-Dicowsky and Dunlop, 1993; Li and Rosenman, 2001). These multi-variate models attempt to explain how costs per unit of activity vary in relation to a variety of variables such as hospital size, service mix, input prices and average length of stay. However relatively few studies have attempted to explain differences in unit costs across different countries. The work by WHO-CHOICE represents the first systematic attempt to develop a model to estimate country-specific costs using macro-level indicators such as GDP per capita and other determinants such as capacity utilization and types of costs included (Adam *et al.*, 2003 and Johns *et al.*, 2003). Glick *et al.* (2003) also attempted to develop a method of estimating unit costs, for hospital diagnoses for four countries in Europe, and found that average length of stay in the US was a good predictor of unit costs.

A variety of methods for standardizing or transferring costs across different countries or regions are also encountered in the literature (see for example Schwartländer *et al.*, 2001, Kumaranayake *et al.* 2001, Schulman *et al.* 1998). However, detailed information on methods and assumptions behind transferring unit cost estimates to regions or countries is often not available. One of the exceptions is the work by Schulman *et al.* (1998). Here, the authors developed a standardized costing methodology in seven countries and applied it to the costing of treatments for subarachnoid haemorrhage. Where unit costs estimates were not available the analysts developed an index table based on a "market basket approach" reflecting the relative costs of a basket of resources for six services for which unit cost data were available for all countries. The Commission for Macroeconomics and Health (Kumaranayake *et al.* 2001) employed an apparently similar approach, but used a regional index based on purchasing power parities to transfer between the unit costs of priority health interventions.

2 DCPP METHODS

2.1 Frames of reference

The aim is to produce price data suitable for chapter authors to use in estimating the cost-effectiveness (or cost-benefit) of a wide range of health care interventions in six low and middle income World Bank regions. Annex 1 lists the countries included within each region. As chapter authors were guided to use an ingredients approach to calculating costs (Disease Control Priorities Project, 2003) the aim of this exercise was to provide a set of standardized unit costs, by region. Multiplying these costs by intervention specific quantities of resource inputs (defined by chapter authors) would then form the basis for estimating the change in total costs of moving from one (set of) health intervention(s) to another. Making costs explicit in this way fosters a clear separation of costs and quantities in economic evaluations. Both costs and quantities can be subject to sensitivity analysis within the economic analyses and the extent to which quantities respond to either differences in the relative price of inputs or different scales of production can be considered, to help promote understanding about variation in cost-effectiveness ratios. It also allows analysts and policy makers to validate the assumptions used and assess the extent to which the estimates can be applied to their settings.

The costs provided are intended to reflect delivery through a public health system and, as far as possible, the opportunity cost of health resources in each World Bank region. However, as the speed of the exercise also required that the data be collated from publicly accessible sources, the guiding principles were to use the best available data, to adjust as far as possible where deviations were obvious, and to retain transparency in all data manipulations.

2.2 Classification of health care inputs

We first identified those inputs important either in explaining the total cost or variations in cost. WHO CHOICE divides costs into "patient costs", those incurred at the point of delivery of health interventions, such as cost of a lab test, outpatient visit, surgical operation; and "program costs", which are costs incurred at a level other than the point of delivery of the intervention, and where overhead or general administrative activities such as planning, supervision, training, media and outreach are involved. Using these two broad categories, we provide information for patient costs on the unit cost per in-patient day, ambulatory visit at hospital outpatient departments or health centers, key diagnostic and surgical procedures; and for program costs on annual salary, transport operation, building and equipment costs. As can be noted from this classification, the ingredients approach is implemented differently for patient and program costs. We use unit cost per output, such as outpatient visit, for patient costs and per factor input such as personnel, supplies and capital for program costs.

Certain types of costs did not need to be provided. For example we did not provide information on drug prices as authors could readily access comprehensive price lists. The International Drug Price Indicator Guide published by Management Sciences for Health is recommended as the principal source of prices (see http://erc.msh.org).

2.3 Sources of data

Much of the unit price data and methods presented here is based on data collected and collated by the WHO-CHOICE project (see http://www.who.int/evidence/cea for more detail). As noted earlier, WHO-CHOICE attempted to assess the overall costs and effects of a wide variety of health interventions by region. This has involved the development of models to predict unit costs in different countries based on key macroeconomic indicators such as GDP per capita (Warner, 2002; Rodrik, 1999; Liu and Hsiao,1995; Newhouse, 1992 and Peden and Freeland, 1998). Because of concerns about the appropriateness of transferability of unit costs from single studies, or even groups of studies, we have used the results of the models developed by WHO-CHOICE to generate unit price data for individual countries. The results are aggregated to the World Bank regions using regional population weights. Full details of the model specification employed for the analyses are provided in Annex 2.

Where we did not employ WHO-CHOICE models to estimate costs in different regions, e.g. for laboratory and procedure costs, we relied on a review of published and unpublished studies to obtain unit price data for each region. Given the paucity of data for some categories, we had to use a number of sources with differing methods of data collection and interpretation, and undertook standardization where necessary. Table 1 summarises types and sources of cost data.

Table 1. Types of costs and sources

Type	Sources
Traded goods	
Equipment	WHO Product Information Sheets (2000) Durbin Price Catelogue 2003 Gerry Mission Supplies
Non-traded goods	
Salaries	WHO-CHOICE
Buildings	Gardiner & Theobald (2002) http://www.gardiner.com/Projects/Projects.htm. (Extracted 05/05/03) Davis Langdon & Seah International. Cost data - major cities in Asia. http://www.davislangdon-asia.com/dlasiacostdata.html . 2003. (Extracted 20/07/03). Levett & Bailey. China - construction costs data. http://www.lnb.com.hk/costs-data/china/cost-constructioncosts-data-yr2000-1.html. 2000. (Extracted 20/07/03) Davis Langdon & Seah International. Cost data. http://www.davislangdon.com/dlafrica/html/dlflcostdata2.html . 200. (Extracted 20/07/03).
Mixed goods and services	
Hospital inpatient day	WHO-CHOICE
Hospital outpatient visit	WHO-CHOICE
Health center visit	WHO-CHOICE
Laboratory and hospital procedures	Essential Laboratory Services Project (2001) Goodman *et al.* (2000) Schwartländer *et al.* (2001) Barnum (1983) Floyd *et al.* (1997) Marseille (1999) Shepard (1993)
Fuel costs	World Bank (2003) Metschies (1999)
Vehicle operating costs	World Bank (2003) Metschies (1999) South African Automobile Association (2003)

2.4 Unit of account

International comparisons of costs and effects require that unit costs reflect the economic cost of goods and allow for inter-country comparison of interventions during the same time period (Hutton and Baltussen, 2002). For this reason, the world price level was chosen as the price level and all results are presented in 2001 US Dollars.

To transfer costs across time, we used World Bank gross domestic product implicit price deflators (World Bank 2003). This measures the change in the price level of GDP relative to real output and has an advantage over consumer price indices as it is not based on a fixed basket of goods and services. Changes in consumption patterns or the introduction of new goods and services (for example the rate at which a country is investing in technology, which is relevant for the health sector) are therefore better reflected.

2.5 Dealing with traded and non-traded goods

As shown in Table 1 health inputs can be distinguished by whether they are traded or non-traded. Traded goods are commodities that are available on the international market, and in theory, all countries can purchase them at an international market price. The international price can therefore be considered to reflect the opportunity cost of purchasing traded goods to a country, adjusted to include insurance and freight (c.i.f) for imported goods. In each case we attempted to find the lowest price available, with optimum quality, to represent the socially efficient price. We excluded import duties and subsidies from the price since these are transfer payments from one part of the economy to another and does not involve the use of resources. Prices were derived from WHO publications and non-governmental organisations operating at an international level and excluded costs of shipment and taxes. We asked authors to assume a baseline 15% mark-up for shipping and handling charges and an additional 10% to account for distribution costs (Sawert, 1996). However, given that distribution costs vary widely and are dependent on a complex combination of geography, infrastructure, administrative barriers and the structure of the shipping industry (Limao and Veneables, 2001), we also asked authors to explore this variation in their sensitivity analyses.

In contrast to traded goods, the price of non traded and mixed goods like labor are likely to vary across regions. Therefore it is necessary to estimate costs on a regional basis. In many instances the distinction between traded and non traded is not so straightforward and most inputs are made up of a traded and non-traded component. Fuel is one example where there exists an international price, but in practice there are regional costs of distribution which influence the untaxed retail pump price. The costs of medical procedures such as laboratory tests also comprise traded (equipment, drugs and supplies) and non-traded (labor, buildings) components. For these kinds of mixed inputs we have also estimated regional costs.

2.6 Standardizing costs across regions

For the costs of inputs with a non-tradable component which were not derived from WHO-CHOICE data, it was necessary to transfer and standardize unit price estimates across regions. Our aim was to convert costs obtained in one region into the likely costs in other regions. We assumed that the country specific estimate or average of estimates *de facto* represented the region in which the country resided. To assign costs for regions where data were missing, we adopted a similar methodology to Schulman *et al.* (1998) and developed an index table that reflected the relative costs of hospital services for pairs of regions in the study. These indices were derived from population weighted regional averages of hospital inpatient unit price estimates (see section 2.7 below). For example, in Sub-Saharan Africa the estimated cost of a hospital inpatient day in a primary level facility was $6.17. In Latin America and the Caribbean, the cost was $26.57. To create the SSA-LAC index, we divided the SSA cost per bed day by the LAC cost per bed day giving an index value of 0.32. This pair-wise comparison was performed 36 times to develop a complete set of pair-wise comparisons for all six regions (see Table 2).

Where only one data point existed, the point estimate was divided into traded and non-traded components and the appropriate regional price index (see Table 2) was applied to the non-traded components to arrive at relative costs for the other regions. Where data existed for more than one data point in a region, the average was calculated to arrive at the point estimate and the highest and lowest estimates used to provide the range. Where data existed for data points in more than one region, the most 'appropriate' regional estimate (or average of estimates) was used before applying regional weights to the non-traded component. For example if estimates for Sub-Saharan Africa and South Asia existed, the estimate(s) for South Asia was considered as appropriate to use for East Asia and Pacific.

Country specific data were converted to US 2001 dollars and the appropriate regional index was applied to the non-traded components of costs to reflect relative differences in input prices. Where price data were transferred across countries and time, we made the time adjustment first followed by the currency conversion.

Table 2. Relative hospital cost indices for World Bank regions

WB region	EAP	ECA	LAC	MNA	SA	SSA
EAP	1.00	0.67	0.65	0.86	1.55	2.03
ECA	1.50	1.00	0.97	1.29	2.32	3.03
LAC	1.54	1.03	1.00	1.32	2.39	3.12
MNA	1.16	0.78	0.76	1.00	1.81	2.36
SA	0.64	0.43	0.42	0.55	1.00	1.31
SSA	0.49	0.33	0.32	0.42	0.77	1.00

Cost indices derived from a weighted average of hospital inpatient costs. These costs were estimated using a regression model for public hospitals with 80% occupancy rate. Estimate includes hotel costs of hospital stay (capital, salaries, building, equipment and food) (see Adam et al. 2003).

2.7 Approaches and assumptions behind pricing of each health care input or service

This section describes the specific methods used to estimate each type of unit price for each health care input or service.

Hospital costs per bed day and outpatient visits

Unit cost per bed day was estimated using an Ordinary Least Squares regression model developed by WHO-CHOICE and published by Adam *et al.* (2003) (See Annex 2.1).

The WHO dataset used to develop this model included estimates from the published literature and specially commissioned country studies. Unit cost data were drawn from 49 countries, with a total of 2173 country-years of observations from the period 1973-2000, 96% of which were after 1990. The model predicts unit costs with different specifications by setting the values of the explanatory variables as required. It also allows for differences in the level of capacity utilization, which is an important source of variation in unit costs. It controls for cross-country price level differences using unit costs adjusted for purchasing power parity, and for differences in quantity and complexity of resource use using per capita GDP. For chapter authors, we predicted unit costs with the "hotel" component only, i.e., including overhead, salaries, food and capital and excluding ancillary and drug costs. They are estimated by country and hospital level (see definition of level in Box 2) for public hospitals working at 80% capacity. Country level GDP per capita were collected and results estimated for all countries of the World Bank regions. Results were averaged using country population weights (see Box 3 for a worked example). High and low estimates are also provided, reflecting the upper and lower ranges obtained for each region.

Box 2. Hospital level definitions adopted by WHO-CHOICE

Primary-level hospital: Has few specialities, mainly internal medicine, obstetrics-gynecology, paediatrics, general surgery or just general practitioners; limited laboratory services are available for general but not for specialized pathological analysis; bed size ranging from 30-200 beds; often referred to as district hospitals or first level referral.

Secondary-level hospital: Highly differentiated by function with five to ten clinical specialities; bed size ranging from 200-800 beds; often referred to as provincial hospital.

Tertiary-level hospital: Highly specialized staff and technical equipment, e.g.cardiology, ICU and specialized imaging units; clinical services are highly differentiated by function; might have teaching activities; bed size ranging from 300-1,500 beds; often referred to as central, regional or tertiary level hospital.

Hospital costs per outpatient visit are also based on a WHO-CHOICE model (see Annex 2.2), using the same dataset. In this case the model predicts the ratio of the cost per outpatient visit to the cost per hospital bed day. The results of the model together with estimates of cost per bed-day from the model presented above are used to calculate the cost per outpatient visit by level of hospital, ownership and country .

.Health center visits

The third source of information using the WHO-CHOICE datasets is cost per visit at health centers. Several steps and models are involved. First, a model was developed to estimate the unit cost per health center visit at different levels of capacity utilization, defined as the average number of visits per health worker per day. The results show that as capacity increases the unit cost per visit decreases reflecting the presence of economies of scale. Again this model employed a mix of data from commissioned costing studies and the literature with a total of 481 observations from the period 1980-2001. Second, region-specific data on the maximum number of visits per health worker per day, when health workers are working at 80% capacity and optimum quality; the average visits per person per year; and the yearly number of working days in health centers were used to construct the catchment areas around a primary health facility. These data were then entered in a Geographical Information Systems (GIS) model to determine the capacity utilization of each health center in the region. This was done by assuming that health centers are placed not more than 1 hour travel distance from the catchment population. The model assumes that as coverage expands, and health facilities are placed in more remote areas, capacity utlization declines since the 1-hour-travel-distance assumption in more remote areas will lead to a reduced catchment population. Therefore facilities in remote areas are expected to operate at less than full capacity, which leads to higher unit costs. Using this information and the parameters estimated from the first model, unit cost per visit was calculated at different coverage levels, namely 50%, 80% and 90%. The estimated unit cost includes capital costs but excludes the costs of laboratory procedures and other ancillary services. Country-specific macro-economic data were used to generate country level results, which were averaged to give regional estimates using country population weights. High and low estimates are provided, reflecting the upper and lower country level results obtained for each region. Details of the parameters estimated from the unit cost model can be found in Annex 2.3 (see Adam *et al.*, forthcoming).

Labor

The estimation of labor costs in each region originate from a WHO-CHOICE regression model. Regional expert teams provided the data on local costs for different categories of labor for reference countries in their regions. WHO-CHOICE also obtained supplementary information from other sources on country-specific costs of labor, most notably the International Labor Organization database on occupational salaries. The model predicts regional salaries for five grades of staff using a dataset of 752 observations for 72 countries (see Box 3 for definitions of staff level). The unit price refers to the gross wage received by the employee and includes paid vacation and regularly paid guarantees or allowances (such as social security). It does not, however include costs such as overtime, bonuses, etc. The model controls for cross country price level differences using per capita GDP, population density and WHO region. The final model predicted salaries in US dollars for the 14 WHO regions. The results were then mapped to the six World Bank regions using country population weights. High and low estimates are provided reflecting the upper and lower results obtained. Full details of the model specification and coefficients employed are provided in Annex 2.4 (see Johns *et al.*, forthcoming)

Box 3 WHO-CHOICE definitions of staff levels

The job categories were divided into five educational levels, corresponding to UNESCO's educational classifications.

Level 1: requires lower secondary education or second stage of basic education (e.g. Cleaner, Porter, Transport Driver)

Level 2: requires (upper) secondary education (e.g. Health worker, Data Entry Clerk, receptionist)

Level 3: requires post-secondary non-tertiary education, or first stage of tertiary education (e.g. Registered Nurse, Health Educator Trainer)

Level 4: requires second stage of tertiary education (leading to an advanced research qualification) (e.g. Medical Officer, Public Health Specialist, Nursing Manager)

Level 5: same as level 4 but requires additional substantial work experience or specialist training (e.g. Medical Specialist, Program Director)

(UNESCO, 1999)

Laboratory and hospital procedures

Many disease treatments require a selection of common laboratory, diagnostic and surgical procedures. We undertook a review to obtain cost data for ten laboratory and diagnostic procedures for each of the regional groupings. These procedures were: malaria microscopy, malaria dipstick test, blood transfusion, TB microscopy test, stool microscopy test, blood test, HIV voluntary counselling and testing, operating theatre time, X-ray test, generic laboratory cost per patient. The choice of procedures was largely pragmatic and chosen on the basis that they were important to many of the diseases covered by DCPP and data were easily available. Sources of data included a mix of published and unpublished data (Goodman *et al.*, 2000; Floyd *et al.*, 1997; Liverpool School of Tropical Medicine, 2002, Schwartländer, 2001; Barnum, 1983; Shepard, 1993, Hongoro, personal communication 2003).

Where more than one observation was found, the mean of the estimates available for the appropriate region was used as the best estimate and a high-low range provided. However in several instances only a single estimate could be obtained and in these instances simply a point estimate is provided. Where an estimate could not be found for a particular region, costs were standardized as outlined in section 2.7. Items were broken down by their estimated tradable and non-tradable components and regional price adjustments were undertaken for the non-tradable component using regional cost indices. A worked example is provided in Box 4. To transfer costs across time we used World Bank GDP price deflators.

Box 4 Standardizing costs across regions for hospital and laboratory procedures

In estimating relative costs for different regions, a number of approaches were adopted depending on the nature of the original price data.

Where only one data point existed

In this situation, we divided the point estimate into traded and non-traded components and applied regional hospital price indices shown in Table 2 to the non-traded components to arrive at relative costs for the other regions.

Worked example: A stool microscopy test

Estimate from Malawi, SSA = $0.67

Step 1 Split estimate into tradable/non-tradable components

Tradable	$0.58 (87%)
Non-tradable	$0.09 (13%)

Step 2 Multiply non-tradable component by SSA regional weight from Table 9
i.e. $0.09 * 2.03 for EAP
$0.09 * 3.03 for ECA and so on:

Step 3 Add tradable and non-tradable components together to arrive at regional estimate

	World Bank region					
	EAP	**ECA**	**LAC**	**MNA**	**SA**	**SSA**
Tradable	$0.58	$0.58	$0.58	$0.58	$0.58	$0.58
Non-tradable	$0.18	$0.27	$0.28	$0.21	$0.12	$0.09
Total	$0.76	$0.85	$0.86	$0.79	$0.70	$0.67

This approach can be used by authors for their own costs. If the breakdown between traded and non-traded components is unknown, analysts can apply the appropriate regional weight to the entire estimate.

Where data existed for more than one data point in a region

For all available estimates regional costs were calculated as above. The average taken as the point estimate and the highest and lowest estimates were used to provide the range.

Where data existed for data points in more than one region

For the remaining regions the most appropriate available regional estimate was used before applying regional weights to the non-traded component. For example if estimates from Sub Saharan Africa and South Asia existed, the estimate from South Asia was used for East Asia and Pacific.

Transport

Although fuel is an internationally traded good, to reflect regional differences in the price of distribution we estimated the regional price of the most widely sold grade using data collected by GTZ (see Metschies, 1999) and reproduced by the World Bank (2003). However these sources give the pump price of fuel including all taxes and subsidies. To estimate the regional untaxed pump price we adopted the methodology suggested by WHO-CHOICE. We divided all countries into four regions based on GTZ's classification (subsidized prices, low tax, middle tax and high tax). We then subtracted the minimum tax rate for these classifications (since an average tax rate results in some negative numbers). For countries subsidising gasoline prices we inputted the international untaxed pump price. Although this method does not completely eliminate taxes it brings the pump price closer to the untaxed price.

Equipment

International prices for capital equipment and medical supplies were derived from price indices in WHO publications and catalogues of prices from non-governmental organisations. In general the lowest international listed price with optimum quality was selected which assumes that health facilities are able to purchase items in bulk (Johns *et al.*, 2003).

Buildings

Although in the short term there are not many alternative uses of health care facilities and thus the opportunity cost of these building is close to zero, in the longer term there are options such as use in other public activities. Therefore, it is important to provide regional estimates of building costs for some interventions. Several international construction cost surveys were reviewed and the replacement cost per square metre (i.e.

the cost of constructing a similar building today) was calculated for an office and a basic building in an urban location. The equivalent annual cost was estimated by annualising the total cost over an expected life of 20 years and at a discount rate of 3%.

3 RESULTS

Tables 3-12 provide a breakdown of unit costs by health care resource category for each World Bank region in US dollars. In general, costs tend to be higher in Europe and Central Asia, and Latin America and the Caribbean, for all health care inputs. For example the price of a hospital bed-day in a primary level health facility ranges between a low of $6.17 in Sub- Saharan Africa and a high of $26.57 in Latin America and the Caribbean. An annual salary for a Level 1 job (e.g. health auxiliary) ranges between $1,287 in South Asia to $5,576 in the Middle East and North Africa. There is considerable variation in those laboratory and diagnostic procedures which have a high non-tradable component. For example, the estimated cost of voluntary counselling and testing per patient ranges from $9.33 in sub-Saharan Africa to $25.16 in Latin America and the Caribbean. Similarly, a minute of operating theatre time ranges from $1.68 in Sub Saharan Africa to $4.66 in the Americas. There is less variation across regions in procedures with a low non-tradable component such as malaria microscopy tests ($0.50–$0.80) and stool microscopy test ($0.67 – $0.86).

Table 3. Cost per inpatient hospital bed day (USD, 2001)

World Bank region	Hospital level	Best	Low	High
East Asia and Pacific	Primary	$8.47	$3.06	$48.75
	Secondary	$11.04	$4.00	$63.59
	Tertiary	$15.09	$5.46	$86.86
Europe and Central Asia	Primary	$15.08	$2.78	$34.27
	Secondary	$19.67	$3.63	$44.70
	Tertiary	$26.87	$4.96	$61.06
Latin America and Caribbean	Primary	$26.57	$6.43	$48.61
	Secondary	$34.66	$8.39	$63.42
	Tertiary	$47.35	$11.46	$86.62
Middle East and North Africa	Primary	$20.71	$2.78	$59.38
	Secondary	$27.02	$3.63	$77.47
	Tertiary	$36.91	$4.96	$105.81
South Asia	Primary	$6.51	$2.64	$14.52
	Secondary	$8.50	$3.45	$18.94
	Tertiary	$11.61	$2.64	$25.87
Sub-Saharan Africa	Primary	$6.17	$1.92	$41.79
	Secondary	$8.05	$2.51	$54.52
	Tertiary	$10.99	$3.42	$74.47

Table 4. Cost per outpatient hospital visit (USD, 2001)

World Bank region	Hospital level	Best	Low	High
East Asia and Pacific	Primary	$2.20	$0.80	$12.67
	Secondary	$3.09	$1.12	$17.81
	Tertiary	$4.68	$1.69	$26.93
Europe and Central Asia	Primary	$4.42	$0.82	$10.05
	Secondary	$6.30	$1.16	$14.31
	Tertiary	$9.32	$1.72	$21.17
Latin America and Caribbean	Primary	$7.44	$1.80	$13.61
	Secondary	$10.40	$2.52	$19.02
	Tertiary	$15.39	$3.73	$28.15
Middle East and North Africa	Primary	$5.54	$0.74	$15.88
	Secondary	$7.77	$1.04	$22.27
	Tertiary	$11.53	$1.55	$33.07
South Asia	Primary	$1.67	$0.68	$3.73

World Bank region	Hospital level	Best	Low	High
	Secondary	$2.35	$0.95	$5.24
	Tertiary	$3.52	$0.80	$7.85
Sub-Saharan Africa	Primary	$1.48	$0.46	$10.03
	Secondary	$2.13	$0.66	$14.45
	Tertiary	$3.13	$0.98	$21.22

Table 5. Cost per health center visit (USD, 2001)

World Bank region	Population coverage level	Best	Low	High
East Asia and Pacific	90%	$1.30	$0.76	$4.10
	80%	$1.01	$0.59	$3.18
	50%	$0.94	$0.55	$2.97
Europe and Central Asia	90%	$1.91	$0.56	$4.10
	80%	$1.48	$0.43	$3.17
	50%	$1.39	$0.40	$2.97
Latin America and Caribbean	90%	$3.35	$1.78	$6.57
	80%	$2.59	$1.38	$5.09
	50%	$2.43	$1.29	$4.76
Middle East and North Africa	90%	$3.10	$0.95	$10.63
	80%	$2.40	$0.74	$8.23
	50%	$2.24	$0.69	$7.70
South Asia	90%	$1.43	$0.74	$2.34
	80%	$1.19	$0.58	$1.81
	50%	$1.03	$0.54	$1.69
Sub-Saharan Africa	90%	$1.42	$0.66	$4.39
	80%	$1.10	$0.51	$3.40
	50%	$1.03	$0.47	$3.18

Table 6. Annual Salaries (USD, 2001)

World Bank region	Level	Best	Low	High
East Asia and Pacific	Level 1 Jobs	$1,443	$943	$2,062
	Level 2 Jobs	$1,850	$1,245	$2,586
	Level 3 Jobs	$2,668	$1,782	$3,787
	Level 4 Jobs	$4,491	$2,986	$6,369
	Level 5 Jobs	$7,093	$4,398	$10,385

World Bank region	Level	Best	Low	High
Europe and Central Asia	Level 1 Jobs	$1,746	$1,224	$2,292
	Level 2 Jobs	$2,237	$1,616	$2,901
	Level 3 Jobs	$3,226	$2,301	$4,167
	Level 4 Jobs	$5,432	$3,904	$7,091
	Level 5 Jobs	$8,579	$5,806	$12,046
Latin America and Caribbean	Level 1 Jobs	$3,431	$1,552	$4,045
	Level 2 Jobs	$4,397	$2,034	$5,057
	Level 3 Jobs	$6,341	$2,927	$7,407
	Level 4 Jobs	$10,677	$4,853	$12,407
	Level 5 Jobs	$16,861	$7,246	$20,874
Middle East and North Africa	Level 1 Jobs	$5,576	$1,517	$12,337
	Level 2 Jobs	$7,145	$1,953	$15,638
	Level 3 Jobs	$10,306	$2,817	$23,034
	Level 4 Jobs	$17,351	$4,714	$38,286
	Level 5 Jobs	$27,403	$7,138	$64,401
South Asia	Level 1 Jobs	$1,287	$925	$4,356
	Level 2 Jobs	$1,649	$1,221	$5,585
	Level 3 Jobs	$2,378	$1,747	$8,178
	Level 4 Jobs	$4,004	$2,929	$13,590
	Level 5 Jobs	$6,323	$4,313	$22,501
Sub-Saharan Africa	Level 1 Jobs	$1,779	$1,320	$4,281
	Level 2 Jobs	$2,280	$1,706	$5,489
	Level 3 Jobs	$3,289	$2,486	$8,038
	Level 4 Jobs	$5,537	$4,143	$13,356
	Level 5 Jobs	$8,744	$6,165	$22,113

Table 7. Daily salary rates (USD, 2001)

World Bank region	Level	Best	Low	High
East Asia and Pacific	Level 1 Jobs	$6.87	$4.49	$9.82
	Level 2 Jobs	$8.81	$5.93	$12.31
	Level 3 Jobs	$12.70	$8.48	$18.03
	Level 4 Jobs	$21.39	$14.22	$30.33
	Level 5 Jobs	$33.78	$20.94	$49.45
Europe and Central Asia	Level 1 Jobs	$8.31	$5.83	$10.92
	Level 2 Jobs	$10.65	$7.69	$13.81
	Level 3 Jobs	$15.36	$10.96	$19.84
	Level 4 Jobs	$25.87	$18.59	$33.77
	Level 5 Jobs	$40.85	$27.65	$57.36
Latin America and Caribbean	Level 1 Jobs	$16.34	$7.39	$19.26

World Bank region	Level	Best	Low	High
	Level 2 Jobs	$20.94	$9.69	$24.08
	Level 3 Jobs	$30.20	$13.94	$35.27
	Level 4 Jobs	$50.84	$23.11	$59.08
	Level 5 Jobs	$80.29	$34.51	$99.40
Middle East and North Africa	Level 1 Jobs	$26.55	$7.22	$58.75
	Level 2 Jobs	$34.03	$9.30	$74.47
	Level 3 Jobs	$49.07	$13.42	$109.69
	Level 4 Jobs	$82.63	$22.45	$182.31
	Level 5 Jobs	$130.49	$33.99	$306.67
South Asia	Level 1 Jobs	$6.13	$4.41	$20.74
	Level 2 Jobs	$7.85	$5.81	$26.60
	Level 3 Jobs	$11.32	$8.32	$38.95
	Level 4 Jobs	$19.07	$13.95	$64.71
	Level 5 Jobs	$30.11	$20.54	$107.15
Sub-Saharan Africa	Level 1 Jobs	$8.47	$6.28	$20.39
	Level 2 Jobs	$10.86	$8.12	$26.14
	Level 3 Jobs	$15.66	$11.84	$38.27
	Level 4 Jobs	$26.37	$19.73	$63.60
	Level 5 Jobs	$41.64	$29.36	$105.30

Notes

- Based on an estimated working year of 42 weeks p.a. 5 days p.w.

Table 8. Costs of selected laboratory tests and hospital procedures (US dollars, 2001)

	Region						
	EAP	ECA	LAC	MNA	SA	SSA	Sources
Malaria Microscopy test							
Best	$0.62	$0.75	$0.80	$0.67	$0.52	$0.50	Essential Laboratory Services Project (2001)
Low	$0.42	$0.51	$0.54	$0.46	$0.36	$0.34	Goodman *et al.* (2000)
High	$0.80	$0.96	$1.02	$0.86	$0.67	$0.64	
Malaria Dipstick test							
Best	$1.96	$2.09	$2.11	$2.00	$1.86	$1.82	Goodman *et al.* (2000)
Low	$1.58	$1.69	$1.70	$1.61	$1.50	$1.46	Yeung personal communication
High	$2.30	$2.46	$2.48	$2.35	$2.19	$2.14	
Cost per unit of safe blood transfused							
Best	$18.93	$21.37	$21.58	$19.73	$17.18	$16.43	Essential Laboratory Services Project (2001)
Low	$13.71	$15.48	$15.63	$14.29	$12.44	$11.91	Schwartländer *et al.* (2001)
High	$24.14	$27.25	$27.52	$25.17	$21.91	$20.96	
TB Microscopy test							
Best	$1.72	$2.25	$2.29	$1.89	$1.34	$1.18	Essential Laboratory Services Project (2001)
Low	$1.19	$1.56	$1.59	$1.31	$0.93	$0.82	Barnum (1983)
High	$2.18	$2.85	$2.91	$2.40	$1.70	$1.50	Floyd *et al.*. (1997)
Stool microscopy test							
Point estimate only	$0.76	$0.85	$0.86	$0.79	$0.70	$0.67	Essential Laboratory Services Project (2001)
Haemoglobin test							

	EAP	ECA	Region LAC	MNA	SA	SSA	Sources
Point estimate only	$2.57	$3.40	$3.47	$2.84	$1.97	$1.72	Essential Laboratory Services Project (2001)
HIV: Voluntary counselling and testing, per person							
Best	$17.00	$24.51	$25.16	$19.48	$11.62	$9.33	Schwartländer *et al.* (2001)
Low	$9.69	$13.96	$14.33	$11.09	$6.62	$5.32	Marseille (1999)
High	$35.84	$51.67	$53.02	$41.05	$24.49	$19.67	
Operating theatre time, cost per minute							
Point estimate only	$3.12	$4.53	$4.66	$3.59	$2.11	$1.68	Shepard (1993)
X ray test, per test							
Point estimate only	$9.64	$13.90	$14.27	$11.04	$6.59	$5.29	Barnum (1983)
Generic laboratory cost per patient							
Point estimate only	$8.90	$11.52	$11.74	$9.76	$7.02	$6.22	Personal communication with Dr Charles Hongoro, LSHTM.

Notes on all lab and procedure costs

- Includes staff, equipment, supplies and overheads
- Split into traded and non-traded components. Regional price adjustments made to non-traded components
- District hospital setting

Notes on blood transfusion costs

- Includes all the costs associated with screening the donor for anaemia, hepatitis B, syphilis and HIV, bleeding the donor, determining the blood group of the donor and the recipient and checking the donor recipient compatibility of the blood.

Notes on Haemoglobin test

- Using HCN reference method

Table 9. Selected equipment costs (USD, 2001)

Item	Unit cost	Estimated useful life years (a)	Source
Vehicles			
4 Wheel Drive 4000 cc (Toyota Landcruiser hardtop)	$24,238	9	Gerry Mission Supplies (personal communication)
Motorcycle 97 cc (on/off road)	$1,491	7	WHO (2000)
Major Equipment			
Portable X ray Unit	$7,150	10	Durbin PLC (2002)
Reconditioned Mobile X ray unit	$3,972	5	Durbin PLC (2002)
Refrigerator	$278	11	Durbin PLC (2002)
Refrigerator, tropical, transportable	$1,653	11	Durbin PLC (2002)
Instruments and other equipment			
Microscope	$542	10	Durbin PLC (2002)
Sphygmomanometers (hand held with adult cuff)	$14	8	Durbin PLC (2002)
Stethoscope (economy model)	$6	8	Durbin PLC (2002)
Thermometers	$1	8	Durbin PLC (2002)
Weighing scales (infant and toddlers)	$68	8	Durbin PLC (2002)
Weighing scales (new born infants)	$26	8	Durbin PLC (2002)
Vaccine carrier (1.7 litres)	$33	6	Durbin PLC (2002)
Vaccine carrier (0.6 lites)	$97	6	Durbin PLC (2002)

Notes

- Life expectancies taken from Goodman (2000), Halbwachs (2000) and WHO-CHOICE. Assumes equipment was bought in good condition and well maintained.

Table 10. Fuel, cost per litre (USD, 2001)

World Bank region	Regional estimate	International price
East Asia and Pacific	$ 0.10	$0.24
Europe and Central Asia	$ 0.24	$0.24
Latin America and Caribbean	$ 0.30	$0.24
Middle East and North Africa	$ 0.20	$0.24
South Asia	$ 0.28	$0.24
Sub-Saharan Africa	$ 0.26	$0.24

Table 11. Building cost per square metre (USD, 2001)

World Bank region	Best estimate	
	Office*	**Basic***
East Asia and Pacific	$51.20	$18.37
Europe and Central Asia	$52.83	$22.07
Latin America and Caribbean	$24.05	$10.25
Middle East and North Africa	$52.96	$28.41
South Asia	$22.76	$12.44
Sub-Saharan Africa	$22.95	$13.19

Notes

- *Office*: building cost for a typical building in an urban location. Includes suspended ceilings, air-conditioning, lighting and power. Excludes partitioning and all equipment and facilities.

- *Basic:* building cost for a basic unit in an urban location with services and heating to the office space (approx 5% of area)

4 DISCUSSION

This paper presents the unit costs of selected health care inputs for the six low and middle income World Bank regions. The main objective of this work was to provide DCPP chapter authors with a consistent set of costs to incorporate into their cost-effectiveness analyses. However, others interested in comparisons across countries and regions may also find uses for these data. Those involved in multi-country costing studies may also find useful our description of the methods to estimate data for regions where we could find no data. More generally, policy makers need information on the regional cost of inputs to feed into global estimates of the scale of resources required to tackle priority diseases such as malaria, TB, HIV/AIDS (Kumaranayake, 2001; Schwartländer *et al.*, 2001, Opuni *et al.*, 2002), and regional or national estimates of costs provide support to decision making on how to allocate resources across diseases and countries.

As Hutton and Baltussen (2002) also found, it became clear during the course of this work that the question of how to transfer cost data between countries and regions has received relatively little attention in the literature. It is hoped that the data and methods presented here can be used in a number of ways depending on the perspective of the user. For those conducting their own cost-effectiveness analyses on a regional basis, the input prices can be used directly to facilitate comparisons within the DCPP chapters. The prices can also be used as an approximation for the cost of inputs in particular countries. (for example the country price of an input in Brazil can be assumed to be the same as the regional price for Latin America and the Caribbean). The way in which the data are used within analyses themselves will depend on the extent to which information on resource use quantities are available. Box 7 gives some illustrative examples for two different scenarios: i) where there is information on quantities for different health care inputs and ii) where there is information only on total costs for health inputs.

Box 7: How might the data be used?

Chapter authors are expected to estimate the quantities of resources needed for each intervention and where relevant attach the standardized regional cost to obtain the total cost of an input in another region.

Where data on quantities are available

An intervention to deliver a vaccine to 10,000 children in a rural area is estimated to require 250 person days and 60 days for supervision. In this case the relevant unit costs provided here for the different regions can simply be multiplied by the quantity of resources as follows.

Assuming level 1 salaries for the 250 person days and level 2 for supervision. Total costs:

In SSA: (250 x 8.47) + (60 x 10.86) = $2769
In LAC: (250 x 16.34) + (60 x 20.94) = $5341

Analysts can then use the range of high and low costs and different quantities in the sensitivity analysis.

To help adjust estimates of total cost when quantities are not available

Often resource use quantities are not reported in the literature. Instead only the proportion of costs attributable to an input might be known for a particular country or region. For example the total recurrent staff costs for health care workers to deliver the vaccine in SSA = $100,000 and labor costs are 35%.

To obtain the equivalent cost in LAC use the ratio of LAC to SSA costs for level 1 staff to multiply the 35% of total costs in SSA to obtain new total cost of labor in LAC.

Thus: ratio of level 1 annual salaries between LAC and SSA is $3431: $1779 = 1.9

new total costs of labor in LAC = 1.9 x $35,000 = Int. $66,500

For a generic indicator of relative costs in the hospital sector, analysts can also use the regional hospital cost indices provided in Table 2 to transfer costs between regions.

4.1 Critical consideration of methods

Despite the fact that costs are often required for multinational studies, few analysts have explored the theory and practice of multi-country costing (Drummond and Pang, 2001). Comparisons with previous studies are also hampered by the fact that detailed descriptions of methods are often lacking. A key question that arises from this work is the extent to which the regional estimates accurately reflect unit costs in the different World Bank regions. This leads to two sets of concerns. One concern relates to the validity of regional costs *per se* for certain health care inputs. For example, estimating regional prices for salaries is particularly problematic where monopsony power of local hospital employers leads to the true value of local wages being lower than is suggested by the data here. Equally, local purchasers of highly skilled labor (eg medical specialists or experienced program managers) may face a higher international rather than a regional price to reflect scarce labor which may mean the salary data presented here could be under-estimates of the true value.

A second set of concerns relates to the validity of the methods used to estimate costs for regions. Methods adopted here drew upon the results of two types of analyses, namely, econometric approaches (i.e. for the hospital, health center and salaries data) and standardization approaches where estimates are taken from the literature for one or more regions and are extrapolated to the remaining regions using relative price indices (i.e. for laboratory procedures, fuel and vehicle costs). The pros and cons of each method are considered below.

Compared to previous econometric models of hospital costs the WHO-CHOICE models exploit more extensive databases on unit costs for hospitals, health centers and salaries than has previously been available (Adam *et al.*, 2003). Arguably, this wider range and scope of observations enhances the validity of extrapolations of cost estimates for countries in which data are not available**.** In addition the work by Adam *et al.* (2003) showed that the hospital cost regression lines had a good fit with the data used to develop the inpatient hospital models, implying that the models are a good predictor of country costs and by implication regional costs. The estimates produced by the models were also sent to health economists and researchers in several countries in all regions to check their face validity. Individuals were given a description of the estimated unit costs (including which costs were included) and were asked whether they thought they approximated unit costs found in their countries. The findings from this consultation indicated that the results had good face validity (for further information see Adam *et al.*, 2003).

However it is clear that there are limitations with the econometric approach adopted. First it assumes that GDP per capita and other macro-economic variables are able to capture adequately different levels of technology. The extent to which this is the case is uncertain and will depend on the rate of technological advances in the health sector following that of the economy in general. Second the approach is inevitably only as good as the studies included. With respect to the hospital and health center models, many studies document how resources are allocated within a hospital, but these are mostly top down studies that do not fully take account of the different hospital cost functions which exist in facilities. The salaries model similarly assumes that centrally reported salary rates are reflective of the salary for the entire country. In addition accounting practices vary greatly between countries, and this makes it more difficult (although not impossible) to generate a consistent set of unit costs or prices (Drummond and Pang, 2001). Finally, it is important to note that WHO CHOICE are currently in the process of finalizing their data and the results presented here represent work in progress. For updates, interested readers are advised to go to the DCPP (http://www.fic.nih.gov/dcpp/index.html) and WHO CHOICE websites (www.who.int/evidence/cea).

The standardization approach is at first sight a more transparent method for estimating regional costs: estimates from one region or country are simply adjusted to reflect the price in another region through a regional relative price index. The data needs for this approach are also much less demanding since single estimates can be transferred to other regions. However, since relative price indices are an average and thus of limited generaliseability, this advantage is also an obvious limitation. Further, the estimation of the regional price is based on one or a few data points, and the quality of the results depend on the quality of these initial data. The method adopted here is similar to that employed by previous studies (see for example Schulman *et al.* 1998). The advantage of using an index based on hospital costs rather than a general index based on, for example, purchasing power parities is that it captures more accurately relative price differences in health care inputs rather than the economy as a whole. However, given the lack of regional costing work in this area (particularly that which explores the use of other types of relative price indices for the health sector), it is difficult to judge to what extent our indices result in an over or under estimate of unit costs for these inputs in different regions.

4.2 Conclusion

The rapidly growing use of economic evaluation to aid decisions on the adoption and utilization of health technologies has generated an urgent need for comparative and consistent costs for key inputs. One effect of pulling together existing sources of unit costs is to highlight areas where further work is needed, and if cost-effectiveness analyses are to proceed on a multinational level, analysts must develop resource cost data that are comparable (Schulman *et al.*, 1998; Drummond and Pang, 2001). It is clear from this work that substantial gaps remain (for example there is an urgent need for better data on the unit costs of diagnostic tests) and more work must be done to define consistent cost-reporting formats for countries. One response to this is to encourage more economic data collection in more countries and a wider variety of settings (Drummond *et al.,* 1998). However, this paper has also argued that greater transparency in methods and sources will help analysts to transfer existing estimates to settings where these is little or no data and/or resource constraints preclude extensive data collection. This should improve the efficiency of economic evaluation activities overall and reduce duplication of effort. It is hoped that the approach described in this paper will not only provide practical means of transferring costs across countries and regions but also allow others to critique the methods adopted, thereby encouraging progress in this methodological area.

Annex 1. Countries in cost analysis by regional classification

Region	Countries
East Asia and Pacific (EAP)	American Samoa, Cambodia, China, Fiji, Indonesia, Kiribati, Korea, Dem. Rep., Korea, Rep., Lao PDR, Malaysia, Marshall Islands, Micronesia, Fed. Sts., Mongolia, Myanmar, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Thailand, Tonga, Vanuatu, Vietnam,
Eastern Europe and Central Asia (EEC)	Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Isle of Man, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Macedonia, FYR, Moldova, Poland, Romania, Russian Federation, Slovak Republic, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan, Yugoslavia, Fed. Rep.,
Latin and Central America (LAC)	Antigua and Barbuda, Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela, RB,
Middle East and North Africa (MNA)	Algeria, Bahrain, Djibouti, Egypt, Arab Rep., Iran, Islamic Rep., Iraq, Jordan, Lebanon, Libya, Morocco, Oman, Saudi Arabia, Syrian Arab Republic, Tunisia, West Bank and Gaza, Yemen, Rep.,
South Asia (SA)	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka,
Sub-Saharan Africa (SSA)	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Cape Verde, Chad, Comoros, Congo, Cote d'Ivoire, Dem. Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Syrian Arab Republic, Togo, Uganda, United Rep. Of Tanzania, Yemen, Zambia, Zimbabwe.

Annex 2. WHO-CHOICE models to estimate country-specific unit costs

A2.1 Hospital cost per inpatient inpatient day

Dependent variable: Natural log of cost per bed-day in 1998 $

Adjusted R^2= 0.80 F statistic = 509 p of F statistic <0.00001 N: 1171

Variable	Description	β Coef	SE	P
Ln GDP per capita	Natural log of GDP per capita	0.7624	0.0295	<0.0001
Ln occupancy rate	Natural log of occupancy rate	-0.2318	0.0474	<0.0001
Drug costs	Dummy variable for inclusion of drug costs. Included =1	0.6410	0.1769	<0.0001
Food costs	Dummy variable for inclusion of food costs. Included =1	0.2116	0.1394	0.152
Level 1 hospital	Dummy variable for level 1 hospital	-0.5777	0.0742	<0.0001
Level 2 hospital	Dummy variable for level 2 hospital	0.3118	0.0594	<0.0001
Public	Dummy variable for level public hospitals	-0.2722	0.1172	0.021
Private for profit	Dummy variable for level private for profit hospitals	0.2444	0.1316	0.064
USA	Dummy variable for USA. USA =1	1.7471	0.1022	<0.0001
Constant		-2.5036	0.3264	0.026

Smear adjustment = 1.25
Dummy variables for levels of hospital are compared with level 3 hospitals
Dummy variables for hospital ownership are compared with public not-for-profit hospitals
Source: Adam et al. (2003)

A2.2 Hospital cost per outpatient visit

The hospital cost per outpatient visit is estimated from the ratio of cost per outpatient visit to cost per bed day, estimated from the model presented in A2.2, and the cost per bed day estimated from A2.1)

Dependent variable: Natural log ratio of cost per outpatient visit to cost per bed-day
Adjusted R^2= 0.63 F statistic = 85 p of F statistic <0.00001 N: 832

Variable	Description	β Coef	SE	P
Ln GDP per capita	Natural log of GDP per capita in 1998 $	0.11	0.03	0.003
Ln occupancy rate	Natural log of occupancy rate	0.17	0.06	0.007
Ln hospital beds	Natural log of hospital beds	0.08	0.02	<0.0001
Public	Dummy variable for level public hospitals (1)	-1.63	0.63	0.009
Ancillary costs	Dummy variable for inclusion of ancillary (2) costs. Included =1	-0.09	0.12	0.471
Food costs	Dummy variable for inclusion of food costs. Included =1	-0.19	0.08	0.014
Costs or charge	Whether observation is cost or charge data. Costs =1	1.27	0.65	0.048
Sri Lanka	Dummy variable for Sri Lanka. Sri Lanka=1	-1.21	0.10	<0.0001
Thailand	Dummy variable for Thailand. Thailand=1	-0.26	0.09	0.005
China	Dummy variable for China. China=1	0.38	0.06	<0.0001
Ecuador	Dummy variable for Ecuador. Ecuador=1	-0.81	0.11	<0.0001
Constant		-2.16	0.31	<0.0001

Smear adjustment = 1.13
Dummy variables for hospital ownership is compared with public not-for-profit hospitals
Ancillary costs include laboratory and other diagnostic tests.
Source: Adam et al., Rules of Thumb for Allocating Hospital Costs Across Departments. A Multi-Country Analysis *(forthcoming)*.

A2.3 Health center costs

Dependent variable: Cost per health center visit
Adjusted R^2= 0.40 F statistic = 82 p of F statistic <0.00001 N: 481

Variable	Description	β Coef	SE	P
Ln GDP per capita	Natural log of GDP per capita	0.2926	0.0588	0.001
Cap_incl	Dummy variable for including capital costs. Included = 1	0.6144	0.2423	0.043
Anc_incl	Dummy variable for inclusion of ancillary services (eg lab tests). Included =1	0.3916	0.1802	0.035
Lnopvcap	Natural log of outpatient capacity (set at 75 visits per health worker per day)	-0.6313	0.1149	0.001
High	Dummy variable for high income countries (WB regions). Included = 1	0.9730	0.4339	0.029
Constant		0.2008	0.5967	0.741

Smear adjustment = 1.49
Source: Adam et al., Cost of Scaling up Health Interventions at Primary Facilities. A Multi-Country Analysis *(forthcoming).*

A2.4 Salaries

Dependent variable: Annual salaries

F statistic = 520 p of F statistic <0.00001 N: 752

Variable	Description	β Coef	SE	P
LnGDPusd	Log of GDP in US dollars	0.6508	0.0135	<0.0001
Lnpopdens	Log of population density	-0.0368	0.0130	0.005
Lv1	Dummy for level 1 jobs. Included =1	-1.5921	0.1003	<0.0001
Lv2	Dummy for level 2 jobs. Included =1	-1.3441	0.0948	<0.0001
Lv3	Dummy for level 3 jobs. Included =1	-0.9778	0.0960	<0.0001
Lv4	Dummy for level 4 jobs. Included =1	-0.4570	0.0994	<0.0001
Asia	Dummy if country is located in WHO regions: SEAR B, SEAR D or WPRO B	2.679	0.3461	<0.0001
_IAsiaGDP	Interaction Dummy if country located in SEAR B, SEAR D or WPRO B x log of GDP	-0.4911	0.0519	<0.0001
_ItLtnAmrGDP	Dummy if country is located in AMR B, AMR D x log of GDP	-0.0902	0.0075	<0.0001
EastEur	Dummy of country is located EUR B or EUR C	-2.8795	0.3250	<0.0001
_IEastEurGDP	Dummy if country is located in EUR B or EUR C x log of GDP	0.2552	0.0416	<0.0001
Constant		4.9784	0.1590	<0.0001

Smear adjustments by region: AFRO = 1.142; AMR B & AMR D = 1.378; EMR = 1.082, EUR B & C = 1.269, SEAR B, SEAR D & WPR B = 1.056; AMR A, EUR A & WPR B = 1.055
Dummy variables for job levels compared to level 5 jobs
Source: Johns et al., Determinants of Variation in Health Sector Wages Across Countries *(forthcoming).*

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