

**ANALYSIS OF HOSPITAL COSTS:
A MANUAL FOR MANAGERS**

by

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CHAPTER 1: INTRODUCTION

1.1 Purpose of the Manual

According to a major World Bank study of public hospitals (Barnum and Kutzin, 1993), the share of public sector health resources in developing countries consumed by hospitals ranges from 50 to 80 percent. This manual seeks to help managers make the best use of these resources. By better understanding the costs of various activities, managers can improve the efficiency of various hospital departments, as well as hospital systems as a whole. Finally, the data can help national policy makers decide which curative care is best delivered in hospitals, and to examine the tradeoffs among various preventive, primary curative, and secondary curative services.

This manual is written for all officials involved with the management and funding of hospitals in developing and transitional economics. Thus, our target audience includes hospital managers (both financial and programmatic), public sector managers at the district, regional and national levels of the health system, and persons responsible for non-profit and private hospital systems.

The type of information available for cost analysis varies substantially across countries and hospitals, from extensive to rudimentary. Hospitals vary in the extent to which costs are allocated to specific hospital departments, and the accuracy with which such allocations are recorded. In light of this, we spell out alternative approaches wherever possible, and suggest what approaches can be taken when information is incomplete

This manual provides a framework for both deriving and analyzing hospital costs. Chapter 2 shows how to compute unit costs. Since often times data may be incomplete, the chapter also shows how cost allocations among cost centers can be imputed from staffing data or approximated from other available information. Complementary information from each department can be obtained from interviewing hospital personnel (e.g., staff time, wages, allowances, supplies, space occupied, and activities performed), or from extracting data from management information systems or medical records (e.g., amounts of care provided). Chapters 3 and 4 apply knowledge gained from the previous chapters by discussing ways in which cost data can be utilized at the level of the individual hospital (chapter 3) or the hospital system (chapter 4). In many hospitals in developing countries, particularly smaller ones, costs may not be reported at all by individual departments, or that reporting may be very incomplete or arbitrary. Thus, chapter 4 shows how to compute unit costs when line item data are completely missing or not usable. Since managers of various units of the health system are concerned with different parts of the health system, we expect that many readers will consult this manual selectively and concentrate only on the components that apply to them. The manual has been used in and benefited from workshops in Bangladesh and Harare. Appendix V contains case studies based on those workshops. We found that the workshop manual proved a stimulating format for introducing the topics in this manual, and encouraging managers to think more broadly about strengthening their institutions. These case studies can be used to facilitate that process.

1.2 Cost Finding and Analysis as Management Tools

In both developing and industrialized countries, hospitals are viewed as vital and necessary community resources that should be managed for the benefit of the community (Institute for Health Policy Studies, 1996; World Health Organization 1987, 1992; Van Lerberghe and Lafort 1990). As

such, hospital management has a responsibility to the community--to provide health care services that the community needs, at an acceptable level of quality, and at the least possible cost. Cost finding and analysis can help departmental managers, hospital administrators, and policymakers to determine how well their institutions meet these public needs.

Cost finding and cost analysis are the technique of allocating direct and indirect costs as explained in this manual. They are also the process of manipulating or rearranging the data or information in existing accounts in order to obtain the costs of services rendered by the hospital. As financial management techniques, cost finding and analysis help to furnish the necessary data for making more informed decisions concerning operations and infrastructure investments. If structured accurately, cost data can provide information on operational performance by cost center. This information can be compared to budgeted performance expectations in order to identify problem areas that require immediate attention. These data give management the material to evaluate and modify operations if necessary. Moreover, knowledge of costs (both unit and total) can assist in planning for future budgets (as an indicator of efficiency) and to establish a schedule of charges for patient services. A hospital cannot set rates and charges which are realistically related to costs unless the cost finding system accurately allocates both direct and indirect costs to the appropriate cost center.

Finally, cost finding and analysis are also of value to management in ensuring that costs do not exceed available revenues and subsidies. It is the best available technique for accomplishing this.

CHAPTER 2: COMPUTATION OF UNIT COSTS USING LINE-ITEM EXPENDITURE DATA

Two fundamental items of financial data needed by a hospital manager are allocated costs by cost center (a program or department within a hospital) and the unit cost of hospital services. A unit of hospital services may be as small as one meal, or as broad as an entire inpatient stay. This chapter explains how to allocate costs by cost center and how to compute unit costs. To perform these calculations precisely, the hospital needs an accurate and comprehensive financial accounting system. In many hospitals, however, existing accounting systems have gaps, such as excluding some costs or lacking the data to relate the costs to specific cost centers. In these cases, estimates are needed. This chapter provides a number of suggestions for generating such approximations. It is organized based on seven steps for computing unit costs, a framework built on the procedures of the UNICEF manual for analysis of district health service costs and financing (Hanson and Gilson, 1996)¹. The steps are:

1. Define the final product.
2. Define cost centers.
3. Identify the full cost for each input.
4. Assign inputs to cost centers.
5. Allocate all costs to final cost centers.
6. Compute total and unit cost for each final cost center.
7. Report results.

In leading the reader through this framework, we explain what data elements are needed, how different cost items can be treated, and how costs can be computed in certain situations or cases. In each case, we discuss a set of problems that have been identified in various studies of specific countries (see Table 2.1).² In addition, we work through examples of certain highlighted points (see Boxes 2.2 to 2.5 and Tables A-1 through A-5).

2.1. Define the Final Product

What are the services or departments for which you are interested in computing unit costs? For example, do you want to know the unit cost for all inpatient services, or a separate unit cost figure for each ward or service? The decision will depend on two key questions:

¹ The presentation of the steps in this manual differs slightly from the nine steps presented by Hanson and Gilson for costing district hospitals, but the concepts and methodologies are consistent with each other.

² The principal studies are listed in Table 2.1 in alphabetical order by country. Full citations are provided in the references section of this manual. For a review of the findings of some of these studies, see Barnum and Kutzin (1993).

- *Purpose of the Analysis*³. If you want to do a comparison of costs of certain hospital departments, you will want to compute unit costs for each department separately. If you want to compare multiple hospitals with similar caseloads (e.g., all district hospitals within a particular state or region), it may be sufficient to compute a single unit cost for all inpatient care for each hospital.
- *Type of Data Available*. Your ability to compute unit costs will be constrained by how aggregate or disaggregate the available data are for both costs and utilization. For example, in order to compute unit costs by ward, you would need to have at minimum utilization data by ward (e.g., actual total patient days for each ward for a particular budget year). If these data cannot be broken out by ward, it will make more sense to compute unit costs at the next higher level (e.g. all inpatient wards or units that house internal medicine patients or surgery patients).

In some cases, it may be unclear whether to compute a separate unit cost for a certain activity, or allocate its costs to some other output. For example, some studies have computed separate unit costs for lab and radiology departments, thereby excluding those costs from the cost per inpatient day or discharge. Others have treated lab and radiology as intermediate outputs, and fully allocated their costs to the inpatient cost centers. Again, the desirability of each approach depends on the purpose of the analysis, but it is important to be consistent. It may even be desirable to report results in both forms (as was done in the Lesotho study).

Units of Output. For each final cost center (see Section 2.2 for descriptions of types of cost centers), one must define the unit of output (e.g., inpatient day, admission, visit). For inpatient care, the usual choices are inpatient days or admissions. For outpatient care, number of visits is the unit of output. A variety of other output units have been used for other cost centers. Examples include the number of tests or exams (for laboratory and x-ray departments), the number of operations (for operating theaters), and the number of prescriptions (for pharmacy departments).

Data Period. One can analyze unit cost based on data for a single month, a quarter, or a year. The data period chosen will depend first upon how the available data are organized. Sometimes important data such as utility costs are only available on an annual basis, and to do a quarterly analysis, one would have to make assumptions about use patterns within the year. In such situations, it may make more sense to analyze data for a whole year rather than for each quarter.

A second consideration in the choice of the data period is the purpose of the analysis. If managers are trying to understand a rapid recent change in costs, then quarterly or monthly analysis may be appropriate. However, if the aim is to compare a particular hospital's costs to other hospitals, or fees paid by patients treated at similar health care settings, it may make more sense to use a longer time-period. Using annual data may help to "equalize seasonal variations" since each hospital is affected by these factors differently.

³See Chapter 4 for a fuller discussion of the purposes of unit costing.

Table 2.1 Selected Studies of Hospital Costs

Country	Authors	Title	Year
Algeria	Djelloul, Berrached	Hôpital spécialis'e en maladies infectieuses d'EI-Kettar (Alger)	no date
Belize	Raymond, Susan et al.	Financing and costs of health services in Belize	1987
Bhutan (I)	Huff-Rousselle, Maggie	Financial study of Thimphu General Hospital	1992
Bhutan(II)	Huff-Rousselle Maggie	Dzongkhag costing study for Tashigang Dzongkhag	1992
Bolivia	Olave, Manuel and Zuhma Montano	Unit cost and financial analysis for the Hospital 12 de abril in Bolivia	1993
Colombia	Robertson, Robert et al.	Hospital cost accounting and analysis: the case of Candelaria	1977
Dominica	Gill, Llewelyn	Hospital costing study: Princess Margaret Hospital	1994
Dominican Republic	Lewis et al.	Measuring public hospital costs: empirical evidence from the Dominican Republic	1995
Ecuador	LaForgia, Gerald and Mercy Balarezo	Cost recovery in public sector hospitals in Ecuador	1993
Egypt(I)	Zaman, Samir	Cost analysis for hospital care	1993
Egypt(II)	Salah, Hassan	Cost Analysis for Hospital care: Summary Output	1996
Gambia	Ministry of Health/WHO	Cost analysis of the health care sector in the Gambia	1995
Guinea	Carrin, Guy and Kodjo Evlo	A methodology for the calculation of health care costs and their recovery	1995
Indonesia	RAND Corporation	Unit cost analysis: a manual for facility administrators and policy makers	1992
Jamaica	Kutzin, Joseph	Jamaican Hospital restoration project: final report	1989
Lesotho	Puglisi, Robert and William J. Bicknell	Functional expenditure analysis: final report for Queen Elizabeth 11 Hospital	1990
Malawi	Mills, Ann	The cost of the district hospital: a case study from Malawi	1991
Montserrat	Gill, Llewellyn and Alison Percy	Hospital costing study: Glendon Hospital Montserat	1994
Namibia	Bamako Initiative Management Unit	Cost, resource use and financing of district health services	1994
Niger	Wong, Holly	Cost analysis of Niamey Hospital	1989
Papua New Guinea	John Snow, Inc.	Papua New Guinea: health sector financing study project	1990
Russia	Teliukov, Alexander	A guide to methodology: Integrated system of cost accounting and analysis for inpatient care providers	1995
Rwanda	Shepard, Donald S.	Analysis and recommendations on health financing in Rwanda	1988
St. Lucia	Russell, Sharon et al.	Victoria Hospital	1988
Sierra Leone	Ojo, K., et al.	Cost analysis of health services in Sierra Leone	1995
Tuvalu	Wong, Holly	Health financing in Tuvalu	1993
Zimbabwe	Bijlmakers, Leon and Simon Chihanga	District health service costs, resource adequacy and efficiency: a comparison of three districts	1996

2.2. Define Cost Centers 2.2. Define Cost Centers

The next step for computing unit costs is to determine the centers of activity in the hospital to which direct and/or indirect costs will be assigned. The major direct cost categories of most departments include salaries, supplies, and other (purchased services such as dues, travel, and rents). Indirect cost categories include depreciation and allocated costs of other departments.

The rationale for choosing centers of activity that correspond with the hospital's organizational and/or accounting structure is managerial. Hospitals are organized into departments and, since we want to strengthen the management of these departments, it is useful to have cost centers that correspond to the existing organizational structure of the hospital. This provides: (1) the road map by which costs can be routed, through the process of cost finding, to final cost centers; and (2) a framework for costing the distinct functions of each center. Following this road map shows individual managers how they are using available resources in relation to what has been budgeted and the services that they are providing.

From an administrative standpoint, cost centers can be distinguished based on the nature of their work--patient care, intermediate clinical care and overhead centers. As explained below, some costs centers represent patient-centered activities (i.e., final or intermediate cost centers), while others are primarily for general services (i.e., overhead cost centers) such as housekeeping, laundry, maintenance, and the many other tasks necessary for the satisfactory operation of a complex organization like a hospital.

Patient Care: These cost centers are responsible for direct patient services, for example, wards or inpatient care units as a whole, or the ambulatory care center.

Intermediate: These cost centers provide ancillary services to support inpatient units but are organized as separate departments. Examples include laboratory, pharmacy, and radiology.

Overhead: These cost centers provide overhead support services to both patient care and intermediate cost centers. Examples of departments are finance (accounts receivable, accounts payable, payroll, etc.), dietetics, and security.

Within each of the above groups, there are also decisions about how many cost centers to define. For example, if you are planning to analyze unit costs by ward, then you would need to treat each ward as a separate cost center. Or, if you want to distinguish ancillary costs by (type (e.g., x-ray vs. clinical laboratory), then establish separate cost centers for each.

The aim of unit cost analysis is to allocate hospital costs (direct and indirect) to centers whose costs are to be measured. Typically, you will be computing the unit cost mainly for patient care centers (e.g. maternity wards, outpatient clinics, or pediatric units). However, in some instances, you may need to know the cost per lab test or drug prescription, in which case unit costs are computed for intermediate departments such as laboratory and pharmacy. On occasion, you may even need to know the unit cost of an overhead service, like dietetics, if, for example, you are considering opening a competitive bidding process to contract food services rather than keeping it in-house, or you wish to compare the performance of dietetic departments across different hospitals.

In order to see the extent to which user charges (e.g., fees for room, board, and nursing [a daily rate inclusive of diagnostic and therapeutic services], drugs and dressings, x-ray, laboratory, and physical therapy) cover their associated costs, it may be necessary to have a cost analysis system that identifies (1) cost centers which produce revenue (i.e., patient care and intermediate cost centers) and

(2) general cost centers that do not produce revenue (e.g. security, housekeeping and payroll). This identification is necessary when it is desirable to allocate all direct or indirect expenses incurred by the general cost center (non-revenue-producing centers) to revenue-producing centers which could be the final cost centers.

Finally, one may eventually want to compute two types of unit costs: with or without allocated ancillary amounts. For example, if calculating the cost per admission or inpatient stay, one figure could include laboratory and x-ray costs and one excluding them (see the Lesotho study by Puglisi and Bicknell, 1990, for a discussion of both types of unit cost).

2.3. Identify the Full Cost for Each Input

An important part of computing unit costs is to make sure that you have cost data which are as complete as possible. Two issues are involved: (1) the conceptual issue of determining which expenditures should be counted as costs based on an economic sense of resources used up during production of health care, and (2) the actual measurement of true costs using available data (which may be incomplete or untrustworthy). Various studies have developed ways to impute or approximate cost when existing data are problematic, and we describe some of these. Since the problems and responses often differ according to the line item, our discussion is partly organized by line item (e.g. drugs and salaries).

Salaries: To calculate the full or total cost of salaries, one should ideally use actual salary amounts paid to hospital employees. Sometimes these data may not be available such as in cases where employees are paid by the Ministry of Health and therefore the hospital cannot access this payroll data. However, as some studies have shown, individual salaries can be approximated by using the midpoint of the salary range of the employee's classification level. In the Mills' study on hospitals in Malawi, the midpoint estimation approach appeared reasonable given that the estimated total wage costs was similar to the hospital's true wage costs. On the other hand, another study has shown that using the midpoint estimation approach may not accurately reflect true salaries. Researchers in Nigeria obtained data on the mean salary for each job classification across all hospitals and found it was consistently lower than the midpoint often by as much as 30%. Reanalyzing their data, we determined that using the midpoint in this study would have overstated true payroll cost by around 35%.

In some hospitals, salary information on certain expatriate staff may be hard to obtain since they are paid by foreign donor agencies with salaries denominated in foreign currency. However, some studies have costed these staff using local physician wages, arguing that, if the expatriate staff leave, they would be replaced by local physicians. The validity of this approach depends on the purpose of the costing analysis. If the aim is to project future budget/resource needs after the expatriates leave, then using local wage rates is appropriate. However, if the goal is to estimate current unit costs, local wages may understate the true cost of resources used depending on the currency rate and differentials between expatriate and local wages. Thus, the rationale behind the costing analysis will drive which measure is most appropriate.

In some cases, individuals may be employed and paid by more than one hospital. In each case, the proportion of their time spent in each hospital must be determined and applied accordingly. For example, if an employee spends four days working in your hospital and one day a week elsewhere, then you should be only paying 80% of his/her salary and the other facility paying the remaining 20%. The same rationale should be applied to fringe benefits.

Fringe Benefits: In principle, fringe benefits (e.g. health care insurance, vacation and sick pay, dental care, etc.) received by personnel as part of their employment should be included as part of total payroll costs. This is true whether these benefits are paid by the hospital and/or public sector funds managed by the Ministry of Health. Examples of such benefits are "gratuities" to physicians (the St. Lucia study) and employees' share of hospital fees or revenues (the Niger study).

To obtain a full, accurate picture of personnel costs of a hospital, one may need to know not only the cost of paid salaries and fringe benefits but, for planning purposes, may be interested in "in-kind costs" (like unpaid work time or volunteer time). In a hospital study in Colombia, Robertson and colleagues measured unpaid work time along with fringe benefits and determined that both accounted for 40% of true personnel costs (or 30% of total direct costs). They measured unpaid work time by using outside observers to monitor staff activities and record time-study measurements for each employee. An example of unpaid work is time spent treating patients beyond normal clinic hours because of physician or nursing inefficiencies, overbookings and/or missed appointments. By not including unpaid labor when determining levels of productivity or efficiency, program managers or planners may make an erroneous conclusion.

Donated Items: Typically, when materials and equipment have been provided by foreign donors, they will not appear in hospital spending records. However, since the hospital is using these donated items, they should be included in calculations of hospital unit cost. This is especially relevant for regional or national level health authorities responsible for comparing the performance of different hospitals. If the value of donated inputs is not included in the cost analysis, hospitals or wards with more donated items may appear more efficient than their peers, even though their actual efficiency may be the same. Such items can account for a substantial share of hospital resources. In a study in Niger, for example, donated drugs were 19% of total drug spending and donated food was 20% of total food spending.

The treatment of donated capital items is discussed later. In this section we consider donated recurrent items, that is, those used up within the analysis period. Examples of these would be bandages, and syringes. The correct costing procedure is to prepare a list of these items and find out the replacement cost of each (i.e., what it now would cost to purchase each).

It is worth explaining the reasons to cost donated items, since in some situations, they may not apply. First, donated items may have an "opportunity cost," that is, one may want to consider how productive they would be if transferred to a different ward or hospital than the one where they currently happen to be used. This issue is less relevant if the donation cannot be transferred (e.g. due to restrictions imposed by the donor) *and* the ministry cannot reallocate funds toward hospitals which receive fewer donations (e.g. due to 'maintenance of effort' restrictions imposed by donors). The second reason to cost donated items is that, at some point, donations may dry up or a long-lived donated good may need replacing. The hospital needs to anticipate these possibilities. As mentioned previously, the third reason is to avoid penalizing hospitals which look inefficient compared to others merely because they receive fewer donations.

Ministry of Health Spending. In many countries, the Ministry of Health pays directly for some resources used by hospitals, for example, stationery, vehicle maintenance and even salaries. This arrangement poses no special problem if the ministry keeps records on how funding was allocated among hospitals. When this is the case, you need only to add allocations to the appropriate expenditure line items.

However, sometimes the ministry cannot determine specific spending levels by hospital. In this case, you will need to estimate the allocated amounts by line item yourself, preferably in consultation with officials at your hospital and the ministry. For example, in Tuvalu, most spending on the single hospital came from the ministry's budget and was not distinguished from spending on other health centers. The study authors estimated the hospital's share for each line item after discussion with those involved. These discussions suggested that, for example, the hospital accounted for 100% of lab costs, 90% of electricity, and 80% of medical supplies. These suggested percentages were applied to the national expenditure data, and the resulting figures were assigned to the hospital.

Drugs. Sometimes spending data on drugs and other consumable medical supplies are not available from the hospital's own accounts or those of the central ministry. For example, in some countries, drugs are purchased by a centralized government agency, which then supplies the drugs to hospitals without this appearing in the Ministry of Health or hospital budget. In such cases, it is necessary to access the agency's records, and determine the value of drugs shipped to the hospital(s) of interest. Sometimes (as in the Papua New Guinea study) the central agency can provide a printout of the value of shipments. Othertimes, only quantities are reported, in which case the value of the drugs can be computed by obtaining the price paid for each drug item and multiplying this figure by the respective quantity.

If the agency recorded which departments within each hospital ordered or received the drugs, this information is important for later stages of the cost analysis, and should be included in any transfer of data.

The large volume of drug data may make it impractical to analyze a full year experience. In some studies, consultants analyzed a sample of pharmacy records rather than a full year of data. In fact, to estimate one year's use, the St. Lucia study used a two-month sample of pharmacy requisitions from the Central Medical Stores. If this approach is taken, one should try to sample various points in the year to account for seasonal variations in drug utilization.

As in the case of Mills' Malawi study, the hospital pharmacy can have information on drug deliveries to each ward but may not know the value or price of the drugs. If this is due to drugs being paid by a centralized government agency, then one can ask the agency the price it pays for each of the drugs concerned and evaluate drug consumption using those prices.

Fuel. If actual records of spending on fuel are not available, it may be possible to estimate spending indirectly. Some hospitals keep logbooks for personnel to record vehicle mileage for all trips. By estimating the number of miles-per-gallon performance, one can convert these mileage totals into estimates of total petrol (gasoline) consumed over a given period. In turn, petrol spending can be estimated by valuing the petrol consumption at the local retail price per gallon or litre.

Similarly, spending figures may be unavailable for generators and other hospital equipment. As in the case of the WHO Gambia study, spending can be estimated using information about how often the equipment is used, the rate at which it consumes fuel, and the price per unit of fuel.

Maintenance. In some countries, personnel who maintain public hospitals are employed by the ministry of health rather than the individual hospital. Ignoring this practice might lead one to understate the true cost of operating the hospital. As with other centrally supplied inputs (such

as drugs), the question is whether the central agency can report how much service it provided to each hospital. If not, one must devise a rule to allocate some portion of the central maintenance budget to each hospital being studied. The simplest way would be to assume that the hospital's share of maintenance costs is proportional to its area (square feet or metres). A more accurate approach might then be to weigh older hospitals more heavily, assuming they need more intensive maintenance.

Spending From User Fee Revenue. A common component of many cost recovery programs is to allow the hospital to retain a portion of fees charged for its discretion. For example, in the Jamaican hospitals studied by Kutzin, hospitals were allowed to keep 50% of revenues generated. Spending of retained revenues may be hard to measure especially if financial controls are poor. Yet, it is important to try, given the growing importance of this revenue source in many poor countries.

In some countries the amount of revenues retained (or costs recovered) is not well-documented. If this is the case, one can estimate retained revenues by applying the fee schedule to available utilization data. For example, if the hospital charges 10 francs per outpatient visit and 50 francs per inpatient day, and provided 1000 outpatient visits and 1000 inpatient days on a monthly basis, then the total fee revenue for that time period would be 60,000 francs ($[10 \times 1000] + [50 \times 1000]$). If some patients received free care due to their inability to pay or incomplete collection, total cost recovery would be overstated if not taken into account.

Having estimated total cost recovery, one can determine how the money was spent by line item or cost center. Even if hospital records do not indicate uses of fee revenues, interviews with staff may shed light on this question. For example, through staff interviews, Kutzin concluded that the Jamaican hospitals were spending much of their revenue fees on "breakdown" maintenance.

A further complication exists in hospitals where staff are practicing 'unofficial' cost recovery without transmitting the proceeds to the hospital accounts. Ojo and colleagues estimated these amounts to be substantial in the Sierra Leone hospitals which they studied. Even if one can measure these amounts, their treatment depends on how one thinks they are being spent and the purpose of the analysis. If staff are spending the money to buy supplies, then these are costs of the hospital and should be included in a cost analysis (if measurable). If the unofficial fees are being treated as private income by staff, and spent outside the hospital, then they should not be included in a hospital cost analysis. On the other hand, the amounts collected may be relevant to a cost recovery analysis, as they indicate patients' willingness to pay which might be better tapped by the hospital itself.

Delayed Payments. As in conventional accounting analysis, cost measures may be misstated when services are paid in a different accounting period from when they are used. The Jamaica study by Kutzin found large fluctuations in utility payments which did not reflect real resource use even within a fiscal year. This occurred because some hospitals were able to delay payment for months, then later make large settlements. The study author corrected for this by using actual kilowatt-hours when available, and otherwise using hospitals' budget requests for utilities. Without the correction, the same facility would have shown variations over time in calculated unit cost which would be difficult to explain.

Capital items. Capital assets are assets having an economic useful life exceeding one year and not acquired primarily for resale. A unit cost analysis which ignores capital is essentially assuming that the present physical assets will be available forever. In reality, assets are being worn down by the hospital's daily activities, and this depreciation is an expense. Unlike drug purchases or salaries, depreciation is not an expenditure, it does not require an actual cost outlay. However, depreciation may be hard to measure, if certain information is not available (such as purchase price and the useful life of its equipment). If this is the case, then determining the depreciation expense becomes more sensitive to the analyst's assumptions.

For the present analysis, we are not necessarily trying to compute a “depreciation allowance,” or how much to save up for equipment replacement. Rather, the aim is to estimate the opportunity cost of the capital being used up, in a way that is consistent across periods. Reflecting this, the methodology we present here differs somewhat from more accounting-based approaches with which you may be familiar.

If one decides to measure the cost of eventually replacing capital, then several questions must be answered for each asset (see Box 2.1 for an example calculation of annual capital costs):

1. What is the asset's total life?

A typical assumption for a building is a total life of 30 years. Other studies have assumed that beds and furniture last 10 years, and vehicles last five years. The assumption matters most for items with a large share of cost, for example, buildings, vehicles and major medical equipment.

2. What will be the cost of replacing it at the end of the year?

Financial accounts often calculate depreciation based on an asset's original purchase price ('historic cost'). However, if there is inflation (as in most countries), historic cost will understate the amount required to replace a given asset. Replacement cost is the more relevant measure for those planning resource use.

From this viewpoint, the original purchase cost is really only useful as a starting point for figuring out the cost of replacing the asset. Of course, even the original cost may not be available, if it was purchased by a donor or the ministry of health. Assuming some estimate of original cost is made, this must then be updated to this year and each future year in which replacement could occur. In other words, one must forecast the inflation which is likely to occur from now until the year of replacement. Estimates of local inflation are often available from governments or aid agencies for a number of years ahead, but become increasingly unavailable (and unreliable) beyond five years.

If the replacement must be paid with foreign currency, one should also predict how the cost of foreign currency (i.e., the exchange rate) will change over the period in question. Sometimes exchange rate forecasts are available from the central bank, or otherwise one can extrapolate from recent experience. In the Gambia study, the authors assumed an annual exchange rate deterioration of 27%.

3. What interest rate should be applied to money saved now for future replacement?

Calculations of a 'capital cost' typically apply some kind of interest rate, based on the local return to a savings account. This is often justified by imagining that the hospital is saving up to replace its equipment, and can deposit the savings in an interest-bearing account. This approach

has been criticized by Carrin and others, as unrealistic in many developing countries where public hospitals lack authority to save in this way.

The method we propose here continues to use the real (inflation free) interest rate, but we justify it by imagining that the hospital could rent medical equipment instead of buying it. To find the maximum rental payment the hospital should be willing to make, one would use this same approach (assuming perfect capital markets).

Box 2.1. provides an example of these calculations for two assets, one which can be purchased with local currency and one which must be imported.

Finally, given the uncertainty associated with measurements of capital costs, it may be advisable to present two sets of results, one including capital cost and one excluding it. This approach was taken by Ojo and colleagues in Sierra Leone. Their results show that including capital costs substantially increases unit costs on inpatient wards (30 to 50%) but has little effect on unit costs of the operating room. This appears to be because the wards had more valuable equipment and, in most cases, more floor space than the operating theatre.

In general, we suggest using a real interest rate of 3%. This rate has been found in many industrialized and developing economies. As this rate was used in a comprehensive set of cost effectiveness studies for the health sector (Jamison et al 1993) its use makes hospital costing consistent with the international literature.

Box 2.1 Example of how to compute the annual capital cost

Table 2.2 provides data for this example of how to compute annual capital cost on two assets, one available locally and one which must be imported. Each was purchased 10 years ago and has 10 years of useful life remaining. The answers to the standard questions are as follows:

1. Total life of the asset: 20 years.
2. Replacement cost: to replace each asset at today's prices would cost 1,000 francs (the local currency). The price of locally produced items is increasing at 3% per year. However, the gradual devaluation of the local currency means that prices of imported goods rise at a faster rate, namely 4% per year.
3. Real interest rate: This depends on the nominal interest rate and the inflation rate. Therefore, in our example, the real interest rate differs for the two assets, as we show below.

Using these assumptions, the hospital can compute a reasonable measure of its annual capital cost using the following formula:

$$\text{Capital cost in year } k = \text{Replacement cost in year } k / \text{annualization factor}$$

The annualization factor is defined based on the real interest rate and the total life of the asset. Values are provided in Appendix IV.

For the first asset, the real interest rate is computed as

$$\begin{aligned} \text{real } r &= \frac{(1 + \text{nominal interest rate})}{(1 + \text{annual inflation})} - 1 \\ &= (1.06/1.03) - 1 \\ &= .0291 \end{aligned}$$

So the real interest rate is 2.9%. We will round it to 3% for this example. Indeed a real interest rate of 3% has been applied to a range of countries.

In Appendix IV, we find the annualization factor for a 3% real interest rate and a life of twenty years. The annualization factor is 14.877.

The replacement cost next year will be 1030 francs, since 3% inflation will have occurred. Dividing by the annualization factor, the capital cost for next year is therefore 69.23 francs. The following year's capital cost is similarly computed as 71 francs (=1060.90/14.877). The capital cost therefore increases from year to year at the rate of inflation. (Equivalently, capital cost computed in this way stays constant in real terms).

If you need to consider a discount rate or time period which is not provided in Table q, you can compute the annualization factor using the formula:

$$\text{Factor} = (1/r) * [1 - 1/(1+r)^n]$$

where r is the real interest rate and n is the number of years of life.

So the capital cost this year is 69 francs, and this becomes part of the hospital's costs to be allocated across cost centers in a full step-down analysis.

For the second asset, the annual inflation is higher (4%). In the first year, replacement would cost 1040 francs (1000*1.04), so the capital cost in that year is 69.90 francs (1040/14.877), and it increases in subsequent years at the rate of inflation in the foreign asset's price.

Note: If you instead used the first asset's original purchase cost of 744 francs and depreciated it over 20 years on a straight-line basis, the annual depreciation for each asset would be 37 francs (i.e., 744 divided by 20). This approach would understate the true opportunity cost of the capital being used up, since it ignores inflation in the purchase price.

Table 2.2 Data for worked example of annual capital cost

	Beginning of this year	End of this year	End of next year
Total useful life	20	20	20
Annualization factor	14.877	14.877	14.877
Domestic asset:			
Replacement cost	1000.00	1030.00	1060.90
Annual capital cost	n.a.	69.23	71.31
Foreign asset			
Replacement cost	1000.00	1040.00	1081.60
Annual capital cost	n.a.	69.91	72.70

Notes:

1. For interpretation, see Box 2.1.

Assumes interest paid annually at end of year.

3. Fr. = franc (or other local currency) 4. n.a. = not applicable

2.4 Assignment of Inputs to Cost Centers

At this point, you have presumably gathered information about the hospital's total costs, whatever the source of payment. This information alone may provide useful insights even before you start computing unit costs: for example, in identifying which line items account for most of cost and whether this is changing over time (see Box 2.2). However, to compute unit costs one must proceed to the next step: assigning costs from each line item to the relevant cost centers.

Box 2.2 Worked example for a hypothetical hospital

This box is the first in a series which works through an example of unit costing for a hypothetical hospital. Table A1 lists the hospital's costs by line item, such as salary and drugs, and by source of payment. Note that although most costs (70%) are paid by the Ministry of Health, other payment sources are also important. Donors pay for one physician's salary and for half of 'other supplies', while a government drug agency pays for drug shipments. If one failed to include these other payment sources, one would both understate total cost and misrepresent the true distribution of spending (for example, by omitting drugs).

Even if one does not proceed to compute unit costs, construction of a table like this can by itself provide helpful information. We now know the relative importance of the different payment sources and where the contributions of each are concentrated. Comparisons to previous years may help identify problems or trends, e.g. declining donor support or spiraling drug purchase costs.

Some inputs can be assigned directly to certain cost centers. For example, if 'kitchen' is a cost center, then the line item 'food' could all be assigned to that cost center. More often, inputs are used by several cost centers, and the analyst must seek to assign spending for an input across those centers.

Correct assignment is most important for those inputs which account for a larger share of costs, such as staff time and drugs. For an illustration, see Box 2.3.

Box 2.3 Cost assignment in the worked example

Table A2 takes the cost data for the hypothetical Hospital X (from Table A1), and shows how the line items can be assigned to cost centers. We are trying to obtain unit costs for the three wards: medical, surgical and maternity. We start with data on salaries, drugs and supplies which must be assigned to the wards and to the three intermediate cost centers: administration, cleaning and pharmacy. (Note that this simplified, hypothetical hospital does not even have a kitchen!)

The first column of Table A2 shows the total cost for each line item, including contributions from government, donors and elsewhere. The remaining columns show how this total cost is attributed to different cost centers. There are examples where an item is only assigned to one cost center (e.g. cleaner's wages and cleaning supplies to 'cleaning'). There are other examples where an item is attributed to several cost centers: for example, some staff work on more than one ward. Also, some drugs are shipped direct to wards while most are shipped to the pharmacy.

From Table A2, we see that the three wards incur 44% of the total costs. More than half of total costs cannot be directly linked to a specific final cost center, a proportion similar to what is found in many real hospital studies. The indirect costs must now be allocated using accounting rules, a task which is taken up in Section 2.5 and Box 2.4 below.

Staff Time. A variety of methods have been used to assign staff time among cost centers, ranging from simple (using administrative data) to elaborate (direct measurement).

Administrative data. Many hospitals have duty rosters showing which staff are assigned to which departments. Since many staff typically work in only one department, the roster can be used to allocate these staff. For the remainder who work in multiple departments, you can interview them individually, which may be time-consuming if they are numerous. Alternatively, you could ask their manager how many hours they work in each department, and prorate their salary (and fringe benefits) accordingly.

Direct measurement. The Dominican Republic study by Lewis and colleagues used the most comprehensive approach to allocating staff time. They employed data collectors who followed medical staff over a period of weeks and recorded the time spent with each patient. This was supplemented by interviews with patients. The study authors found that physicians only worked 12% of the time for which they were paid. This is an example of how the process of cost analysis can generate important information, even without computing unit costs. The information they gained was that the hospital was paying for labor it did not obtain.)

Comparison of approaches. The direct measurement approach has the advantage of giving direct information about the sources of inefficiency, where other approaches merely identify to which cost center expenditures should be assigned. The disadvantage of the direct-measurement approach is the high cost of implementing it, at least in the way defined by Lewis and colleagues. Analysts may want to consider a more limited implementation, perhaps in the second phase of a hospital cost study

after getting other systems working. The simplest method is to examine duty rosters for staff (if available), and allocate their time and associated salaries and fringes accordingly.

Excluded Activities. At some hospitals, certain activities generate costs which need to be excluded from the unit cost computation. There are several possible reasons for such exclusion:

Non-patient care. The prime example is teaching. Suppose you plan to compare unit costs between some hospitals which do a lot of teaching and others which do not. The teaching hospitals will naturally appear to have higher costs, even if they provide patient care very efficiently. In this situation, it is desirable to identify and exclude teaching costs to the extent possible. Some costs may be identifiable using job rosters which identify how many hours were spent teaching. However, teaching and patient care often occur simultaneously. Robertson and colleagues developed an approach to this in their Colombia study, which tracked physicians with time-and-motion methods. When care was being provided by a resident, the resident's time was charged to patient care while the supervisor's time was charged to teaching. When the resident and physician-supervisor conferred after seeing a patient, the time of both was charged to teaching.

Not under hospital control. Sometimes the central government operates some directly controlled programs on the hospital premises: for example, immunization campaigns. If these programs are not under the hospital's control, it would be unreasonable to include them in the hospital's unit costs.

In both cases, the excluded activities should be treated as final cost centers, in the sense that overhead will be allocated to them, and they will not be reallocated to other centers. However, unit costs will not be computed for them (unless you are interested and can identify outputs to measure).

Drugs. Drugs usually account for a substantial share of hospital resources, so it matters how their costs are treated in your analysis. If you are hoping to compute a unit cost per prescription, then you will definitely need to create a separate cost center for drugs (say, 'pharmacy'). If you are not treating drugs as an 'output', then you can choose between two approaches:

- Create a separate 'pharmacy' cost center but allocate its costs to final cost centers *during* the step-down process
- Assign drug costs to the cost centers (intermediate and final) *before* the step-down process.

Each approach has different advantages. The first approach is simpler, in that pharmacy costs will eventually be allocated based on a single statistic (e.g., each ward's share of prescriptions written). The second approach has value if you have better information, and know you can do better than allocating drugs based on a single statistic. For example, if you have data on the value of each department's actual drug purchases, you could assign the currency amounts to each department at this stage. However, against this, there is a managerial issue: the pharmacy is usually a separate hospital department run by a manager or responsible person, who should be able to track (and account for) use of the resources provided. The pharmacy manager will be better able to manage resources if the pharmacy is treated as a separate cost center. In addition, identifying Pharmacy as a separate cost center in all hospitals would help regional and national managers to monitor and compare the relative performance of pharmacy departments in different hospitals. Therefore, we would regard this as the preferred option, barring exceptional circumstances.

2.5. Allocation of All Costs to Final Cost Centers

The next step is to reallocate all indirect costs to the final cost centers. In this way, the unit cost will include overhead costs incurred in producing an admission, day or visit, not just direct costs. Indirect costs will include all costs which could not be allocated directly to final cost centers at an earlier stage. In some hospitals, this will only comprise services such as administration and laundry. In others, intermediate services such as pharmacy and radiology may also need allocating at this point, with little or no information about how much of their workload was generated by each of the medical departments.

Allocation Basis. Where each department's use of an indirect cost center is unknown, one must devise some rule to allocate the indirect costs across departments. The rule is called an 'allocation basis', and is intended to reflect whatever factors determine each department's use of the indirect (i.e., overhead, intermediate, or general) cost center. These factors may differ depending on the center. For example, most studies allocate laundry costs among wards based on the percentage distribution of total patient-days in each ward, since patients who stay longer use more laundry services. On the other hand, cleaning services are often allocated according to each department's floor area, since more spacious departments cost more to clean. (Of course, this may involve measuring the floor area of each department if such information is not readily available from sources such as building plans).

Knowledge of your own hospital may lead you to devise an allocation basis which predicts costs accurately, even if it has not been used elsewhere. For example, Weaver et al., the authors of the Niger study, decided that the number of air-conditioning units would be a good predictor of water and electricity costs, so they used that basis to allocate utility costs across wards (i.e., percentage distribution of air-conditioning units). They also learned that patients in private wards received were served better food, so that it would be incorrect to allocate kitchen cost simply based on the number of bed-days. Instead, they used a weighting scheme in which one day in a private room was equivalent to several days in the general ward. This example shows the importance of the judgment and creativity that the person doing costing may bring from specific knowledge of the hospital or the local situation.

Table 2.3 presents a summary of the bases for allocating various types of overhead costs in previous studies (in those cases where methods were described). For some services, a clear consensus is apparent, for example in the use of inpatient days to allocate laundry. For others, more variation is apparent, with four different methods being used to allocate maintenance. The large number of empty cells (denoted by dashes) results from the very different ways cost centers were defined across these studies (e.g. electricity and water appear separately in some studies, but are combined as 'utilities' in other studies).

Table 2.3 Bases used for allocating overhead cost centers to output centers: Overview of prior studies by cost center

Study	Laun- dry	Kit. food	Maint	Dom- estic	Clean Trans	-ing	Admin	Utils	Water	Elec.	Phone	Fuel	Secur -ity
Algeria	P	P	P	P	-	-	P	-	-	-	-	-	-
Bhutan (I)	-	D	-	-	A	-	PC	-	-	-	-	-	-
Bhutan (II)	-	-	F	-	A	-	P	-	-	-	-	-	-
Dominica	F	D	F	F	-	-	PC	-	-	-	-	-	F
Dominican R.	A	D	F	-	-	F	DC	-	-	-	-	-	-
Ecuador	A	D/P	P	-	-	P	P	-	-	-	-	-	-
Egypt (II)	A		DC	-	DC	-	-	-	-	-	T	-	DC
Gambia	D	D	F	-	-	-	P	-	F	F	-	-	-
Jamaica	D	D	DC	DC	DC	DC	DC	DC	-	-	-	-	-
Lesotho	D	PC	PC	-	PC	-	PC	-	-	-	-	-	PC
Malawi	D	D	F	F	A	-	DC	-	-	-	-	-	-
Montserrat	-	D	F	F	-	-	PC	-	-	-	-	-	-
Niger	-	-	-	-	-	-	P	-	AC	AC	P	P	-
Papua	D	D	DC	-	-	F	DC	-	-	-	-	-	-
Russia	D	D	F	-	DC	F	P	-	-	-	-	-	-
Sierra Leone	D	D	F	-	-	-	DC	-	-	-	-	-	F
St. Lucia	D	D	F	F	-	-	DC	-	-	-	-	-	-
Tuvalu	NS	NS	NS	NS	NS	NS	PC	NS	NS	NS	P	P	NS

KEY: A = estimated actual use
AC = air conditioning units
B = beds
D = days of care
DC = direct cost
F = floor area
P = personnel numbers
PC = personnel cost
T = telephones
NS = not specified
= not identified as a separate cost center

Note: Some authors contributed more than one study.

Allocation Using Direct Cost. A more rough-and-ready approach is to allocate all indirect costs based on a department's percentage share of direct costs. We discuss this approach in Appendix II, and would recommend it only when other data are not available for allocating direct costs.

Step-Down Sequence. The order in which centers are allocated may affect final results, and therefore deserves some consideration. Step-down analysis basically assumes that resource flows are 'one-way', and that one can therefore make use of this in choosing the step-down sequence. Table 2.4 illustrates this by showing flows among overhead cost centers at our hypothetical hospital. The first row shows that the administration cost center serves all others, so it should be allocated first. The next two rows show that the Cleaning cost center serves the Pharmacy, but does not receive drugs in return. The Cleaning cost center should therefore be allocated before the Pharmacy cost center. The order of the remaining rows does not matter since they will not be allocated (they are final output centers).

Table 2.4. Resource flows in a hypothetical hospital

Department providing service	Department receiving service		
	Administration	Cleaning	Kitchen
Administration	-----	X	X
Cleaning		-----	X
Kitchen			-----

Note: X denotes flow of resources from 'provider' to 'recipient' department.

It may help you to draw up a similar grid for overhead cost centers at your hospital. (You need not include the final cost centers since their costs will not be allocated anyway, but it may be useful to include them anyway because this will help you to see clearly which are the 'receiving' departments). Notice the shaded cells in Table 2.4, which have no X's in them. If you find the equivalent area on your grid has many X's, you should try to reduce the number of X's by swapping rows (i.e., changing the order in which you list the departments in the column and row headings). The reason is that X's below the diagonal introduce inaccuracy into the step-down, because you would be forced to ignore some resource flows where the receiving center would have already had all its costs allocated. It is possible that even after swapping rows, some X's will remain below the diagonal of cells with dashes in them. This is because in reality, most hospitals do have some two-way resource flows (for example, the administrative cost center does receive services from cleaning, when its offices are cleaned). This is an unavoidable source of inaccuracy in simple step-down analysis, but probably small in magnitude and deserving of less attention compared to more basic issues of cost measurement. (If absolutely necessary, techniques to handle two-way flows can be found in accounting texts such as Berman and Weeks, 1974).

Table 2.5 presents the cost centers used in the Lesotho study, in reverse order. Allocation started with 'all other administration' (number 29) and finished with pharmacy (number 11).

Inpatient/outpatient split. In some studies, the authors choose this point to separate inpatient from outpatient costs at certain cost centers. For example, some make the assumption that it costs three times as much to perform a surgical procedure on an inpatient basis, compared to outpatient. This allows them to allocate costs at the operating-theater cost center between inpatient and outpatient.

The intention of this practice is worthwhile: since inpatient and outpatient care are measured in different units (days vs. visits), they should be costed separately. However, we would argue that the inpatient/outpatient distinction should be made earlier in the step-down process, by defining inpatient and outpatient surgery as separate cost centers. This allows the analyst to use information about how specific overhead items are used differently for inpatient versus outpatient care. For example, outpatients may generate very few costs for kitchen and laundry, but a disproportionately high share of drug costs. These differences should be tracked cost center by cost center, rather than using an across-the-board rule of thumb at the last stage. (Of course, the rule of thumb may be the only option if there is no better information available).

Table 2.5. List of cost centers in Lesotho study

A. Direct patient care

1. Adult medical/surgical wards
2. Theater
3. Obstetric wards
4. Pediatric wards
5. Satellite clinics
6. Public health
7. Dental
8. Casualty
9. Clinics
10. Nursing

B. Ancillary clinical services

11. Pharmacy
12. Laboratory and blood bank
13. Radiology
14. Physiotherapy
15. Orthopedic workshop

C. Support services

16. Sterile supply
17. Maintenance
18. Security
19. Food service
20. Laundry
21. Portering
22. Transport
23. Mortuary

D. Administration

24. Medical records
 25. Accounts
 26. Personnel
 27. Stores
 28. Registry
 29. All other administration
-

Source: Puglisi, Robert and Bicknell, William 1990. Functional Expenditure Analysis: Final Report for Queen Elizabeth II Hospital, Maseru, Lesotho. Health Policy Institute, Boston University: Boston, Massachusetts.

Allocation of Ancillary Services. The allocation of costs of ancillary services is an important step, as they represent a substantial proportion of hospital costs. For X-ray and lab, most analysts try to estimate actual use. In the Papua New Guinea study, however, the number of admissions proved to be a good approximation (John Snow Inc. 1990).

Estimation of actual use involves gathering data on each department's share of utilization at the ancillary cost center, during a sample period. If one assumes that the sample period is

typical of the whole year, one can then apply the proportion from the sample to the full year's data. For example, if during the sample period, the surgical ward used 20% of total x-rays performed by the radiology department, one can assume it also used 20% of the x-ray volume performed annually.

There are two main ways to obtain the sample data needed for this approach. One is retrospective: review of past records kept by the ancillary department, for one or several months. For example, the Papua study found that the local hospitals radiology and lab departments kept logbooks for recording which departments had ordered each test. To avoid processing a whole year's logbooks, the authors sampled a 15-day period at each hospital and assumed that would be representative of the whole year.

Another way to obtain sample data is to ask staff at the ancillary cost center to track utilization by department over a short period of time. This approach has been used in the Dominican Republic (Lewis 1990, 1995) and Jamaica (Kutzin 1989). Typically, hospital staff in the x-ray, physiotherapy and lab cost centers are surveyed about the source of patients seen during one week (inpatient, outpatient etc.) and the number and type (e.g. basic/special) of exams performed. The information is then used to allocate ancillary costs between inpatient and outpatient care.

Finally, if no data can be obtained, interviews with staff may provide an approximate idea of utilization patterns. For example, in Kutzin's Jamaica study, the national laboratory did not record its supplies to individual hospitals, but staff there were able to estimate rough shares for each hospital.

One concern with these approaches arises if an ancillary department produces various outputs of differing value, and the some departments are more likely to use the higher-cost outputs. For example, suppose that the medical ward uses more complex lab tests than an obstetric ward. In this case, the medical ward's share of lab tests will understate its true share of cost.

Various studies have dealt with this by assigning a 'relative value' to each type of test, before computing departments' shares of volume. In some cases, there may be information in logbooks or ledgers about the relative value of different outputs. For example, some hospitals in Francophone countries assign a 'B-value' to each ancillary test, indicating its relative complexity (on a scale from 4 to 80). This value has been used to adjust for relative costliness of tests in studies of Niger (Wong) and Algeria (Djelloul).

Table 2.6 provides a comparison of how frequently these various methods were used in some of the studies we reviewed. It may be noted that many studies used one basis to allocate ancillary costs between inpatient and outpatient care, followed by a different basis to allocate inpatient costs among wards or departments.

Table 2.6. Bases used for allocating ancillary cost centers to output centers: Overview of prior studies by cost center

Study	Lab	Pharmacy	X-ray	Medical records	Operating theater	Physiotherapy
Dominican R.	-	-		-	-	-
Ecuador	N	M	N	-	-	N
Egypt (II)	E/AD	M	AD	-	S	N
Gambia	E/AD	M	E/AD	AD	A	-
Jamaica	A/D	D	A/D	AD	S/A	A/D
Lesotho	E/D	E/D	E/D	D	N	E/D
Malawi	AD	A	M	-	S	-
Niger	M	A	M	-	-	-
Papua	A	D	A	-	S	D
Sierra Leone	N	N	N	A	N	N
St. Lucia	N	A	N	AD	N	N
Tuvalu	M	M	M	-	-	-

EY:

A = estimated actual use from sample

AD = admissions

D = days of care

E = estimates by employees

S = number of surgeries

N = not allocated (final cost center)

NS= not specified

- = not identified as a separate cost center

Note: Two-item cells (e.g. E/AD) denote 2-stage allocation, with first item (e.g. E) denoting basis for allocating between inpatient and outpatient, and second item (e.g. AD) denoting basis for allocating among inpatient services.

Centers Not Allocated to Patient Care. Although the aim is to allocate most of the hospital's costs to final output centers, some costs may not be relevant to production of admissions or days. For example, several studies computed the costs of teaching medical students or nurses, but did not allocate those costs to any of the final cost centers for patient care. The idea is that resources used for teaching were not 'necessary' for the production of medical care, so they should be excluded from its cost. However, exclusion of these costs is equivalent to creating a separate final cost center for teaching (or whatever the other excluded activities are). Eventually, you may want to find output measures for these other final cost centers too, in order to know whether productive resources are being allocated reasonably - for example, between teaching and patient care.

Box 2.4 and Table A3 continue our worked example, by applying step-down cost analysis to the hypothetical hospital analyzed in earlier boxes.

The stepdown for the hypothetical example is simpler than will be encountered in real applications. We therefore also reproduce a real-life stepdown analysis from the St. Lucia study, as Tables 2.7 and 2.8. Amounts are in Eastern Caribbean dollars, when one US\$1 equals 2.3 Eastern Caribbean dollars (EC\$). Table 2.8 presents the stepdown itself (slightly adapted from the original study), starting with direct cost figures for 11 indirect and 15 direct cost centers. (In

this study, the ancillary departments were not allocated, but treated as final cost centers.) The second column shows each department's share of direct expense other than administration, and those shares are used to allocate the Administration cost (EC\$696,931) across the other cost centers. The remainder of the stepdown proceeds across subsequent pages until all indirect cost centers have been allocated. Table 2.8 then computes unit costs for the direct cost centers, using service units provided and the fully allocated cost from the stepdown.

This more realistic example yields several additional insights. First, if the stepdown is done by hand, there is some possibility of rounding errors. For example, the exact share of maintenance in non-administrative direct cost is 4.89214% (computed as $376,622 / (8,395,428 - 696,931)$). Using this share, one would allocate \$34,094.91 of the administrative cost to maintenance. However, if one had rounded the share to 5%, the amount allocated to maintenance would be \$34,846.55. This latter figure is 2.2% higher than the earlier, more exact allocation. The error will then be carried forward to subsequent stages. To the extent possible, one should therefore avoid rounding during the stepdown process.

Box 2.4 Cost allocation in the worked example

Table A3 shows a simplified step-down allocation for our hypothetical hospital X. The first column shows the direct cost for each of the six cost centers, which was obtained earlier, in Table A2. The first general cost center to be reallocated is administration, since it services all the other centers. The costs of administration are allocated to each of the other centers based on their share of the remaining direct cost (which is \$72,000, after subtracting the direct cost of administration from total cost). For example, the cleaning cost center accounts for 15% of this remaining cost, and is therefore allocated 15% of \$28,000, which is \$4,728. When this \$4,728 is combined with the \$11,000 in direct costs at the cleaning cost center, this center now has costs of \$15,728. The other cost centers are all assigned a share of the administrative cost, in the same fashion, proceeding down the same columns.

The next center to be reallocated is cleaning. The fifth column shows that \$15,278 in costs are to be reallocated from cleaning. These costs are allocated to each remaining department in proportion to its floor space. Since the pharmacy occupies 10% of the hospital's floor space, it is allocated 10% of \$15,278, which is \$1,528. Note that no costs are allocated to administration, since it preceded cleaning in the step-down sequence.

The final reallocation is that of pharmacy. The only remaining cost centers are the three patient care wards. Pharmacy costs are allocated based on each ward's share of the value of direct drug shipments (recalling that some drugs were shipped direct to the wards). The medical ward has the highest proportion of such shipments and is assigned a correspondingly high share of the costs at the pharmacy cost center.

The final column of Table A3 depicts the total, fully allocated costs at each ward, at the end of the step-down process. Note that the total costs add up to \$100,000: all the hospital's costs have been attributed to the three wards. Costs are highest at the medical ward, which also had the highest total direct cost. In the next stage, we will see how the costs compare to utilization in each ward.

Table 2.7 (Part 1)
Victoria Hospital: Stepdown Allocation

Departments	Direct Expense	Administration		Maintenance	
		Allocation Statistic	Allocation Of Expense	Allocation Statistic	Allocation of Expense
		Direct Expense		Square Feet	
<i>Indirect Departments</i>					
Administration	\$696,931	*100%	*\$696,931		
Maintenance	\$376,622	4.9%	\$34,095	*100.0%	*\$410,717
Domestic	\$299,774	3.9%	\$27,138	0.2%	\$821
Hospital Stores	\$33,560	0.4%	\$3,038	1.3%	\$5,339
Pharmacy	\$89,991	1.2%	\$8,147	1.1%	\$4,518
Nursing administration	\$124,238	1.6%	\$11,247	1.2%	\$4,929
Laundry	\$141,776	1.8%	\$12,835	6.2%	\$25,464
Seamstress	\$139,174	1.8%	\$12,599	0.2%	\$821
Catering/Kitchen	\$363,787	4.7%	\$32,933	1.3%	\$5,339
Medical Records	\$71,235	0.9%	\$6,449	1.9%	\$7,804
Handymen	\$134,256	1.7%	\$12,154	0.0%	\$0
Subtotal	\$2,471,344	23.0%	\$160,634	13.4%	\$55,036
<i>Direct Service Departments</i>					
Maternity Ward	\$596,511	7.7%	\$54,001	4.7%	\$19,304
Gynecology Ward	\$323,662	4.2%	\$29,301	2.6%	\$10,679
Baron (Private) Wing	\$216,956	2.8%	\$19,641	4.8%	\$19,714
Medical Wards	\$738,291	9.6%	\$66,836	11.2%	\$46,000
Surgical Wards	\$659,103	8.6%	\$59,667	7.1%	\$29,161
Pediatric Ward	\$368,720	4.8%	\$33,380	6.0%	\$24,643
Ophthalmology Ward	\$193,207	2.5%	\$17,491	2.5%	\$10,268
Operating Theatre	\$1,181,195	15.3%	\$106,931	7.9%	\$32,447
Laboratory	\$489,830	6.4%	\$44,343	2.4%	\$9,857
Radiology	\$315,032	4.1%	\$28,519	2.8%	\$11,500
Physiotherapy	\$42,244	0.5%	\$3,824	0.8%	\$3,286
Mortuary	\$42,077	0.5%	\$3,809	0.8%	\$3,286
Casualty (with clinics)	\$622,010	8.1%	\$56,309	5.4%	\$22,179
Medical Clinic	\$17,978	0.2%	\$1,628	0.5%	\$2,054
Psychiatric Clinic	\$10,781	0.1%	\$976	0.3%	\$1,232
Subtotal	\$5,817,597	.6%	\$526,657	59.8%	\$245,609
<i>Other Departments</i>					
Nurses' Home	\$106,487	1.4%	\$9,640	20.4%	\$83,786
Central Medical Stores (space only)	\$0			6.4%	\$26,286
Subtotal	\$106,487	1.4%	\$9,640	26.8%	\$110,072
Totals	\$8,395,428	100.0%	\$696,931	100.0%	\$410,717

* Amount to be allocated, not included in total.

Table 2.7 (Part 2)
Victoria Hospital: Stepdown Allocation

Departments	Domestic		Hospital Stores		Pharmacy	
	Allocation Statistic	Allocation of Expense	Allocation Statistic	Allocation of Expense	Allocation Statistic	Allocation of Expense
	Square Feet		Direct Expense		Direct Expense	
<i>Indirect Departments</i>						
Administration						
Maintenance						
Domestic	*100.0%	*\$327,733				
Hospital Stores	1.2%	\$3,933	*100.0%	*\$45,870		
Pharmacy	1.1%	\$3,605	0.1%	\$46	*100.0%	*\$106,307
Nursing administration	1.3%	\$4,261	0.1%	\$46		
Laundry	6.1%	\$19,992	5.2%	\$2,385		
Seamstress	0.2%	\$655	9.3%	\$4,266		
Catering/Kitchen	1.3%	\$4,261	22.8%	\$10,458		
Medical Records	1.9%	\$6,227	0.4%	\$183		
Handymen						
	13.1%	\$42,933	37.9%	\$17,385	0.0%	\$0
<i>Direct Service Departments</i>						
Maternity Ward	4.7%	\$15,403	6.1%	\$2,798	16.0%	\$17,009
Gynecology Ward	2.7%	\$8,849	1.8%	\$826	10.9%	\$11,587
Baron (Private) Wing	4.8%	\$15,731	1.0%	\$459	4.0%	\$4,252
Medical Wards	11.3%	\$37,034	5.0%	\$2,294	18.2%	\$19,348
Surgical Wards	7.1%	\$23,269	4.3%	\$1,972	15.8%	\$16,796
Pediatric Ward	6.0%	\$19,664	1.6%	\$734	9.1%	\$9,674
Ophthalmology Ward	2.5%	\$8,193	1.0%	\$459	4.0%	\$4,252
Operating Theatre	7.9%	\$25,891	14.3%	\$6,559	8.9%	\$9,461
Laboratory	2.4%	\$7,866	10.8%	\$4,954		\$0
Radiology	2.8%	\$9,177	10.9%	\$5,000		\$0
Physiotherapy	0.8%	\$2,622	0.1%	\$46		\$0
Mortuary	0.8%	\$2,622	0.1%	\$46		\$0
Casualty (with clinics)	5.5%	\$18,025	0.9%	\$413	12.5%	\$13,288
Medical Clinic	0.5%	\$1,639	0.0%	\$0	0.5%	\$532
Psychiatric Clinic	0.3%	\$983	0.0%	\$0	0.1%	\$106
	60.1%	\$196,968	57.9%	\$26,559	100.0%	\$106,307
<i>Other Departments</i>						
Nurses' Home	20.4%	\$66,858	4.2%	\$1,927	0.0%	\$0
Central Medical Stores (space only)	6.4%	\$20,975	0.0%	\$0	0.0%	\$0
	26.8%	\$87,833	4.2%	\$1,927	0.0%	\$0
Totals	100.0%	\$327,733	100.0%	\$45,870	100.0%	\$106,307

* Amount to be allocated, not included in total.

Table 2.7 (Part 3)
Victoria Hospital: Stepdown Allocation

Departments	Nursing Administration		Laundry		Seamstress	
	Allocation Statistic	Allocation of Expense	Allocation Statistic	Allocation of Expense	Allocation Statistic	Allocation of Expense
	Nursing Staff		Patient Days		Nurse Staffing	
<i>Indirect Departments</i>						
Administration						
Maintenance						
Domestic						
Hospital Stores						
Pharmacy						
Nursing administration	*100.0%	*\$144,720				
Laundry			*100.0%	\$202,452		
Seamstress					*100.0%	*\$157,516
Catering/Kitchen						
Medical Records						
Handymen						
<i>Direct Service Departments</i>						
Maternity Ward	13.9%	\$20,116	17.2%	\$34,822	13.9%	\$21,895
Gynecology Ward	6.6%	\$9,552	11.0%	\$22,270	6.6%	\$10,396
Baron (Private) Wing	7.3%	\$10,565	5.5%	\$11,135	7.3%	\$11,499
Medical Wards	16.5%	\$23,879	24.9%	\$50,411	16.5%	\$25,990
Surgical Wards	16.8%	\$24,313	22.6%	\$45,754	16.8%	\$26,463
Pediatric Ward	10.2%	\$14,761	15.3%	\$30,975	10.2%	\$16,067
Ophthalmology Ward	6.6%	\$9,552	3.5%	\$7,086	6.6%	\$10,396
Operating Theatre	13.1%	\$18,958		\$0	13.1%	\$20,635
Laboratory	0.0%	\$0		\$0	0.0%	\$0
Radiology	0.0%	\$0		\$0	0.0%	\$0
Physiotherapy	0.0%	\$0		\$0	0.0%	\$0
Mortuary	0.0%	\$0		\$0	0.0%	\$0
Casualty (with clinics)	8.7%	\$12,591		\$0	8.7%	\$13,704
Medical Clinic	0.2%	\$289		\$0	0.2%	\$315
Psychiatric Clinic	0.1%	\$145		\$0	0.1%	\$158
	100.0%	\$144,720	100.0%	\$202,452	100.0%	\$157,516
<i>Other Departments</i>						
Nurses' Home	0.0%	\$0	0.0%	\$0	0.0%	\$0
Central Medical Stores (space only)	0.0%	\$0	0.0%	\$0	0.0%	\$0
	0.0%	\$0	0.0%	\$0	0.0%	\$0
Totals	100.0%	\$144,720	100.0%	\$202,452	100.0%	\$157,516

* Amount to be allocated, not included in total.

Table 2.7 (Part 4)
Victoria Hospital: Stepdow Allocation

Departments	Catering/Kitchen		Medical Records		Handymen		Total (Allocated cost)
	Allocation Statistic	Allocation Of Expense	Allocation Statistic	Allocation of Expense	Allocation Statistic	Allocation of Expense	
	Nursing Staff		Patient Days		Nurse Staffing		
<i>Indirect Departments</i>							
Administration							
Maintenance							
Domestic							
Hospital Stores							
Pharmacy							
Nursing administration							
Laundry							
Seamstress							
Catering/Kitchen	*100.0%	*\$416,778					
Medical Records			*100.0%	*\$91,898			
Handymen					*100.0%	*\$146,410	
<i>Direct Service Departments</i>							Total cost
Maternity Ward	17.2%	\$71,686	12.6%	\$11,579	17.2%	\$25,183	\$890,306
Gynecology Ward	11.0%	\$45,846	4.7%	\$4,319	11.0%	\$16,105	\$493,390
Baron (Private) Wing	5.5%	\$22,923	1.4%	\$1,287	5.5%	\$8,053	\$342,213
Medical Wards	24.9%	\$103,778	5.5%	\$5,054	24.9%	\$36,456	\$1,155,370
Surgical Wards	22.6%	\$94,192	6.6%	\$6,065	22.6%	\$33,089	\$1,019,845
Pediatric Ward	15.3%	\$63,767	8.7%	\$7,995	15.3%	\$22,401	\$612,781
Ophthalmology Ward	3.5%	\$14,587	1.4%	\$1,287	3.5%	\$5,124	\$281,901
Operating Theatre							\$1,402,078
Laboratory							\$556,850
Radiology							\$369,228
Physiotherapy							\$52,022
Mortuary							\$51,840
Casualty (with clinics)			56.6%	\$52,014			\$810,533
Medical Clinic			2.2%	\$2,022			\$26,456
Psychiatric Clinic			0.3%	\$276			\$14,657
	100.0%	\$416,778	100.0%	\$91,898	100.0%	\$146,410	\$8,079,470
<i>Other Departments</i>							
Nurses' Home							\$268,697
Central Medical Stores							\$47,261
Subtotal	\$0	\$0	0.00%	\$0	0.00%	\$0	\$315,958
Total	100%	\$416,778	100.00%	\$91,898	100.00%	\$146,410	\$8,395,428

* Amount to be allocated, not included in total.

Table 2.8
Unit cost calculation

Department	Total cost	Units of service	Units	Unit cost
Maternity Ward	\$890,306	Day	9866	\$90
Gynecology Ward	\$493,390	Day	6295	\$78
Baron (Private) Wing	\$342,213	Day	3148	\$109
Medical Wards	\$1,155,370	Day	14228	\$81
Surgical Wards	\$1,019,845	Day	12946	\$79
Pediatric Ward	\$612,781	Day	8745	\$70
Ophthalmology Ward	\$281,901	Day	2009	\$140
Operating Theatre	\$1,402,078	Operation	2642	\$531
Laboratory	\$556,850	Test	60823	\$9
Radiology	\$369,228	X-Ray	8964	\$41
Physiotherapy	\$52,022	Treatment	5561	\$9
Casualty (with clinics)	\$810,533	Visit	34052	\$24
Medical Clinic	\$26,456	Visit	1327	\$20

Source: Russell et al., 1988. (Slightly modified).

2.6. Computing Unit Cost for Each Cost Center

At this point you know the total costs that were incurred at each of the final cost centers. What is the output of each center, in days, discharges, lab tests etc.? This requires incorporating utilization data into the analysis.

In reality, you will have used the utilization data already by this point, for example in order to allocate laundry costs across wards in proportion to bed-days. However, this is the point at which any problems with the utilization data become particularly important, because they directly alter the unit costs.

Several studies encountered problems with utilization data. In some cases, the number of admissions seemed accurate, but admission and discharge dates had not been carefully recorded, causing measurement of bed-days to be inaccurate. Correct measurement of bed-days requires that staff count how many beds are occupied in every ward, every 24 hours at the same time of day. The authors of the Lesotho study recommend that this should be done at midnight. A recent report on a Zambian hospital gives details on one way to conduct a bed census (Buve and Foster, 1995).

Once you have obtained the utilization data, the unit cost can be computed. For each of the final cost centers, divide its fully allocated cost (from step 5) by its units of service (see Box 2.5).

Box 2.5 Final computation of unit cost in the worked example

Table A4 presents the final computation of unit cost for our hypothetical Hospital X. The fully allocated costs for each ward, from Table A3, are now divided by the days of care on each ward. We see that although the medical ward had higher total costs, it also had many more days of care than the surgical ward (500 compared to 300). Unit costs are actually lower on the medical than the surgical ward, at \$76 compared to \$96 per day.

As discussed, in some contexts it may be desirable to present intermediate results, that is, those obtained before allocation of ancillaries. Table A5 shows what unit costs look like if one treats pharmacy as a separate cost center, and refrains from allocating its costs. In this case, the direct cost numbers in Table A4 come from column seven of Table A3, i.e. the cost figures after allocating administration and cleaning, but before allocating pharmacy. The results show a similar pattern to Table A4, with surgery having a substantially higher cost per day than either medicine or maternity. However, with pharmacy costs kept out, it is also possible to compute a separate cost per prescription, which is \$5 in this hypothetical case.

2.7. Reporting Results

At this point it is important to remind yourself and any readers what items are and are not included in the unit costs you have calculated. For example, your unit cost does not include drugs and x-rays unless you specifically allocated the costs of those services to other final cost centers, during steps 5 and 6.

Similarly, if you are not reporting outputs for certain final cost centers (e.g. teaching, public health clinic) then it is worth saying so in a footnote. Otherwise, readers may assume these centers' costs have been allocated to the services for which you do report unit costs.

CHAPTER 3: USING COST DATA TO IMPROVE MANAGEMENT OF AN INDIVIDUAL HOSPITAL

3.1 Introduction

This chapter discusses uses of cost data within a hospital; it therefore aims to show program managers and hospital administrators how costing can help improve their performance. This chapter is structured around two levels of decision-making:

Cost center level: Cost center and/or department management

Hospital level: Financial and hospital management

At each level of decision-making, uses of cost data will be drawn from seven categories of tasks: (1) budgeting, (2) variance assessment, (3) profitability, (4) efficiency improvement (both allocative and technical efficiency), that is, identifying areas of waste that can be corrected, pricing policy, and other health financing and policy concerns (e.g., insurance, contracting services vs. in-house services, and projecting future costs), (5) expansion or contraction of services, (6) contracting outside services or producing in-house, and (7) enhancing cost-effectiveness of programs and hospitals at the national level (e.g. comparing alternative approaches such as ambulatory vs. inpatient surgery to controlling a given medical condition).

The *first section* of this chapter discusses the various uses of cost data at the *cost center level* which tend to be in the areas of budgeting, variance assessment, profitability, efficiency (allocative and technical), expansion or contraction of services, and contracting outside vendors/providers versus using in-house staff in service provision. Examples in this section will focus on analysis of cost variance at the department level as well as the usefulness of cost analysis when considering whether to purchase contractual services or use in-house staff.

The *second section* applies cost analysis at the *hospital level* for budget development and monitoring, determining profitability status, pricing services, and identifying waste and technical inefficiencies in the hospital. Other issues facing managers of large tertiary hospitals as well as smaller district hospitals will also be discussed. Examples in this section will focus on issues of profitability and budgeting.

3.2 Cost Center or Department Level

By creating cost centers, assigning costs to them, and allocating them to final patient service departments, the hospital director and/or financial officer learn the quantity of resources used to produce each hospital service. Departmental directors and/or cost center managers also learn the amount of resources they are responsible for managing. There are other benefits to having this information: improved management, more financial accountability among departmental managers, and benchmarks developed for measuring departmental performance over time (e.g., number of meals served, cost of a radiological exam, total personnel cost of eye care, etc.). Perhaps the foremost reason for examining levels and determinants of costs is that it provides useful insight into the relative efficiency of hospital operations.

At the cost center/department level, the major uses of cost analysis are the calculation of cost variances and unit costs as measures of efficiency. Cost variances, which are differences of

an actual dollar⁴ amount from a standard amount (benchmark), are the clues that both signal a potential problem exists and suggest a possible cause. Common examples of such variances are:

- All variances that exceed an absolute dollar size (e.g. \$500 or 15,000 rupees)
- All variances that exceed budgeted or standard values by some fixed percent (e.g. 10%).
- All variances that have been unfavorable for a defined number of periods (e.g. 3 months or an entire quarter).
- Some combination of the above.

Actual cutoff of criteria values in the above examples (or rules) are highly dependent upon management judgment and experience. A variance of \$1000 (or, for example, 30,000 rupees) may be considered normal in some circumstances and abnormal in others. In each case, the objective of cost variance analysis is to assess why actual costs differ from either budgeted values or from prior period actual values.

Budget variance. This historical approach allows a hospital director to assign responsibility to managers of cost centers and to hold them responsible for budget performance of their respective departments. In turn, variance assessments will allow the manager of each department to compare the department's actual costs against budgeted figures. The budget variance is calculated as:

$$\text{Budget Variance} = \text{Budgeted cost} - \text{Actual cost.}$$

Thus, positive numbers are favorable and negative numbers are unfavorable (or considered deficits).

Intertemporal variances. In general, the primary reason for a cost change at the departmental level between two time periods is a function of three factors:

1. Changes in input prices.
2. Changes in input productivity (efficiency).
3. Changes in departmental volume.

The following variances can be calculated to compute the effects of these three factors:

Input Prices: Price variance = (Present price - Old price) X Present quantity

Input Efficiency: Efficiency variance = (Present quantity - Expected quantity at old productivity) X Old price

Volume Changes: Volume variance = (Present volume - Old volume) X Old cost per unit

As shown in the following example, these formulas can be applied in analyzing cost changes at the departmental level.

Example 3.1: Departmental analysis of cost variance. Lakshmi Hospital in India is a fictitious 325-bed referral hospital that provides patient care, teaching and research. It is modeled after actual experiences of certain hospitals in India. In 1996, bed occupancy for the entire

⁴ The word 'dollar' is used as a simplification. Any currency could be substituted.

hospital was 75% but increased to 85% during 1997. As might be expected, Lakshmi's laundry service department was impacted by this bed occupancy change.

From cost accounting studies done in 1996 and 1997, the hospital administrator suspects that unit costs in the laundry department have gone up. Perhaps he/she has compared the total costs in the laundry department with the total inpatient days and sees that laundry costs per day have increased. He/she knows that the increase in unit cost could have been caused by an increase in bed occupancy as well as increased in prices and wages (i.e., inflation), or by a drop in the productivity (input efficiency) of the laundry department. He/she can disaggregate the direct costs in the laundry cost center into personnel costs and supply costs, but he/she needs more detailed information in order to determine the source of the unit cost increase. Therefore, he/she asks the manager of the laundry department to provide the needed details. The laundry manager is able to track records of the total volume of laundry done in each year (in kilograms), the total number of soap boxes used each year, the price per soap box used, and the number of laundry workers employed each year at the hospital. Together with information from the cost study on salary (plus fringes) costs in the laundry cost center, the laundry manager assembles the basic information needed in Table 3.1.

As shown in Table 3.1, the department uses only two inputs: soap and labor. (Note: To avoid rounding errors, several decimal places were retained. Fixed costs for space will be discussed below.). Box 3.1 gives the resulting variances.

Table 3.1 Laundry service at Lakshmi Hospital

Item	1996	1997
Total recurrent costs of laundry cost center (rupees)	2,016,000	3,315,000
Total labor costs	216,000	435,000
Total soap costs	1,800,000	2,880,000
Kilograms of laundry	90,000	120,000
Recurrent cost per kilogram of laundry (in rupees)	22.400	27.625
Boxes of soap	1,200	1,600
Soap boxes per kilogram of laundry (boxes of soap/kilogram of laundry)	.01333	.01333
Price (in rupees) per soap box	1,500	1,800
Number of staff (average per year)	7.5	10
Hours worked (staff x 8 x 365)	21,600	29,000
Hours per kilogram of laundry (worked/kilogram of laundry)	.240	.242
Wage rate (in rupees) per hour	10	15

Box 3.1 Variance components for Lakshmi Hospital

Price variances:

Soap = (1,800 rupees - 1,500 rupees) X 1,600 boxes of soap = 480,000 rupees (*Unfavorable*)

Labor = (15 rupees - 10 rupees) X 29,000 hours worked = 145,000 rupees (*Unfavorable*)

Efficiency variances

Soap = (1,600 boxes of soap - [.01333 soap boxes per kilogram of laundry X 120,000 kilograms of laundry] X 1,500 rupees = 0 rupees

Labor = (29,000 productive hours worked - [.24 productive hours per kilogram of laundry X 120,000 kilograms of laundry] X 10 rupees = 2,000 rupees (*Unfavorable*)

Volume variances:

Volume variances = (120,000 kilograms of laundry produced in 1997- 90,000 kilograms of laundry produced in 1996) X 22.400 rupees = 672,000 rupees (*Favorable*)

With these calculations, Table 3.2 summarizes the factors that created cost changes in the laundry department:

Table 3.2 Causes of Lakshmi Hospital's Laundry Department
Cost Changes - 1996 to 1997

Cause	Rupees	Percent Change
Increase in soap prices	480,000	37.0%
Increase in wages	145,000	11.1%
Change in soap efficiency	0	0.0%
Decline in labor efficiency	2,000	0.2%
Increase in volume	<u>672,000</u>	<u>51.7%</u>
Total Change in Cost	1,299,000	100.0%

In the above example, the increased volume (or output) was the largest source (51.7%) of the total change in cost and a decline in labor efficiency being the smallest source (0.2%). However, all inputs combined (soap and labor prices and efficiencies) contributed to 48.3% of total cost changes in comparison to 51.7% for volume output.

However, the key managerial issue is identifying the extent and causes of a change in input efficiency. The results of the analysis show that there was virtually no change in input efficiency. Thus, the laundry manager can reasonably claim that the increase in unit and total costs was not the fault of the laundry department because of the general inflation effect (and not poor procurement practices).

Input cost variance: Example 3.2 below shows how input prices and efficiency can be combined into input costs. If there are a number of inputs, it may be impractical to measure the quantities used for each. In that case, it is possible to partition cost changes between inputs

(which combine prices and efficiency of all inputs) and outputs. In the following formula, input cost variance can be computed for all inputs combined, for a group of inputs, or for each input separately.

Input cost variance is computed as:

Input cost variance = Present input cost - old input costs X (present volume/old volume).

Example 3.2: Calculating input cost at the departmental level. Using the laundry department as an example, input cost variances of component inputs are given in Box 4.2:

Box 3.2 Input cost variances of components

Input 1: Soap

$$\begin{aligned} \text{Soap} &= [(1,600 \text{ boxes of soap} \times 1800 \text{ Rs. per soap box}) - (1200 \text{ boxes} \times 1500 \text{ Rs. per soap box})] \times (120,000 \text{ kilograms of laundry} / 90,000 \text{ kilograms of laundry}) \\ &= (2,880,000 \text{ Rs.} - 1,800,000 \text{ Rs.}) \times 1.33333 \\ &= 480,000 \text{ Rs. (total cost variance for soap)} \end{aligned}$$

Input 2: Labor

$$\begin{aligned} \text{Labor} &= [(29,000 \text{ productive hours worked} \times 15 \text{ Rs. Per hour}) - (21,600 \text{ hours} \times 10 \text{ Rs. per hour})] \times (120,000 \text{ kilograms of laundry} / 90,000 \text{ kilograms of laundry}) \\ &= (435,000 \text{ Rs.} - 216,000 \text{ Rs.}) \times 1.33333 \\ &= 147,000 \text{ Rs. (total cost variance for labor)} \end{aligned}$$

Box 3.3 presents the combined input costs in this example.

Box 3.3 Combined input costs

$$\begin{aligned} \text{Combined cost variance} &= 3,315,000 - [2,016,000 \times (120,000 \text{ kg} / 90,000 \text{ kg})] \\ &= 3,315,000 \text{ Rs.} - 2,688,000 \text{ Rs.} = 627,000 \text{ Rs.} \end{aligned}$$

We can verify that this sum is correct by showing that it equals the sum of the components of the two inputs.

$$\begin{aligned} \text{Input 1 (soap) cost variance} &+ \text{input 2 (labor) cost variance} = \text{combined input cost variance;} \\ 480,000 \text{ Rs.} &+ 147,000 \text{ Rs.} = 627,000 \text{ Rs.} \end{aligned}$$

The system of cost variance analysis described above is a useful framework for analyzing the sources of changes in departmental costs. It is recommended that this approach be limited to examining major supply categories; there may be little utility in calculating price and efficiency variances for each of a hundred or more supply items. For smaller areas of supply or material costs (e.g. pencils, sheets of paper, and boxes of paper clips), a simple change in cost per unit of departmental output may be just as informative as detailed price and efficiency variances.

Contracting services vs. in-house production. Analysis of unit costs also allows managers to examine the economic advantages of contracting services versus using in-house staff, a type of privatization. Private contractors may have better access to capital for new vehicles and

equipment, access to cash for buying parts, flexibility in hiring staffing with the needed skills, and adjusting staffing to workload by season, day of week, and time of day.

The measure of unit costs for an internally (or in-house) produced ancillary or support service can be compared to the cost of purchasing the same service from a private contractor. In addition to cost, numerous aspects of “quality” complicate examining contracting options. Quality includes not only the service itself (how well and how promptly the service is performed), but other administrative, political, and personnel dimensions. Important elements are the employment security of workers in the support service, and the nature of the infrastructure provided. Workers may oppose the contract option, particularly if their job security is not guaranteed. Yet private contractors may be reluctant to manage a public service at an advantageous price if they have no control over the workforce. A compromise is usually possible that gives hiring preference to the former public workers.

Contracting support services is becoming more common in developing countries. For instance, the Ministry of Health contracts with a vendor for catering services at all provincial hospitals in Sierra Leone. Spanishtown and other hospitals in Jamaica contracted for support services, such a portering and catering, with managerial support from USAID.

Both long run as well as short run costs need to be considered, which factor in equipment and use of space as well as operating costs. Example 3.3, again based on the laundry service at Lakshmi Hospital, illustrates these tradeoffs.

Example 3.3 Decision to replace laundry equipment or contract out. In 1997, Lakshmi Hospital’s laundry manager determined that all of the hospital’s current laundry machinery would no longer be serviceable in 1998. New equipment, which is produced domestically, would cost \$63,700 (1,911,000 Rs.) He is faced with the decision to either replace the equipment or close the laundry and contract with a private contractor who has adequate capacity to handle the 132,000 kgs. of laundry. Using the assumption of 3% inflation for domestic equipment and methods from Box 2.1, the annual depreciation for the new equipment would be \$10,000 (300,000 Rs.) per year. The fixed cost per kilogram of laundry for the new equipment would be 2.2727 Rs. based on 132,000 kg. of laundry per year. Added to the existing fixed cost (for space), the overall fixed cost would be 6.2500 Rs. per kg. After requesting bids from local vendors, the best quote was a price of 32.0000 Rs. per kilogram of laundry for three years. The resulting cost comparison (in Rs.) is as follows:

	<u>Contract</u> <u>Services</u>	<u>Use in-house</u> <u>Staff</u>
Variable cost per kilogram	32.0000	30.3875
Fixed cost per kilogram	<u>included</u>	<u>6.2500</u>
Total cost per kilogram	32.0000	36.6375

Based on the above cost comparisons, we recommend that the laundry department contract with the local vendor provided that: (1) the quality of services is maintained or increased, (2) current in-house laundry personnel can be hired by the private contractor and/or employed elsewhere in the hospital, other costs (such as inventory or replacements) do not increase, and (4) current space can be used by the hospital for other purposes. If these conditions are satisfied, the hospital will save 4.6375 Rs. per kilogram (calculated as 36.6375 less 32.0000) or 612,000 Rs. (\$20,400) per year.

3.3 Hospital Level

Cost variance analysis. Cost variance analysis is also of great importance to the hospital director or administrator. He or she is interested in analyzing the institution's overall performance, or in analyzing how changes in one department affect another. The unit of analysis at the hospital level is a single cost center or combined cost centers within a particular department. As mentioned, the occupancy of Lakshmi Hospital's inpatient clinical units rose from 75% in 1996 to 85% in 1997. Again considering the laundry department, the hospital director may be interested in knowing to what extent both intensity of services and "pure volume" contributed to the 51.7% volume increase from 1996 to 1997 (see Example 3.4 below).

Example 3.4: Analysis of cost variance at the hospital level. For the hospital director, the next step is to determine whether the 51.7% volume variance was due to intensity of services (e.g. increase in pounds of laundry per patient day) or change in volume due to change in overall service (e.g. increase in total patient days). These two factors are computed as follows;

Intensity = (Change in volume due to intensity difference) X Old cost per unit

Pure Volume = (Change in volume due to change in overall service) X Old cost per unit

Using previous information, 1.01159 kilograms of laundry were provided per patient day in 1996 and 1.19011 kilograms of laundry per patient day in 1997:

Fiscal Year 1996: 325 beds X 75% occupancy rate X 365 days = 88,969 total patient days;
90,000 kilograms of laundry/88,969 total patient days = 1.01159 kg of laundry per patient day in 1996.

Fiscal Year 1997: 325 beds X 85% occupancy rate X 365 days = 100,831 total patient days;
100,831 total patient days /120,000 kilograms of laundry = 1.19011 kg of laundry per patient day in 1997.

Box 3.4 presents the volume variances in this example.

Box 3.4 Volume variances

Based on the above information, the two volume variances are:

Intensity variance = [(1.19011 - 1.01159) X 88,969 total patient days in 1996] X 22.400 rupees
= 355,775 Rs.

Pure volume = 1.19011 X (100,831 total patient days in 1997 - 88,969 total patient days
in 1996) X 22.400 Rs.
= 316,225 Rs.

We can verify that the two volume variances are correct by showing that they equal the total volume variance of 672,000 Rs:

Volume variance = Intensity variance + pure volume variance
= 355,775 Rs. + 316,225 Rs. = 672,000 Rs.

Budgeting. Hospitals can use cost information to (1) establish rates and comply with both internal and external reporting requirements, (2) determine whether departments are operating within budget, (3) construct a budget for a department (or new initiative), and (4) allocate budgets among departments or cost centers.

As shown in Box 3.5, variance analysis can be applied in constructing the next year's budget for a department. To do this, hospital management of Lakshmi Hospital has identified those elements of cost that are presumed to be fixed and those that are presumed to be variable. *Fixed costs* do not change with respect to changes in volume whereas *variable costs* do change. We assume that variable costs change in direct proportion to changes in output or volume. That is, if output increases by 10 percent, these variable costs may also increase by 10 percent, that is, there is some constant cost increment per unit of output. In the following example, output in the laundry department is expected to increase by 10% due to an increase in occupancy from 85% to 93.5%. Variable cost is expected to increase due to 10% annual inflation and the output increase. Fixed cost is expected to increase by only 5% as only some components (e.g., utilities and maintenance) rise in cost while others (e.g. depreciation) remain constant.

Box 3.5: Constructing the 1998 budget for the laundry department of Lakshmi Hospital

The cost equation may be represented as follows:

Total 1998 budget = (fixed cost + variable costs)

1998 variable costs = (120,000 kilograms of laundry X 1.10 output growth factor)
X (27.625 X 1.10 inflation factor)

= 132,000 kilograms of laundry X 30.3875 Rs. per kilogram of laundry = 4,011,150 Rs.

1998 fixed costs = 500,000 Rs. X 1.05 inflation factor = 525,000 Rs.

1998 total budget = 4,011,150 Rs. + 525,000 = 4,536,150 Rs.

Example 3.5: 1998 Budget variance for the laundry department of Lakshmi Hospital. As part of the annual financial review process, the administrator of the hospital is examining the laundry department's 1998 budget in relation to actual experience. Table 3.3 presents the relevant data. Overall, the laundry department has a favorable budget variance of 66,150 Rs.

Table 3.3 Budgetary Data for Lakshmi Hospital

Item	1998 Actual	1998 Budget	Variance	Interpretation
Volume of laundry (kgs.)	125,000	132,000	7,000	(Unfavorable)
Variable costs (rupees)	3,945,000	4,011,150	66,150	(Favorable)
Fixed Costs (rupees)	525,000	525,000	0	(Neutral)
Total Costs (rupees)	4,470,000	4,536,150	66,150	(Favorable)*

Note: This favorable interpretation is of underspending relative to the budgeted level. However, the hospital manager could most likely be dissatisfied since this is primarily due to volume being less than anticipated.

Fiscal solvency. On a macro level, hospital administrators use cost data to assess the “break-evenness” of the hospital overall; that is, to what extent revenues were equal to total expenses for a particular fiscal year. “Break-evenness” is also relevant for revenue-producing departments like food services for visitors and families or clinical departments like internal medicine, surgery, or physical medicine and rehabilitation. The favorable difference between total revenues and total expenses (or costs) is called a *profit* or *surplus*. The unfavorable variance is called a *deficit* or *loss*. Determining and attaining a level of profitability that is both acceptable and sufficient is not an easy task. If profits are too low, quality of care can be impaired seriously

because of an insufficiency of resource support, both personnel and capital. In the long-run, the viability of the institution may be threatened because of an inadequate capital base that will ultimately restrict the organization's ability to expand clinical or ancillary services, pay for increasing costs like personnel, or reconstruct an old building. If profits are too high, the community may feel exploited by its hospital.

Example 3.5: Determining the fiscal solvency of Lakshmi Hospital. Table 3.4 presents the data for assessing the “breakevenness” of the hypothetical teaching hospital. This hospital is paid by patients, insurers, and governments according to the services that it provides. Approximately 30 Rs. (rupees) equal one US dollar.

Table 3.4 Lakshmi Hospital: Statement of Revenue and Expenses for the Year ended December 31, 1996

Item	Rupees
Patient service revenues ^a	61,824,000
Allowances and uncollectible accounts	<u>7,956,000</u>
Net patient service revenue	53,868,000
Other operating revenue ^b	<u>650,000</u>
TOTAL OPERATING REVENUE	54,518,000
Operating expenses	
Nursing services	12,306,000
Medical and clinical services	10,907,000
General services ^c	8,285,000
Administrative services	7,683,000
Education and research	5,285,000
Depreciation	3,888,000
Interest	<u>2,806,000</u>
TOTAL OPERATING EXPENSES^d	51,160,000
Net operating income	3,250,000
Non-operating revenue ^e	360,000
EXCESS OF REVENUES OVER EXPENSES	3,610,000

a Patient user fees, insurance payments, and government reimbursements. This amount is equivalent to 695 Rs. (\$23.16) per patient day.

b Visitor meals and gift shop.

c Support services (e.g. laundry and housekeeping).

d This amount is equivalent to 575 Rs. (\$19.16) per patient day.

e Donations.

The most commonly cited measure of profitability is the operating margin ratio:

Net Operating Income
Total Operating Revenues

For Lakshmi Hospital, the value of this ratio in 1996 is:

$$\frac{3,250,000}{54,518,000} = .0596$$

The higher the value of the ratio, the better the hospital's financial condition. A single way to understand this ratio is to think of it as a measure of profit retained per dollar of sales. For example, in 1996 Lakshmi Hospital retained 6 cents of every revenue dollar (or 6 rupees per 100 rupees of revenue) as profit. Given this relatively low operating margin, Lakshmi Hospital may need to examine its rate structure, increase its bed occupancy rate, and examine its cost structure to find items that could be contained.

3.4 Hospital Revenues

The revenue generated by a hospital, expressed as a proportion of its costs, is the product of three factors: the fee level (average fee as a proportion of average unit cost), the proportion of services which are paying (not exempted), and the collection efficiency (proportion of fees owed which are actually collected and remitted to the hospital's account). Generally, only a share of patients are actually charged the set fee, with the remaining ones being exempted due to poverty or other privileged categories (e.g. school children, or disabled war veterans). The first two factors are policy variables set by the hospital. A high degree of acceptability and a high degree of affordability for the service favor setting these percentages high, while a high level of cost-effectiveness and a high elasticity of demand favor lower fees and proportion paying. The last factor is a measure of administrative capacity. The efficiency of collection is greatest when only a few providers can dispense a given service in a limited location, and when the service is generally provided on an elective basis.

The three factors are summarized in Table 3.5. The "current situation" represents the authors' impression of fee collections in government hospitals in Bangladesh and Zimbabwe, where the manual was discussed in workshops. The fee level is currently low overall because fees for inpatient services and drugs generally cover only a small share of the costs involved, and these costs represent the majority of the operating costs of the country's hospitals. The proportion paying is also low because of broadly defined policies of indigence. As hospitals do not retain the fees they collect, they have every reason to be generous in interpreting the need for an exemption. Finally, the collection factor reflects the absence of specific programs to enhance collection.

Table 3.5. Factors explaining rate of cost recovery

Factor	Interpretation	Current situation	High fee	Moderate fee
Fee	Full fee for paying patients as proportion of unit costs	20%	100%	85%
Proportion paying	Proportion of patients exempted from fee	50%	50%	50%
Collection	Proportion of fees not exempted actually collected	40%	60%	70%
Recovery	Proportion of costs recovered	4%	30%	30%

In Jamaica, where a comparable collection rate previously existed, efforts of the Health Sector Initiatives Program substantially increased revenues. There, hospitals were given the liquidity and flexibility of spending their revenues, even though their government subsidies were often reduced as revenues rose. Collectors were trained, building modifications were made if needed to create a cashier's window, and additional positions were created to ensure that cashiers were on duty during evenings and weekends, in addition to normal government hours.

The "high fee" scenario below shows what would happen if nominal prices were set with no subsidies (i.e., 100% of costs). With only a moderate proportion of patients asked to pay (50%), and a low level of collections (40%), the overall level of cost recovery is 30%. By contrast, the same revenue is raised with a more moderate level of fees (15% lower on average), the same level of exemptions (50%), but better collections (70% enforcement). In some hospitals, "leakage" in collections occurs between the patient and the hospital account. While the patient may pay an "informal" fee, it may be retained by a gatekeeper, personal attendant, aide, nurse, physician, or deposited in a location other than the official hospital account. To improve collection, administrators may consider establishing policies to ensure that at least part of official fees are retained by the hospital that collects them and used to visibly benefit the institution, the patients, and the staff.

CHAPTER 4: USING COST DATA TO IMPROVE MANAGEMENT OF A HOSPITAL SYSTEM

4.1 Introduction

This chapter discusses cost analysis at the level of a hospital system. It spans the levels from the simplest hospital system, a district or province, up to the national level.

At the *district level*, managers often have the authority to set prices and allocate budgets to district health services in systems where such decisions are decentralized to the district level. Discussions will focus on issues relating to improving the referral system within the district and appropriate use of different providers of services.

At the *national level*, the manual suggests ways to identify relative inefficiencies among different but similar types of hospitals nationally or within a specified geographic area (i.e., province, state or region). It focuses on improving the referral system among hospitals and appropriate use of different providers of services. This section also focuses on the cost-effectiveness of programs, that is, what kinds of medical conditions should the hospital treat (e.g., high-level curative care vs. primary care prevention).

4.2 Estimating Volumes in a Hospital System

In some hospitals, data are so limited that costs cannot be analyzed using the techniques described Chapter 2. Nonetheless, it is still possible to draw some conclusions even if decision-makers only have aggregate cost data and some limited service or activity data. This section discusses what analyses can usefully be performed in such situations, and the limitations of these analyses.

Projections from Very Limited Data. The most limited situation occurs when only two very limited types of data are available for an individual hospital or a system of similar hospitals: the total operating costs and some measure(s) of size or activities. The preferable measure of size or activities is the number of services performed during a given period (such as the last year). A usable proxy, however, is the number of beds.

Shepard and Gonzales (1982) used this approximation to project the cost impact of a major expansion in hospitals underway in Honduras from 1980 to 1983. With data on the numbers of beds and recurrent costs for general public hospitals, they calculated that the annual operating cost per bed had grown at a 6.9% real annual rate of growth from 1976 to 1980 because of increasing intensity of services (or simply because of increasing budget allocations). They used this trend to project the future cost per bed. They multiplied it times the projected future number of beds (computed by adding beds under construction/planned to current bed capacity). As shown in Table 4.1, real costs were projected to rise by 53% in just 3 years. The increase would have represented more than the entire budget for ambulatory care in the country's health system.

Table 4.1 Projecting Costs of Hospital Services in Honduras (in constant 1980 US dollars)

Item	Actual, 1980	Projected, 1983
Number of beds	3,579	4,490
Annual operating cost per bed (\$)	5,708	6,973
Total cost of hospital system (\$ million)	20.4	31.3
Projected real increase over 1980	n/a	53%

To the consternation of financial officials, the results proved realistic. With the construction and planning processes well underway, the Ministry and donors added the beds essentially as scheduled. Financial constraints delayed the opening of several hospitals, however, until years after they were completed.

Similar approaches could be applied to an individual hospital, or to various types of hospital systems, such as:

- all government district hospitals in a given region, or in the country as a whole;
- all provincial hospitals in the country;
- all multi-purpose referral or teaching hospitals in a given region, or in the country as a whole;
- all specialty hospitals with a given purpose, such as mental health, tuberculosis.

Estimating Costs From Relative Values. A more accurate approach is feasible if data are available on the volume of services produced (activities) for a hospital over a defined period (generally one year), as well as on the annual operating costs. This approach differs from that in the preceding chapter, however, because it does not require operating costs to be assigned to individual departments or cost centers. Deriving unit costs from these data entails the following five steps.

1. *Identify the output-producing centers.*

As in the preceding chapter, the question is: for which services will unit costs be computed? This choice depends primarily on the level of detail for which activity data are available. For most hospitals, data are available on at least the aggregate number of ambulatory visits and the aggregate number of inpatient bed-days per year. In this case, one can estimate total cost of inpatient versus outpatient care and the unit costs of a bed day and ambulatory visit.

In some cases, the number of bed-days is reported by clinical department or ward (e.g., medicine, surgery, and maternity). In that case, one can estimate the unit costs per bed-day by ward.

2. *Define units of output.*

For each patient care cost center, one must define a unit of output. Within each cost center, the unit of output must be readily counted and reasonably homogeneous. In most cases, inpatient services are best expressed in terms of days, and ambulatory services in terms of visits. Inpatient admissions represents an alternative, though less homogeneous, measure. Costs will then be expressed in terms of per day or per visit. If data are also available on admissions as well

as patient days, this will allow for a calculation of average length of stay (ALOS). Average cost per admission could then be calculated by multiplying the estimate of average cost per day times ALOS.

3. *Define the data period.*

Data can be analyzed on a per-year, per-quarter or other basis. The crucial issue is to make sure that the same time period applies both to your aggregate cost figure and your utilization data.

4. *Identify the full costs of the facility*

Financial statements for the hospital may be a useful starting point, although as previously noted they may understate cost. Where possible you should try to add in costs of resources used by the hospital but paid for by others, e.g.

- donated items
- drugs purchased by a central state agency
- employees' time paid for out of other budgets

See Section 2.3 for a full discussion of how to develop complete cost data.

5. *Obtain external data on relative costliness of services*

To implement this approach, you will need estimates of the relative costliness of different types of care. These are rules of thumb, such as:

- One day of inpatient care costs three times as much as one outpatient visit.
- One surgical admission costs 10% more than the average inpatient admission overall.

We call these data 'external' because they will have to come from outside your hospital. (If you had such data internally, you could probably use the techniques in the previous chapter, instead of this one.)

Possible sources for these estimates could include:

- Other hospitals in your country for which step-down cost accounting studies (as described in Chapter 2) have been done
- Judgment of clinical experts or hospital staff on the relative amounts of resources used for the different services
- Studies from other countries you are familiar with
- Table 4.2 in this chapter of the manual (derived from step-down studies for which unit costs were available).

However, you will generate more useful information if you use estimates from hospitals which are similar to your own (e.g. in the same country, same level of hospital).

Table 4.2 Relative values for estimating costs by service*

Service	Unit	Relative Value		Number of observations
		Mean	Range (Low-High)	
All inpatient care+	Day	1.00	--	19
Medical with ICU	Day	1.28	0.67 - 3.54	8
Medical only	Day	0.81	0.67 - 0.96	5
ICU only	Day	2.65	1.39 - 4.79	5
Surgical with operating room	Day	1.26	1.10 - 1.50	7
Surgical only	Day	0.77	0.56 - 1.01	6
Operating room only	Operation	4.92	0.24 - 8.16	7
Obstetrics and gynecology	Day	1.00	0.50 - 1.33	10
Obstetrics only	Day	1.21	0.81 - 2.08	7
Gynecology only	Day	0.99	0.84 - 1.21	3
Pediatrics	Day	0.84	0.49 - 1.39	15
Outpatient	Visit	0.32	0.12 - 0.60	14

*A department's relative value (RV) is the ratio of its cost per day (or per visit for outpatient care) to the overall average inpatient cost per day.

+ Numeraire. The relative value for this service was set equal to one.

Example 4.1 Relative Values with Costs by Inpatient Ward. Table 4.3 shows how this calculation would work for the hypothetical hospital from the preceding chapter, which only provides inpatient care. Begin by identifying what you want to calculate and what you already know prior to manipulating the data. In this case, we want to calculate average cost per day in the medical, surgical, and maternity wards. What we know is total hospital expenditure (\$100,000), and total inpatient days in each of the three wards. Thus, in order to make the simplified unit cost calculation using the relative value approach, we need only to identify the relative cost of a day in each ward.

Table 4.3 Unit cost calculation from relative values for Hospital X

Ward	Reported Items			Calculated Items			
	Total Cost	Inpatient days	Relative Value (RV)	RV Units	% of RV Units	Cost of each service	Cost per Inpatient day
Medical (no ICU)		500	0.81	405	32.8%	\$32,847	\$66
Surgical with operating room		300	1.26	378	30.7%	\$30,657	\$102
Obstetrics & gynecology		450	1.00	450	36.5%	\$36,496	\$81
ALL INPATIENT	\$100,000	1,250	1.00	1,233	100.0%	\$100,000	\$80

Steps. The steps in this example were performed as follows:

Patient care cost centers: as before, we are distinguishing medical, surgical and maternity (but not pharmacy). The results will therefore be comparable to Table A4.

Unit of analysis: we have chosen the day as the unit of analysis, because the 'rules of thumb' about relative costliness are more readily available on a per-day basis than per-discharge.

Time period: although monthly utilization data are available, the financial data are annual so we compute unit cost on an annual basis.

Relative values: we take the ones from the analysis presented in Table 4.2.

Calculations: The first column reports the total cost to be apportioned. The second column repeats the inpatient days by ward, from Table A4. The third column introduces the 'relative value weights' from other studies, as presented in Table 4.2. Use of these weights implies that we are assuming that compared to the average inpatient day, a surgical day is 26% more costly and a medical day is 19% less costly. The fourth column uses these weights to convert days into relative value units (RVUs). It may be noted that although the medical ward provides more days than maternity, it provides fewer RVUs because each medical day has a lower relative value.

The fifth column computes each ward's share of total RVUs. The sixth column applies that share to the total hospital cost of \$100,000 (from Table A1). For example, the surgical ward has 30.7% of the RVUs, so we assume it is responsible for 30.7% of the hospital's cost, or around \$30,657.

Finally, we divide each ward's total cost by the inpatient days (first column) and obtain the unit cost by ward. The surgical ward has a cost of \$102 per day, compared to \$81 per day on the maternity ward and \$66 per day on the medical ward.

Uses. How can these figures be used? We can use them to compare surgical costs across hospitals, or to see whether it would be cheaper to transfer some surgical patients elsewhere. We can not use the results to conclude that surgery days are costlier than obstetrics and gynecology

days, because this was an assumption we used in the analysis, not something we learned from doing the analysis.

Comparison to Step-Down Results. In the present case, we can return to the results of step-down analysis in chapter 2, and see whether the 'relative value' approach gave different results. (This would not be possible if you were unable to do step-down analysis in the first place, due to poor data). How different are the results?

Comparing Tables A4 and 4.3, we see that the 'relative value' method understates unit costs by 14% for medical care and overstates unit cost for obstetrics and gynecology (maternity) by 10%. Unit cost for surgery is the same for both approaches. (The overall cost per day is the same in both tables, since we have only changed the way total costs are allocated across wards, not the amount of total cost or days of care).

From the comparison, we can conclude that our rules of thumb were somewhat inaccurate for two of this hospital's wards. Using the findings from our step down analysis, the correct rules of thumb would have specified that a medical day costs only 1% less than the average inpatient day, not 19% less. Also, maternity days are less costly than the overall inpatient average, not equally costly as specified by our rule of thumb.

Example of Approach with Costs by Inpatient/Outpatient Visit. Table 4.4 provides another worked example, for a different hospital which only knows total cost and the total number of inpatient days and outpatient visits, but not the allocation of costs between inpatient and outpatient settings. This hospital can still estimate separate unit costs for inpatient and outpatient care, by applying our relative values from Table 4.2 to its utilization data.

Table 4.4 Unit cost calculation from relative values: Inpatient versus outpatient

Service	Total Cost	Units	RV	RV Units	% of RV Units	Total Cost	Unit cost
Inpatient		100 days	1.00	100	21%	\$2,066	\$20.66/day
Outpatient		1200 visits	0.32	384	79%	\$7,934	\$6.61/visit
Total	\$10,000	-	-	484	100%	\$10,000	-

The first two columns show that this hospital incurred a cost of \$10,000 and provided 100 inpatient days and 1200 outpatient visits during the period studied. The third column gives the relative value weights from Table 4.2, which assume that one inpatient day costs the same as about 3 outpatient visits. Column 4 uses the weights to convert days and visits into RVUs, and Column 5 shows the share of RVUs provided in each setting. Since inpatient care accounts for 20.66% of RVUs, we assume it also accounts for 20.66% of total cost, that is \$2,066. This gives an inpatient cost per day of \$20.66. Similarly, the outpatient cost per visit is \$6.61.

The above example shows that the relative value approach can be applied even if different departments use different units. Even though the inpatient department provides days and outpatient provides visits, the two can be compared by converting dissimilar units to a common standard (the relative value).

Strengths and Limitations of these Approaches. The strength of the approaches described is their simplicity. The requirements in data are few; the analytic computations are easily done with a calculator. It is easy to explain the derivations. Also, results are likely to be less susceptible to misunderstanding when only approximate data are available.

The limitation of these approaches is the potential for inaccuracy, if the rules of thumb used are not appropriate for the hospital being studied.

4.3 Allocation of a Budget among Hospitals

Bed-day equivalents provide a useful statistic to allocate a central budget equitably among public hospitals. If this statistic were the only one used, then each hospital would receive a budget proportional to its share of total bed-day equivalents. That is, if a hospital generated 10% of the country's bed-day equivalents in the latest year with full data, it would be awarded 10% of the country's hospital budget next year. This statistic is one of the terms in the formula used by the Zimbabwe Ministry of Health to allocate funds to its central hospitals and provinces.

While not perfect, this type of system has several advantages. It is more objective and rational than the allocations based on past budgets and political influence seemingly practiced in some countries. It rewards productivity and efficiency, so each hospital receives the same budget per inpatient day and per outpatient visit. By contrast, budgets based on historical costs perpetuate, and may even encourage, overspending and inefficiency.

Limitations of a system based on bed day equivalents are its exclusion of several important factors, and its possible perverse incentives. A system based solely on bed-day equivalents would fail to account for needs for preventive and promotive services (which are not measured by inpatient and outpatient services), for differences in the sophistication of services, for other factors affecting the costs of services (e.g., distance and scale), for varying abilities of hospitals to raise revenue (based on the capacity to pay of the populations they serve), and for the time and central support required for a hospital to adjust to a different budget (i.e., to transfer personnel in or out, trim costs responsibly, or use additional funds productively). Perverse incentives can arise because such a system would reward provider-induced utilization (i.e., excessive admissions, lengths of stay, or follow up visits to boost activity statistics).

These limitations can be addressed by incorporating other factors in the allocation formula, and using a blended formula based on a combination of bed-day equivalents and historic budgets. The Zimbabwe Ministry of Health has addressed many of these concerns by using 13 parameters (including bed-day equivalents) in its allocations of resources. Other factors include population (a proxy for the needs of preventive services), area (a proxy for distance among facilities), numbers of health facilities and of rural health clinics (measures of scale), total beds, number of vehicles, dental ratios, laboratory units (all measures of sophistication), staff salaries and allowances (measures of past budgets), and outpatient attendances, patient days, and occupied beds (all additional measures of volume of activities). Each hospital's allocation is a weighted average of its share of the national total on each of these factors. While the Zimbabwe system does not explicitly incorporate relative income of catchment populations in its formula,

this term could be included in a final adjustment allowed by its system--“manual moderation taking into account practical factors” (Zimbabwe Ministry of Health, 1994).

4.4 Applications to Improve Hospital Efficiency

Overall efficiency. The manager of a hospital system should calculate the unit costs of final outputs for each of the hospitals in the system, and compare the results for the same unit of service in hospitals of the same type (e.g., district, provincial, and referral). For example, costs per patient-day and per outpatient visit can be compared.

For hospitals of comparable sophistication and quality, a low cost per patient-day is an indication of good efficiency, while a high cost per patient-day may suggest poor efficiency. A manager will first want to examine the data to rule out three spurious factors. First, if unit costs are excessively high in one hospital, resources may have been over-allocated to that hospital and under-allocated to another. For example, suppose two institutions share some important service, such as a pharmacy but all, or almost all, the cost were allocated to just one institution. Then the costs of that institution would be inappropriately high, while those of the other would be inordinately low. The manager should examine the unit costs of hospitals that might share services to see if they are inordinately low. If so, he or she should consider revising the basis of allocating the shared resource to see if results change substantially.

Second, the share of resources allocated to a particular service may have been inappropriately high. For example, if a hospital's cost for an outpatient visit were high, perhaps an excessive share of personnel or pharmacy costs was allocated to that service. To determine whether this spurious factor is responsible, the manager should examine possible reallocations of that resource. A service which represents a small share of a hospital's total costs is especially prone to errors in allocation. A small absolute difference in allocation will then make a big relative change in unit costs. For example, suppose a manager were unsure whether an emergency (casualty) ward represented 5 or 10 percent of hospital personnel. The total personnel costs, and thus the unit personnel costs, will be twice as high under the 10 percent allocation. For a large service, however, a 5 percentage point difference is much less crucial. The difference of 5 percentage points between, say a 50 versus a 55 percent share of personnel for medical/surgical inpatient stays would change unit costs by only a tenth. If unit costs for a given hospital tend to be very high for some services and very low for others, then it is possible that the basis of allocation is in appropriate. On the other hand, if a hospital's unit cost is consistently above average for different services, then that hospital is probably less efficient.

Third, an especially low unit cost may indicate that important resources are not being counted, or an estimate for a resource is particularly high. Results from Connaught Hospital in Sierra Leone may indicate this type of result. Many drugs and supplies were not bought officially through the hospital pharmacy (which had limited stock), but were purchased by patients, either through commercial pharmacies in the city, or through semi-formal drug sales at the hospital pharmacy. A knowledge of the hospital's operations facilitates these interpretations.

Once these spurious factors have been ruled out, it is instructive to examine the most efficient hospitals. Characteristics worth noting are: occupancy rate, staffing per bed, and per patient day, the proportion of staff at each of several levels of skill:

- doctor (includes dentists and licenses pharmacists)
- other health and management professional (include nurses, technicians, therapists, administrators)
- non-professional (driver, aides, housekeepers).

The standards of the most efficient hospital are often worth emulating.

Analysis of intermediate cost centers. A cost analysis generates the breakdown of total and unit costs by cost centers. Managers can judge these results against policy norms of how they think money *ought* to be spent, as well as against the positive data of how money *actually* was spent in other times and hospitals.

For example, the Sierra Leone study (Ojo et al., 1995) reported that food for patients represented the majority of costs in the country's referral hospital. As food is a less essential part of the process of hospital treatment than professional advice and medicines, it does not deserve a larger share of hospital budgets. Thus, anomalous allocation of resources prompts examining why food costs are so high. Both data anomalies and real managerial characteristics need to be examined. In Sierra Leone, Ojo et al. (1995) reported that the cost of food (the equivalent of \$5 per patient per day) was based on an estimate of the value of food given by an international donor. Either the estimate was high, or the food given was worth exceptionally high amounts.

Similarly, it is possible to compare results of a specific cost center across hospitals. We suggest examining the cost of this cost center through three ratios: (1) overall costliness: per patient day, (2) intensity: units of service per patient day, and (3) unit costs: cost per unit of service. The first ratio measures the overall resources used by a cost center, combining both utilization and costliness of that cost center. The second ratio is derived by measuring the allocated cost of an intermediate cost center divided by the total units of service. The third ratio is derived by dividing the total cost of the intermediate cost center by its allocation statistic. The three ratios are related by the mathematical identity: $(1) = (2) \times (3)$. This relationship allows the consistency of the data to be verified. In Box 4.5, we show how these concepts apply to the cleaning costs of medical cost center of the hypothetical Hospital X. In Box 4.6, we extend these calculations to all cost centers. An important advantage of this decomposition is that different officials are often responsible for different ratios. While responsibility is shared for the cleaning cost per bed day, the service intensity largely reflects choices in partitioning space among services, while the unit costs reflects decisions of the person responsible for the cleaning service.

Box 4.5 Interpretation of cost ratios for cleaning service in hypothetical Hospital X

Table A2 showed that the cost of the cleaning cost center allocated to the medical service was 3,056 (based on cleaning supplies and the cleaner’s salary). The text indicated that this cost center was allocated based on direct care floor area (the floor area for administration is not considered, since that cost center is allocated previously). Suppose the total patient care floor area was 10,000 square meters. Table A2 also showed that the medical cost center accounted for 20% of hospital’s direct care floor area (i.e., 2,000 square meters). Table A3 showed that this service had 500 units (patient days). Thus, the first ratio (the cleaning cost per day) was 6.13 (Calculated as 3,056/500). The second ratio, the intensity of inputs, is the number of square meters per patient day, or 2000 square meters/500 patient days, or 4.00 meters per patient day. The third ratio (the unit costs of the cleaning service for the medical service) is its allocated cost (3,056) divided by number of units (i.e., medical service floor area of 2,000 meters) giving a cost per square meter of 1.53 (calculated as 3,056/2,000). The consistency relationship is satisfied, subject to rounding. That is 6.11 is approximately equal to 1.53 x 4.00.

The calculations are:

RATIO 1	RATIO 2	RATIO 3
$\text{Cost/day} = (\text{square meters cleaned/day}) * (\text{cost/square meter cleaned})$ $= (2000/500) * (3056/2000)$ $= 4 * 1.53$ $= 6.13.$		

Box 4.6 Efficiency calculations for each service and their interpretation

Comparable calculations can be made for each service, as shown below:

<u>Service</u>	Ratio 1: <u>Cost/day</u>	Ratio 2: <u>Unit costs</u>	Ratio 3: <u>Intensity</u>
Medicine	6.11	1.53	4.00
Surgery	15.28	1.53	10.00
Maternity	13.58	1.53	8.89

Results show that surgery had the highest cost per day and also the greatest intensity of floor area per square meter. Maternity ranked second and Medicine last. The unit costs are identical for all three services because their costs were based on assigned square footage. These results are generally consistent with the needs of each service for operating theaters (in surgery) and delivery rooms (in maternity), compared to beds alone in medicine. Comparing the results for each service in Hospital X to results for other hospitals provides important measures of efficiency.

4.5 Refining the Hospital's Role in the Health System

The unit of analysis at the hospital system level are hospitals within a particular district, province, region or state, or the country as a whole.

Appropriate type of hospital. One of the principles of health planning is that patients should be treated in the least complex and least costly type of health facility which is adequate for their needs. This rule would generally ensure that patients are treated more conveniently, at lesser cost to the family (because they save travel expenses), and often at lower cost to the health system (as lower level facilities are thought to be less costly). Unit cost analysis allows the economic rationale behind this policy to be examined. For example, are tertiary hospitals really producing care more expensively than lower-level hospitals? If the tertiary hospitals have unit costs three times higher for the same services, should their fees also be three times higher?

As with other “real world” policies, cost alone is not a sufficient factor. Important dimensions of quality need examination. Quality entails not only the excellence of the staff, the depth of their training, and the sophistication of their infrastructure. Promptness and courtesy of service are also highly valued by patients. Nevertheless, there are potential economic gains from a more rigorous management of referral procedures.

Disease specific costs. Among adults, the prevalence of HIV infection in developing countries (1.5%) is 13 times as high as in industrialized countries (0.12%) (Mann and Tarantola, 1996). To better plan responses for prevention and control both donors and national governments needed data on current levels of health expenditures related to HIV/AIDS, their allocations and sources. Hospital costs represent a critical component of overall costs. In a study sponsored by the World Bank, the European Commission, and UNAIDS, Shepard (1996) selected five countries of varying economic levels for case studies. Only the one with the highest per capita GDP, Brazil, had existing data on hospital expenditures for AIDS. These were derived from reimbursements through its government run social security system.

For the other countries, several sources of data needed to be assembled. The Côte d'Ivoire (CI), a country of 14.3 million persons severely affected by this condition, illustrates this process (Shepard, 1996). Estimates for the CI were based on both objective data and Delphi estimates by AIDS experts from government, voluntary hospitals, and traditional medicine (Koné et al., 1996). Table 4.5 shows the process used to infer hospital costs. First, the overall number of AIDS patients was derived from reported cases and expanded for underreporting. Second, the experts classified the estimated annual number of new HIV/AIDS clinical cases (18,122) into five groups based on the expected type and amount of care that they typically received. Third, the length of stay and setting for each group was based on clinical data. Fourth, unit costs in each type of hospital were based on available unit cost studies, derived from step-down analyses or relative value approaches. For example, patients with private insurance coverage were estimated to receive care at private clinics, costing on average 52,500 West African Francs (F CFA, equivalent to US \$105) per day. At the other extreme, the hospitals used by rural patients (largely public, district hospitals) cost 5,000 F CFA (\$10) per day. Finally, totals were computed.

Table 4.5 Cost of hospital care for HIV/AIDS patients in Côte d'Ivoire, 1995

Patient Financing and location	Total number of cases	Days per patient	Cost per day+	Cost per patient+	Total days	Total cost+
Private coverage	906	34.0	52.5	1,785	30,804	1,617,210
Civil servants	1,812	20.0	10.6	212	36,240	384,142
Other urban Abidjan	8,699	16.3	15.0	245	141,794	2,126,906
Other urban interior	3,624	14.0	5.0	70	50,736	253,680
Rural	3,081	5.0	5.0	25	15,405	77,025
Total or average*	18,122	15.2	16.2	246	274,979	4,458,965

* This row represent totals for columns with heading beginning with "Total," and averages for other columns.

+ All monetary amounts are in thousands of F CFA, where 1,000 F CFA equals US \$2.00.

The overall average was 16,200 F CFA (US \$32.40). The 18,122 HIV/AIDS patients in Côte d'Ivoire received an estimated 274,979 bed days of hospital care in 1995. The total cost of their hospital care was 4.46 billion F CFA (US \$8.9 million). Compared to independent data on the hospital sector, HIV/AIDS patients represented about 21% of all hospital days and 19% of all hospital costs. Given that the country's seroprevalence is about 5%, these estimates were plausible.

By knowing the typical pattern of financing for each group of patients, the authors were able to estimate the overall financing of hospital care. Governments, which heavily subsidized public hospitals, provided 43% of costs; insurance (serving primarily civil servants and workers in large private sector enterprises) financed 22% of costs; households (through user fees) supported 33%, and other (primarily donors) the remaining 3%.

These data permitted comparisons of actual expenditures and recommended allocations. Compared to other countries in the study, hospitals were both relatively costly and heavily used. Thus, hospitals consumed 48% of curative expenditures. Overall, curative care represented 92% of all HIV/AIDS expenditures in CI, compared to 58% in the five case studies overall. The CI and other countries are using these data to refine their AIDS policies. In the short run, hospital costs can be reduced by providing care in less costly settings, such as ambulatory care or district hospitals, rather than teaching hospitals. In the long run, more vigorous prevention programs, such a vigorous programs to detect and treat other sexually transmitted disease, can help stem the increase in AIDS cases.

Cost effectiveness analysis: disease control approaches. As a final application, cost analysis can help policy makers compare alternative approaches to controlling a given disease. First, it can allow simple comparisons such as ambulatory versus inpatient surgery. A Colombian study, for example, found that the ambulatory form of surgery for repair of an uncomplicated hernia cost only a quarter as much as the inpatient form (Shepard et al., 1993).

Finally, cost analysis can allow approaches based on very different approaches to be compared. For example, for two important health problems in many tropical countries, prevention is difficult. Respiratory infections are airborne. Dengue viruses are carried by mosquitoes that breed quickly, even when spraying has reduced their number. Cost-effectiveness analysis of control programs for both diseases showed that except for vaccination, case management was generally the most cost-effective control procedure (Stansfield and Shepard, 1993; Shepard and Halstead, 1993). An analysis of hospital costs helped derive the costs of the case management approach.

Hospital financing: User fees. Cost analysis is an important ingredient in setting levels of user fees.

In practice, user fees are guided by additional considerations. Currently, hospital services in the public sector are heavily subsidized in almost every country. User fees commonly recover only a tenth of hospital costs.

Governments can, and often should, continue to subsidize care at public hospitals. Nevertheless, the calculation of unit costs allows that subsidy to be allocated more rationally. Principles of social welfare policy indicate that subsidies should be granted under the following conditions. First, if the consumers of a service are poor, so that the subsidy is a kind of in-kind income transfer to them. Second, if the service is a merit good or public good, so that the government wants consumers to use it. Many primary care services, and especially immunization, fit this second criterion.

The above analysis suggests that there is little rationale for subsidizing amenity services primarily consumed by the well off. Analysis of unit costs will indicate how much they should be charged over the long run.

Hospital Financing: Insurance. A number of developing countries are considering, or starting to implement systems of national health insurance. For example, Colombia passed a health reform law in 1994. Trinidad and Tobago completed a major study, and Ivory Coast is planning pilot programs. Typically, these systems entail payment by the insurance system to the provider of care (a hospital or doctor). Unit cost analysis allows an appropriate rate of payment to be developed.

In countries which allow multiple insurers to emerge, there is some risk that each insurer will try to pay less than its share of the hospital's overhead. This has been a problem in the United States, where some insurers have allegedly 'shifted costs' onto others by setting low payment rates. Measuring unit costs can help sort out these issues, by distinguishing direct costs of an admission (to be paid by the insurer responsible) from overhead costs (to be prorated across insurers). In principle, the government could prevent cost-shifting by requiring every insurer to pay the unit cost of a discharge. In practice, this may be undesirable, as hospitals might lose their incentive to restrain overhead costs (Ma and McGuire, 1993).

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APPENDIX I: TABLES FOR COMPUTING UNIT COST AT 'HOSPITAL X'

Table A1 Costs by Line Item and Source of Payment

Line item	Payment Source			Total Cost
	Ministry of Health	Donor	Drug Agency	
Salary Director	10,000			10,000
Secretary	5,000			5,000
Handyman	1,000			1,000
Cleaner	1,000			1,000
Pharmacist	5,000			5,000
Physician 1	6,000			6,000
Physician 2	6,000			6,000
Physician 3		6,000		6,000
Nurse 1	5,000			5,000
Nurse 2	5,000			5,000
Nurse 3	5,000			5,000
Auxiliary	3,000			3,000
Drugs			20,000	20,000
Cleaning supplies	10,000			10,000
Other supplies	8,000	4,000		12,000
Total	70,000	10,000	20,000	100,000

Table A2. Assignment of line item costs to cost centers

Line item	Cost to be assigned	Cost centers						TOTAL	%
		Admin	1. GENERAL			2. FINAL			
			Cleaning	Pharmacy	Med	Surg	Maternity		
Salary Director	10,000	10,000						10,000	100.0%
Secretary	5,000	5,000						5,000	100.0%
Handyman	1,000	1,000						1,000	100.0%
Cleaner	1,000		1,000					1,000	100.0%
Pharmacist	5,000			5,000				5,000	100.0%
Physician 1	6,000				6,000			6,000	100.0%
Physician 1	6,000				1,200	4,800		6,000	100.0%
Physician 1	6,000				1,200		4,800	6,000	100.0%
Nurse 1	5,000				5,000			5,000	100.0%
Nurse 2	5,000					5,000		5,000	100.0%
Nurse 3	5,000						5,000	5,000	100.0%
Auxiliary	3,000				1,200	1,200	600	3,000	100.0%
Drugs	20,000			12,000	3,200	2,000	2,800	20,000	100.0%
Cleaning supplies	10,000		10,000					10,000	100.0%
Other supplies	12,000	12,000						12,000	100.0%
Total	100,000	28,000	11,000	17,000	17,800	13,000	13,200	100,000	100.0%

Table A3. Allocation of costs to final cost centers

Cost Center	----- Admin -----			----- Cleaning -----			----- Pharmacy -----			
	Allocn		Revised	Allocn		Revised	Allocn		Revised	
	stat:	Expense		stat:	Expense		stat:	Expense		
	Direct	Direct	Direct	Floor	Reallo	Direct	Pharm.	reallo-	Direct	
Expense	expense	cated	area	Cated	expense	expense	cated	expense		
General										
Admin	28,000	100%	28,000							
Cleaning	11,000	15%	4,278	15,278	100%	15,278				
Pharmacy	17,000	24%	6,611	23,611	10%	1528	25,139	100%	25,139	
Final										
Med	17,800	25%	6,922	24,722	20%	3056	27,778	40%	10,056	37,833
Surg	13,000	18%	5,056	18,056	30%	4583	22,639	25%	6,285	28,924
Matern	13,200	18%	5,133	18,333	40%	6111	24,444	35%	8,799	33,243
Total	100,000			100,000			100,000			100,000

Table A4 Unit cost calculation (pharmacy costs allocated)

	Inpat days	Direct	Total	Cost per day:		Ratio of total	Direct
		cost (000)	Cost (000)	-----		fully/ partially	as % of total
				Direct	Total		
Med	500	17,800	37,833	35.60	75.67	1.36	47%
Surg	300	13,000	28,924	43.33	96.41	1.28	45%
Matern	450	13,200	33,243	29.33	73.87	1.36	40%
Total	1,250	44,000	100,000	35.20	80.00	1.34	44%

Table A5 Unit cost calculation (pharmacy costs NOT allocated)

	Units	Direct	Total	Cost per unit:		Ratio of total	Direct
		cost (000)	cost (000)	-----		Fully/ Partially	as % of total
				Direct	Total		
Pharm	5,000	17,000	25,139	3.40	5.03		68%
Med	500	17,800	27,778		55.56	1.36	64%
				35.60			
Surg	300	13,000	22,639		75.46	1.28	57%
				43.33			
Matern	450	13,200	24,444		54.32	1.36	54%
				29.33			
Subtotal (inpatient only)	1,250	44,000	74,861	35.20	59.89	1.34	59%

APPENDIX II: STEP-DOWN ALLOCATION USING DIRECT COST

A more rough-and-ready approach to cost analysis is to allocate indirect costs based on each department's percentage share of direct costs. This approach is commonly taken for assigning costs of the hospital's administration, and occasionally used for most overhead costs (for example, in Kutzin's Jamaica study). This approach is substantially simpler than the detailed step-down, and does not require information about floor area, bed days etc. One can therefore legitimately ask: how inaccurate is a 'crude' allocation based on direct costs only? Does it introduce systematic biases which can be offset by the use of 'fudge' (or adjustment) factors? For example, if prior studies show that the direct-cost approach typically overstates unit cost of inpatient wards by 20%, one would know to deflate unit costs by that amount when using the method.

To compare the direct-cost method with more sophisticated approaches, we reanalyzed data from previous step-down studies. In those studies where it was possible to do so, we computed a revised unit cost using the direct-cost method. We then compared the results we obtained with those reported in each original study. Table 3 presents the comparison of the two methods, by study and by department. The comparison is expressed as a ratio of unit costs by method. For example, an entry of 1.4 indicates that unit costs appear 40% higher using the direct-cost method, compared to the method used by the study authors.

Table 4 summarizes results across the 12 studies we reanalyzed. The results confirm that the direct-cost method tends to understate unit costs for inpatient care (in 10 out of 12 studies) and overstate costs for outpatient care (at least in studies where ancillary costs centers were allocated). The discrepancy occurs because inpatient wards use a lot of certain costly indirect resources such as kitchen and laundry, beyond the share one would predict based on direct cost. Equivalently, outpatient services use a relatively low share of these resources. An exception to the pattern is the operating theater, where the direct-cost method overstates unit costs (presumably because most of the theater's costs were easy to assign before the step-down allocation, leaving it a small share of indirect cost).

However, the results across studies differ substantially, especially at the level of individual wards. It is not clear what would be a reasonable adjustment factor for pediatrics, when the direct-cost method can lead one to a unit cost which is 30% too high or 36% too low, depending on the study. This variation may be because the studies differed in many respects which could not be controlled for, including the specific step-down approach that they used originally and the type of costs allocated. As a method for allocating costs, this approach should probably be a last resort, to use only when other data are not available for allocating indirect costs. On the other hand, it is a useful exercise to compute allocation using both methods and compare the results. Suppose one ward has much higher costs using the direct-cost approach than using step-down. Investigating the reason for this may help you understand the sources of cost differences across wards, e.g. which wards use a lot of kitchen or laundry services.

Table 3. Comparison across studies: Unit cost using 'direct cost' method, as a proportion of unit cost reported in study

	Papua		St. Lucia	Jamaica	Lesotho	Sierra Leone	Gambia		Egypt	Dominica	Montserrat	Bhutan (Thimphu)
	Hosp 1	Hosp 2					Hosp 1	Hosp 2				
ALL INPATIENT	0.994	0.928	0.905	1.013	0.958	0.241	0.93	1.072	0.812	0.936	0.951	0.956
Med/surg					0.902					0.829	0.877	
Medical	1.279	0.927	0.896	1.113		0.234	1.088	1.213	0.848			
ICU	1.464					0.785			0.327			
Med,not ICU	1.189					0.188			1.353	0.911		0.768
Surgical	0.510	0.645					0.796	1.202	0.621			
Excl.theater			0.906	0.964		0.259				0.753		0.781
Theater only			1.180		1.665	1.621					1.042	1.217
OB/gyn	0.994	1.039	0.932				0.800	0.909	0.730	1.026	1.017	0.904
OB only	0.930	1.062	0.939	0.807	0.999							
Gyn only	1.276	0.977	0.920									
Pediatrics	1.124	1.002	0.843	1.116	0.647	0.179	0.836	0.927	1.296	0.927	0.977	0.883
Private			0.888									
Outpatient	0.756	1.083	1.067	0.957	0.769	1.451			1.424	0.989	0.919	0.918
OP casualty					0.807							
OP clinics					0.619		1.171	0.588				
Drugs allocated?	y		y	y	y	n	y	y	y	n	n	y
Xray,lab allocated?	y		n	y	y	n	y	y	y	n	n	n

Notes:

1. 'Direct cost' method uses each final cost center's share of direct cost, as basis to allocate indirect cost.
2. 'Original' methods used other allocation bases. In some cases, we combined categories in original study, to make results comparable.

Table 4. Summary across studies
Unit cost using direct cost method, as a proportion of unit cost report in study

Service	Observations	Number of observations where using direct cost method makes unit cost:		Mean value	Standard Deviation
		Lower	Higher		
ALL INPATIENT	12	10	2	0.891	0.205
Med/surg	3	3	0	0.869	0.030
Medical	8	4	4	0.950	0.306
ICU	3	2	1	0.859	0.467
Med, not ICU	5	3	2	0.882	0.403
Surgical	5	4	1	0.755	0.241
Excl. theater	5	5	0	0.733	0.249
Theater only	5	0	5	1.345	0.251
OB/Gyn	9	6	3	0.928	0.100
OB only	5	4	1	0.947	0.085
Gyn only	3	2	1	1.058	0.156
Pediatrics	12	8	4	0.896	0.268
Private	1	1	0	0.888	0.000
Outpatient	10	6	4	1.033	0.226
OP casualty	1	1	0	0.807	0.000
OP clinics	3	2	1	0.793	0.268

APPENDIX III: EXAMPLES OF STUDY SUMMARY SHEETS

Country: Lesotho

Code: 24

Study: Functional expenditure analysis: Final report for Queen Elizabeth II Hospital, Maseru, Lesotho, 2 volumes: Final report, and Manual for users

Authors: Puglisi, Robert and William J. Bicknell

Year: 1990

Hospitals studied: 1 hospital: the national referral hospital.

1. Choice of final cost centers

Medical/surgical, B. pediatric wards

Theater (major/ intermediate/ minor)

Clinics (onsite/satellite), dental, casualty

Aggregate inpatient

Aggregate outpatient

Unit of output:

Day

Case

Visit

Day

Visit

2. Choice of cost centers 29 (10 direct, 5 ancillary, 8 support, 6 administrative) (p. 8) **Criteria:** identified in discussions with officials (p.2)

3. Identification of full cost for each input

Started with budgetary allocations from ministry of health. Where possible, subtracted spending on public health functions. **Travel:** had to subtract travel costs for patients from line item: only wanted staff travel costs (p.2). Lab: National Lab does 97 % of its work for this hospital, but is not in budget. It was added in. **Salaries:** The authors could not get individual salary data, so they used 'personnel emoluments' list. I.e., looks like they assumed each person was paid according to the government pay scale for that position (p.5). **Capital:** not discussed.

4. Allocation of inputs to cost centers

Communication, printing, overhead: allocated to administration.

Staff: allocated based on asking each department head about staffers' time allocations (p.5).

Travel: vehicle hire, mileage allocated among satellite clinics/ public health/ administration based on estimates by department head.

Power, maintenance: allocated based on % of personnel costs

Drugs: all allocated to pharmacy

Dressings: 60% to inpatient, then within that, based on % of patient days

Furniture, equipment: allocated to the service using the equipment.

5. Allocation of cost centers to output centers

5(a): allocation of support services, administration to ancillaries, patient care: (p.8-10)

Personnel costs: used to allocate accounts, personnel, stores, other administration

Inpatient days: used to allocate laundry, portering among inpatient departments after allocating 10% to OP

5(b): allocation of ancillaries to direct patient care (p.11) **Pharmacy:** 60% to inpatient, then allocated among wards based on patient days. **X-ray, lab:** 40% to inpatient, then allocated among

wards based on patient days. **Physiotherapy, orthopedics** similar approach. All based on discussion with department heads.

6. Computing total and unit cost for each final cost center

Problem with utilization data: patient day statistics not kept (p.R10). Instead, assumed 100% utilization of capacity (430 beds: p. 10). Need to do midnight census. Also no data on number of prescriptions filled (p. 10).

7. Findings

Results presented with and without allocation of ancillaries.

Country: Ecuador

Code: 28

Study: Cost recovery in public sector hospitals in Ecuador

Authors: Gerard M. La Forgia, Mercy Balarezo

Year 1993

Hospitals studied: 6 hospitals (4 government, 2 'charity')

1. Choice of final output centers

Inpatient

Surgery

Lab/path/ xray/ sonography

Cardiology

Outpatient, emergency, physiotherapy

Unit of output:

day

operation?

exam

cardiogram, encephalogram

visit

2. Choice of cost centers study names 12 indirect and 10 final, implying 22

3. Identification of full cost for each input

Salaries: Each facility's payroll department provided number of employees, actual salaries (p.87). This study did not count personnel vacancies as a cost, so subtracted them from hospital accounts (which did) **Drugs/ supplies:** Facilities didn't keep records of spending. Instead, used records kept by central stores and pharmacies. These were quantities, so had to obtain prices from purchasing departments. **Services:** taken from accounting ledgers - included utilities and service contracts (p.88) **Capital:** Excluded. Recurrent cost only, due to lack of information on capital spending (p.18) **Other:** The authors discuss why their cost estimates differ from budgeted spending (p. 20)

4. Allocation of inputs to cost centers

Staff: Assigned based on information supplied by personnel departments, and interviews with staff from each department (p.87).

Drugs, supplies: The records kept by central stores and pharmacies identified the receiving department/ward at each facility. Six-month samples of these were used to estimate distribution overall. (p.88)

5. Allocation of cost centers to output centers

NB: allocation done using double apportionment, not step-down (p.19,89). Allocation roles on p.88.

Floor area: was not available, otherwise would have used this to allocate plant operations, cleaning + maintenance (p.89).

Inpatient days: used to allocate kitchen, but so was staffing. Reason: employees get free meals.

Inpatient admissions:

Staff: used to allocate general administration, maintenance, plant operations, cleaning

Kilos washed: used to allocate laundry

estimated actual use: Used to allocate pharmacy, central stores

6. Computing total and unit cost for each output center No mention of problems with utilization data.

7. Findings

Unit costs are not discussed specifically in the text - only in relation to the percent recovered. Data show more than a twofold variation in unit costs of inpatient care (from \$925 to \$2253).

APPENDIX IV. TABLE OF ANNUALIZATION FACTORS

Useful Life (years)	Discount rate																				
	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
1	1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885	0.877	0.870	0.862	0.855	0.847	0.840	0.833
2	2	1.970	1.942	1.913	1.886	1.859	1.833	1.808	1.783	1.759	1.736	1.713	1.690	1.668	1.647	1.626	1.605	1.585	1.566	1.547	1.528
3	3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.444	2.402	2.361	2.322	2.283	2.246	2.210	2.174	2.140	2.106
4	4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.037	2.974	2.914	2.855	2.798	2.743	2.690	2.639	2.589
5	5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605	3.517	3.433	3.352	3.274	3.199	3.127	3.058	2.991
6	6	5.795	5.601	5.417	5.242	5.076	4.917	4.767	4.623	4.486	4.355	4.231	4.111	3.998	3.889	3.784	3.685	3.589	3.498	3.410	3.326
7	7	6.728	6.472	6.230	6.002	5.786	5.582	5.389	5.206	5.033	4.868	4.712	4.564	4.423	4.288	4.160	4.039	3.922	3.812	3.706	3.605
8	8	7.652	7.325	7.020	6.733	6.463	6.210	5.971	5.747	5.535	5.335	5.146	4.968	4.799	4.639	4.487	4.344	4.207	4.078	3.954	3.837
9	9	8.566	8.162	7.786	7.435	7.108	6.802	6.515	6.247	5.995	5.759	5.537	5.328	5.132	4.946	4.772	4.607	4.451	4.303	4.163	4.031
10	10	9.471	8.983	8.530	8.111	7.722	7.360	7.024	6.710	6.418	6.145	5.889	5.650	5.426	5.216	5.019	4.833	4.659	4.494	4.339	4.192
11	11	10.368	9.787	9.253	8.760	8.306	7.887	7.499	7.139	6.805	6.495	6.207	5.938	5.687	5.453	5.234	5.029	4.836	4.656	4.486	4.327
12	12	11.255	10.575	9.954	9.385	8.863	8.384	7.943	7.536	7.161	6.814	6.492	6.194	5.918	5.660	5.421	5.197	4.988	4.793	4.611	4.439
13	13	12.134	11.348	10.635	9.986	9.394	8.853	8.358	7.904	7.487	7.103	6.750	6.424	6.122	5.842	5.583	5.342	5.118	4.910	4.715	4.533
14	14	13.004	12.106	11.296	10.563	9.899	9.295	8.745	8.244	7.786	7.367	6.982	6.628	6.302	6.002	5.724	5.468	5.229	5.008	4.802	4.611
15	15	13.865	12.849	11.938	11.118	10.380	9.712	9.108	8.559	8.061	7.606	7.191	6.811	6.462	6.142	5.847	5.575	5.324	5.092	4.876	4.675
16	16	14.718	13.578	12.561	11.652	10.838	10.106	9.447	8.851	8.313	7.824	7.379	6.974	6.604	6.265	5.954	5.668	5.405	5.162	4.938	4.730
17	17	15.562	14.292	13.166	12.166	11.274	10.477	9.763	9.122	8.544	8.022	7.549	7.120	6.729	6.373	6.047	5.749	5.475	5.222	4.990	4.775
18	18	16.398	14.992	13.754	12.659	11.690	10.828	10.059	9.372	8.756	8.201	7.702	7.250	6.840	6.467	6.128	5.818	5.534	5.273	5.033	4.812
19	19	17.226	15.678	14.324	13.134	12.085	11.158	10.336	9.604	8.950	8.365	7.839	7.366	6.938	6.550	6.198	5.877	5.584	5.316	5.070	4.843
20	20	18.046	16.351	14.877	13.590	12.462	11.470	10.594	9.818	9.129	8.514	7.963	7.469	7.025	6.623	6.259	5.929	5.628	5.353	5.101	4.870
21	21	18.857	17.011	15.415	14.029	12.821	11.764	10.836	10.017	9.292	8.649	8.075	7.562	7.102	6.687	6.312	5.973	5.665	5.384	5.127	4.891
22	22	19.660	17.658	15.937	14.451	13.163	12.042	11.061	10.201	9.442	8.772	8.176	7.645	7.170	6.743	6.359	6.011	5.696	5.410	5.149	4.909
23	23	20.456	18.292	16.444	14.857	13.489	12.303	11.272	10.371	9.580	8.883	8.266	7.718	7.230	6.792	6.399	6.044	5.723	5.432	5.167	4.925
24	24	21.243	18.914	16.936	15.247	13.799	12.550	11.469	10.529	9.707	8.985	8.348	7.784	7.283	6.835	6.434	6.073	5.746	5.451	5.182	4.937
25	25	22.023	19.523	17.413	15.622	14.094	12.783	11.654	10.675	9.823	9.077	8.422	7.843	7.330	6.873	6.464	6.097	5.766	5.467	5.195	4.948
26	26	22.795	20.121	17.877	15.983	14.375	13.003	11.826	10.810	9.929	9.161	8.488	7.896	7.372	6.906	6.491	6.118	5.783	5.480	5.206	4.956
27	27	23.560	20.707	18.327	16.330	14.643	13.211	11.987	10.935	10.027	9.237	8.548	7.943	7.409	6.935	6.514	6.136	5.798	5.492	5.215	4.964
28	28	24.316	21.281	18.764	16.663	14.898	13.406	12.137	11.051	10.116	9.307	8.602	7.984	7.441	6.961	6.534	6.152	5.810	5.502	5.223	4.970
29	29	25.066	21.844	19.188	16.984	15.141	13.591	12.278	11.158	10.198	9.370	8.650	8.022	7.470	6.983	6.551	6.166	5.820	5.510	5.229	4.975
30	30	25.808	22.396	19.600	17.292	15.372	13.765	12.409	11.258	10.274	9.427	8.694	8.055	7.496	7.003	6.566	6.177	5.829	5.517	5.235	4.979

APPENDIX V. EXERCISES*

PART 1. A DISTRICT HOSPITAL IN BANGLADESH

Note: This exercise applies the principles of cost analysis and income analysis at the level of an individual hospital, providing the reader with an opportunity to calculate unit costs and practice other skills in chapters 2 and 3.

A typical district hospital in Bangladesh has 50 beds and 74 staff (14 physicians, 26 nurses, 15 technicians and skilled staff, and 19 unskilled support staff). This type of hospital has three patient care cost centers -- Inpatient Wards, Theatre (for surgical operations), and the Outpatient Department (for both clinics and casualty services). Four intermediate cost centers were used – Ambulance, X-ray, Pharmacy, and Laboratory. Because of the simplicity of the hospital, only one overhead cost center was defined – administration; it subsumes other support functions such as security, cleaning, and maintenance.

Exhibit 1 shows how the cost of hospital personnel by cost center based on how they spent their time. The average annual 1996 salary for each staff position and benefits, rather than the individual salaries at a specific hospital, were used to estimate personnel costs. The exchange rate was 40 Taka (Tk) equal to US \$1.00. The average annual cost (including benefits amounting to 60% of base salaries) per staff are: 89,000 Tk (\$2,225) per physician, 46,000 Tk (\$1150) per nurse, 44,000 Tk (\$1100) per technician or administrative staff, 23,000 Tk (\$575) per unskilled support staff member, and 48,000 Tk (\$1,200) per staff member overall. Non personnel and capital costs incurred in a patient care or intermediate cost center were assigned to that cost center, while all other costs (general maintenance and the annualized capital cost of the buildings and furnishings) were assigned to administration. Exhibit 1 shows the annual costs of this hospital by cost center. The total of about 5.2 million Taka is equivalent to US \$131,222. Ambulance operations and “other” expenses, including utilities, are high shares of expenses because of their high import content in relation to patient care cost centers.

Exercise 1. Compute the total cost of each cost center, by completing all of the blank cells in Exhibit 1.

Hint: As overhead costs represent only about a quarter of the total hospital’s cost and comprise a range of overhead services, administrators felt that overhead costs could be assigned

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proportional to the direct costs of the final (intermediate and patient care) cost centers. Thus, use the direct cost of each final cost center as the allocation statistic. The total of the allocation statistics is all costs except overhead. The allocation percentages are based on this total. The total costs of each final cost center are the sum of its direct and allocated costs. As a check, the total costs should equal (except for possible rounding error) the sum of the overhead costs plus the direct costs of each cost center.

Exercise 2. Compute the unit cost of each final cost center, a target fee for a typical unit of service by that cost center, and the potential revenue generated by that cost center by completing the blank cells in Exhibit 2. Note: Based on section 3.4, the target fee is the percentage of the average unit cost met by the fee in a paying patient. The percentage of patients charged (or paying) is the share of patients not exempted. The collection efficiency is the share of fees imposed that are actually collected from patients and officially remitted to the hospital.

Hint: The hospital administration sets the fee in each cost center equal to the target fee percentage of the unit cost. However, only a share of patients is actually charged the set fee, with the remaining ones being exempted due to poverty or other privileged categories (e.g. school children, or disabled war veterans). These two sets of percentages were based on relative importance, elasticity of demand, affordability, and acceptability of each type of fee. The efficiency of collection is greatest when only a few providers can dispense a given service in a limited location, and when the service is generally provided on an elective basis. The unit cost is the total cost divided by the volume. The target fee is the unit cost times the target fee percentage. The total revenue from each cost center is the product of the volume for service times its target fee times the percentage of patients charged times the collection efficiency.

Exercise 3. The hospital needs to recover a quarter of its total costs from user fees. Determine whether the assumptions above will meet this target, or if not, suggest an alternative set of values that will. Hint: add the revenues from each final cost center in exhibit 2 and compare the sum to the total costs of the hospital. Raising any of the percentages will raise the total; lowering any will lower the total. The impact will be greater by changing the percentages on the larger sources of revenue.

Exhibit 1. Allocating overhead costs to cost centers

Cost Center	Direct Expense* \$	Statistic* \$	Allocation Percent	Allocated Expense \$	Total Expense \$
Overhead: Admin. & other	34,902	0	0.0%	0	0
Intermediate: (Ambulance, etc.)	12,804				
X-ray	6,199				
Pharmacy	11,737				
Laboratory	9,134				
Patient care:					
Inpatient Wards	30,582				
Theater	14,811				
Outpatient Dept.	11,054				
TOTAL	131,222				

Exhibit 2. Calculating unit costs and potential cost recovery

Final Cost Center	Total expense \$	Volume 000	Units	Unit Cost \$	Target Fee (%)	Target fee \$	Patients charged %	Collection Efficiency %	Potential Revenue Tk 000
Intermediate Ambulance	17,443	20	Kilometers		60%		90%	80%	
X-ray	8,445	4	Films		60%		80%	90%	
Pharmacy	15,989	30	Scripts		75%		60%	90%	
Laboratory	12,444	50	Tests		50%		80%	90%	
Patient care:									
Inpatient Wards	41,663	15	Days		30%		70%	70%	
Theater	20,178	2	Operations		20%		80%	80%	
Outpatient Dept.	15,060	20	Visits		60%		70%	80%	
TOTAL	131,222								

PART 2: BUY OR MAKE LAUNDRY SERVICES

Note: This case compares internal production (with either owned or leased equipment) and outsourcing of laundry services.

As a hospital administrator, you are constantly challenged to deliver quality services efficiently. This objective includes deciding when to make a capital expenditure (i.e., one expected to provide benefits for longer than one year). Such a situation has arisen in the laundry department.

Your major piece of equipment in this department has become more and more obsolete to the point that you never know when it will be working. Linen is often not clean as it should be. Employee uniforms are embarrassing. Working conditions are deplorable, and current space is too small to house new or old equipment. Laundry employees are disgruntled because of these conditions; they take great pride in their work. You know that some neighboring hospitals have contracted out their laundry services. Some hospitals have been pleased while others are doubtful of the long-term benefits.

The current equipment is completely depreciated and outmoded. The capital cost of refurbishing the laundry would be as follows:

Refurbish Area	\$30,000
New Equipment	<u>65,000</u>
Total Capital Cost	\$95,000

The expected life of the equipment and renovation is assumed to be twenty years. The inflation rate is 7%, the real interest rate is 3%, and the nominal interest rate is about 10%. In addition, a rural hospital in the next town is willing to buy the outmoded equipment for \$2,000 as a back up to its washing machine.

Currently, the variable cost per kilogram (for soap, water, utilities, and direct labor) is US \$ 0.03 per kilogram, and your hospital processes 300,000 kilograms of laundry per year. Your annual fixed operating costs are:

Maintenance	\$1,400
Administrative Salaries	<u>8,000</u>
Total Fixed Costs	\$9,400

A company with 3 years of experience has indicated that it would collect the laundry, wash at its own off-site facility, and return it for \$.06 per kilogram (rising annually with inflation), if it were to get the contract. In-house administrative oversight of a contract would cost your hospital \$2,000. Alternatively, the company is willing to refurbish the space and lease the equipment to the hospital at \$10,000 per year--renewable annually for up to 20 years with the annual lease payment rising at the rate of inflation. The hospital would be responsible for all variable costs and maintenance.

Exercise 4:

- a. Given this information, identify the three options contained in the description above.
- b. For each option, estimate the capital, operating (both fixed and variable), and total costs.
- c. Choose the “best option” in terms of the lowest annualized costs.
- d. Discuss other features of the best option (e.g. flexibility, future cost expectations, and reliability).
- e. Identify at least one more option, not mentioned above, which could also be considered.

Answer:

a. Failure to make the needed investment would mean a discontinued service. Care should be exercised in identifying the alternatives. In this case, the three options for the hospital administrator are to maintain the laundry department as an in-house service with purchased new equipment, to contract an outside company to perform this service, or to lease the equipment.

b. First, we note that all three of the options involve a one-time income of \$2000 from the sale of the depreciated laundry equipment. We then examine the costs of each these alternatives in the order above. We present below the first year costs, recognizing that they will rise by the rate of inflation.

i. The capital cost of refurbishing and equipping a new laundry facility is estimated to be \$95,000. We annualize this amount using the procedures in Box 2.1. Using 3% as the real interest rate, the annualization factor is 14.877. With an inflation rate of 7 %, the replacement capital cost of the project at the end of the first year would be \$101,650 (derived as $\$95,000 \times 1.07$). The annualized capital cost is \$6,833 (derived as $\$101,650 \div 14.877$). Using the information above, total variable and fixed costs are:

Variable costs	\$ 9,000
Fixed costs/year	
Annualized capital cost	6,833
Maintenance and space costs	1,400
Administrative salaries	<u>8,000</u>
Total Fixed and Variable Costs	\$25,233

The net first year cost of the in-house option is \$23,233 (\$25,233 less the one-time income of \$2,000 from selling the equipment). The second year cost is \$26,999 (derived as $\$25,233 \times 1.07$). We assume that operating costs rise with inflation, and our method of annualizing the capital costs gives values that also rise with inflation.

ii. The next step in the analysis is to determine the cost of the second option, that is, to outsource or contract a company to do the laundry services for the hospital. Using the price quote from a company of \$.06 per kilogram, the cost of the second option is:

Contract fee: $\$0.06 \times 300,000$ kilograms of laundry	\$18,000
Plus: In-house administrative oversight of contract	<u>2,000</u>
Total cost of contract	\$20,000

The net first year cost of the contract option is \$18,000 (\$20,000 less the one-time income of \$2,000 from selling the equipment). The second year cost is \$21,400 (derived as \$20,000 x 1.07), as the price in the renewable contract will rise with inflation.

iii.	The leased equipment would entail:	
	Variable costs	\$ 9,000
	Fixed costs/year	
	Lease payment	10,000
	Maintenance and space costs	1,400
	Administrative salaries	<u>8,000</u>
	Total Fixed and Variable Costs	\$28,400

The net first year cost of the lease option is \$26,400 (\$28,400 less the one-time income of \$2,000 from selling the equipment). The second year cost is \$30,388 (derived as \$28,400 x 1.07), as the lease fee and other costs will rise with inflation.

c. The first-year costs of the three options can now be compared: \$23,233 (in-house option), \$18,000 (contract option), and \$26,400 (lease option). The second costs have the same relationship, without the one-time income. The hospital administrator would then choose the least cost option of contracting (\$18,000). The lease option is most expensive in this example. The private contractor might face higher costs of capital, or be more risk averse, than the hospital. The cost of each of these options, as we have computed it, would rise at the annual rate of inflation (7% per year).

d. The contract option provides flexibility for the hospital in the case that laundry or space needs change. A contract laundry might achieve efficiencies through more productive staff, better management, economies of scale through larger equipment, better use of plant and equipment through multiple shifts, or lower labor costs. One liability with this approach is the risk if transport were interrupted, whether by vehicle malfunction, weather, civil disturbance, or war. If this were a significant risk, the in-house option might be necessary (as it so proved to a hospital administrator in wartime Beirut who analyzed this same situation). Alternatively, additional inventory and storage might provide an alternative way of ensuring adequate laundry even if transportation were disrupted. Financing the in-house option might pose a significant challenge for the hospital. Although the hospital might have some capital reserves, public hospitals would usually need special approval for this type of capital expenditures.

e. Other options are to share laundry services with one or more hospitals, based either at your hospital or another, to buy used equipment, or to see whether some limited refurbishment could keep the laundry functional for a few more years.

PART 3: A MISSED OPPORTUNITY

Note: This case addresses constructing a cost analysis at the level of a hospital, identifying all the departments affected, and interpreting the results for hospital policy.

As the administrator of a crowded but respected public provincial hospital, you have calculated that by the end of this fiscal year, your hospital expects to be operating at a surplus. If you made no changes, your hospital's costs would be \$15,000 less than its budget from the national government and it would need to return this balance to the government. As an experienced administrator, you know that if you return the funds, you would have missed an opportunity to improve services.

Dr. Vivek, Chief Surgeon at your hospital, has just heard the good news about the Ministry's windfall from outside political sources. He approaches you before you could draft the memo to other department heads informing them of this opportunity and requesting their immediate input. With a tone of urgency, Dr. Vivek wants the hospital to purchase new endoscopy equipment that detects and replaces surgical treatment of colon cancer. The equipment is estimated to cost \$10,000. Dr. Vivek tells you that this cost is "minimal" and sees no reason why this request should not be approved for funding.

After discussing this matter with Dr. Vivek for two hours and after talking to a friend who is a financial analyst at a nearby hospital, you realize that there are other costs attached to purchasing this new piece of equipment. Dr. Vivek could only give you "soft numbers" when you asked him (1) how many patients who were treated on an inpatient and outpatient basis in the hospital who had colon cancer within each of the last three years, and (2) of those, how many could have benefited by the proposed equipment. According to Dr. Vivek, approximately 500 patients a year could benefit from the new equipment--about half now patients receiving only other diagnostic procedures and half receiving both diagnostic procedures and surgical treatment. Without the new equipment, each of the surgical cases would have spent a week in the hospital. If they do not need to be admitted, their place would be taken by other elective surgical patients, who usually wait several weeks for admission.

With your friend's help and Dr. Vivek's information, you estimate the full capital costs as follows:

New Endoscopy Equipment (10 year life)	\$10,000
Expand Outpatient Treatment Room (20 year life)	<u>5,000</u>
Total Capital Costs	\$15,000

Your friend advises you that the necessary approvals to apply the \$15,000 anticipated surplus to these capital costs could be obtained if you make an adequate case.

The inflation rate is 7% and the real interest rate is 3% per year. Variable costs are: physician (0.25 of annual salary of \$10,000), technician (0.5 of annual salary of \$3,000), nurse (0.5 of annual salary of \$5,000), and supplies (\$4,500 per year). Fixed annual operating costs are: maintenance (\$500), and salaries (\$1,000).

Dr. Vivek envisions a charge of \$25 for patients receiving diagnosis only, and \$50 per patient receiving diagnosis and treatment. Because of free care and incomplete collections, net income will be half of these amounts.

Exercise 5:

- a. Determine the annualized costs of Dr. Vivek’s proposal, counting all fixed and variable costs, and compare them to his original \$10,000 estimate.
- b. Discuss how this project might affect costs in other patient care units.
- c. Estimate the net income from the new procedure. Compare net income and costs and indicate the impact on the hospital’s finances.
- d. Discuss whether benefits to the health of the hospital’s patients justify these costs.
- e. If the capital costs of the new service are financed through the surplus, would the annualized costs be zero?

Answer

a. We first derive the annualized capital costs. Using a life of ten years, the annualization factor for the new endoscopy equipment is 8.530. The annualized capital cost for the endoscopy equipment in year 1 is \$1254 (calculated as $\$10,000 \times 1.07 = \$10,700$; $\$10,700 \div 8.530$). Using a life of twenty years, the annualization factor for the treatment room is 14.877, and its annualized capital cost in year 1 is \$360 ($\$5,000 \times 1.07 = \$5,350$; $\$5,350 \div 14.877$). Together, the annualized capital costs in the first year are \$1,614.

The variable and fixed costs are as follows:

Variable Costs:

Physician (.25 of annual salary of \$10,000)	\$ 2,500
Technician (.5 of annual salary of \$3,000)	1,500
Nurse (.5 of annual salary of \$5,000)	2,500
Supplies	<u>4,500</u>
Total Variable Costs	\$11,000

Fixed Costs:

Annualized Capital Costs	\$ 1,614
Maintenance	500
Administrative Salaries	<u>1,000</u>
Total Fixed Costs	\$ 3,114

Total Fixed and Variable Costs	\$14,114
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b. The new endoscopy procedure will forestall the admission of 250 surgical patients who would each have spent about a week in the hospital. Thus, the procedure will relinquish the beds that would have been occupied by these patients. As the hospital is crowded, it is likely that doctors would use the capacity in the surgical ward, operating and recovery rooms to admit 250 “replacement” patients who, on balance, would not otherwise have been accommodated at the

hospital. (The number of replacement patients assumes that they would have had the same length of stay as the former surgery patients now receiving endoscopy.) The impact on the surgical department is two offsetting effects: saving the cost of the patients whose surgery was averted, but adding the cost of the replacement patients. If the hospital did not have a long waiting list of eligible patients, then overall surgical admissions might decline.

c. The anticipated gross revenues for new program would be \$6,250 (250 diagnostic patients at \$25) plus \$12,500 (250 surgical patients at \$50) or \$18,750. The net revenues are half of this amount, or \$9,375. Thus, the net revenues would cover about two thirds of the costs of this program. Several options need to be considered to cover this shortfall. First, the charge for diagnosis could be raised to \$38 and that for treatment (which forestalls a week of hospitalization could be raised to \$75). Second, collections could be increased and free care reduced. Third, it might be possible to improve collections overall for the hospital. Finally, additional subsidy from the Ministry of Health could be sought.

d. The project produces three types of health benefits. First, both types of endoscopy patients benefit. The patients receiving diagnosis only may obtain a more reliable diagnosis. Some patients may be spared from what would have been unnecessary surgery. Others will receive treatment earlier. Second, the patients receiving treatment would benefit from a faster recovery and, perhaps, a lower complication risk. Finally, replacement patients admitted to the hospital through the beds made available enjoy an improvement in health. On balance, the new service would allow the hospital to treat 250 additional surgical patients at an annual cost of \$14,114, or \$56 per patient or \$8 per day. This is commensurate with or lower than the costs of many secondary hospitals in developing countries (Barnum and Kutzin, 1993). This service justifies its costs at least as much as that of other hospital services. Dr. Vivek's proposal represents a reasonable, though not extraordinary, program.

e. The annualized capital of \$1614 would not be reduced to zero from an economic viewpoint. It represents the one-year value of money invested in the capital asset of the equipment and the room renovation. The depreciation, computed by accountants, is less. Using straight-line depreciation it would be \$1,250 ($\$10,000/(10 \text{ years})$) plus \$5,000/(20 years). The difference between these amounts is the opportunity cost of the money invested in the project.

PART 4: THE WISH LIST

Note: This case addresses thinking quantitatively about the costs of a new service, and qualitatively about its contribution to the facilities goals.

The Ministry of Health has asked each hospital to submit a “Wish List” of one capital improvement project its administration wishes to be funded. These improvement projects can range from beautifying one or all wards to adding a new medical service to the current bed complement, or opening a new operating theatre. No dollar limit has been given, but instructions that you are to: (1) submit a financial feasibility statement showing all projected costs and revenues within a three-year time frame, and (2) not exceed an allowable net increase in operating cost limit of 1% of the hospital’s operating budget, including annualized capital costs. It is noted that funds from the Ministry are a “one time only” windfall, implying that costs beyond the 1% guideline would need to be self-financed.

Exercise 6:

Think of a capital improvement project for your hospital. Describe the types of data you would obtain to determine whether the impact is worth the cost of achieving it.

Answer

Making decisions on which capital projects will be undertaken is not an easy task for the Ministry of Health. The Ministry’s challenge is to allocate limited resources to a small number of projects. Your challenge is to present the best project information possible to enable it to make a decision. Your part is extremely important because inadequate or inaccurate project information can lead to bad decision-making by the Ministry of Health.

Ideally, there are five major categories of information that should be presented as part of your analysis:

(1) Identifying the Alternatives Available: Too many times, capital expenditures are presented on a “take it or leave it” basis; yet there usually are alternatives. For example, you may want to select different companies in the purchasing process to acquire the highest quality and the lowest cost. Also, you may want to define different boundaries in the scope of the project over a certain time period.

(2) Coherence with Hospital and Ministry Goals: This is the whole rationale behind the Ministry’s decision-making: scarce resources are to be allocated among a virtually unlimited number of investment opportunities. The Ministry’s limitation on allowable operating cost is an encouragement for you to submit only those projects that are in the hospital’s best interests, and to submit those that are not in conflict with the broader goals and objectives of the Ministry as a whole.

(3) Cost Data: It is clear from this manual that cost information is an important variable in the capital project decision-making process. The life cycle costs of your proposed project should

be presented. Limiting cost information just to capital costs or operating costs can be counterproductive.

(4) Benefit Data: Benefit data can be divided into two categories: quantitative and qualitative. Quantitative information is not only synonymous with financial data but it also encompasses service utilization data. Thus, it is important that your proposal includes an impact analysis discussing the “pre and post” effects of implementing a program.

For example, let’s say that your hospital is located in the Tansa Valley of India, a very rural area of many villages and towns. The nearest hospital that provides inpatient Ob-gyn care is located thirty miles in Bombay in a tertiary medical setting. One of the stated goals of your proposed project is to open twelve inpatient beds for Ob-gyn care, using a phased-in approach based on demonstrated demand. A realistic and quantifiable benefit of this project would be a numerical increase in patient days for your institution and an associated increase in revenue (in some small way from paying patients). To show these benefits, you would need to provide demographic data on your catchment area including the proportion of women by certain age categories you expect to admit to your new inpatient unit. A qualitative benefit of the project is that it will allow local residents access to Ob-gyn care without traveling long distances.

(5) Data Regarding Prior Performance: Information on prior operating results of projects funded by the Ministry and/or the hospital can lend insight as to the hospital’s performance and reliability in forecasting.