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Basic Cost Accounting for Clinical Services; Approved Guideline

CLINICAL AND LABORATORY STANDARDS INSTITUTE ™

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This document provides principles and techniques to help laboratory managers establish a workable cost-accounting system.

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Basic Cost Accounting for Clinical Services; Approved Guideline

Abstract

Basic Cost Accounting for Clinical Services; Approved Guideline (NCCLS document GP11-A) provides basic definitions and concepts for cost accounting that will enable laboratory managers and directors to evaluate the costs of producing laboratory results. In contrast to financial accounting, which provides external financial reports (e.g., for tax purposes, financial audits, and reports to stockholders) cost accounting measures internal costs in the light of management objectives. Cost accounting is, in the current economic environment, an important management and financial tool for laboratory managers. This guideline describes the conceptual foundations of cost accounting, provides an overview of various techniques for focusing resources to optimize the benefits of cost accounting, and suggests common applications for calculating costs in laboratory settings. It can also be used as a model for other healthcare services, such as nuclear medicine, nursing, and radiology. Additionally, these healthcare services can apply the common applications provided in GP11-A for calculating costs for their respective operations.

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Basic Cost Accounting for Clinical Services; Approved Guideline

Volume 18 Number 14

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Contents

Foreword

Although NCCLS document *GP11-A Basic Cost Accounting for Clinical Services; Approved Guideline* describes the conceptual foundations of cost accounting and provides an overview of various techniques for focusing resources to optimize the benefits of cost accounting for the clinical laboratory, It can also be used as a model for other healthcare services, such as nuclear medicine, nursing, and radiology. Additionally, these healthcare services can apply the common applications provided in GP11-A for calculating costs for their respective operations.

When the focus on health care gravitated to regulation and managed care, cost-effective services became a primary emphasis within the healthcare arena. Laboratories have quickly adopted management techniques that allow them to maximize resources and minimize costs. All laboratories find themselves in a competitive and changing environment that forces them to become more selective and specific about test costs for special and routine use. It is critical to a laboratory's financial success in this volatile economic environment that laboratory managers know how to determine actual costs and estimate standard costs for tests based on their own equipment, methods, and test menu.

Cost accounting is an important area of acquired expertise for laboratory management staff that enables managers to identify costs for budgeting and control. Healthcare organizations, group practices, and even physician offices are being asked to look at many options, including sending laboratory tests to reference laboratories to reduce costs. Before a laboratory manager makes a decision to "make or buy" laboratory tests, it is essential to know what it costs to do a test, once it has been determined that its medical necessity is appropriate. Many laboratories do not have formal cost-accounting systems, and most laboratory practitioners have not been formally trained in accounting principles, which provided the impetus and inspiration for this work.

By its very nature, cost accounting is a pragmatic discipline, a rational system for gathering and disseminating information. In practice, cost-accounting systems range from simplistic to complex, from hand-posted notebooks to sophisticated electronic equipment. However, the latter can be overemphasized, and the goals of improving cost management and laboratory operations under stress may become secondary to data gathering and analysis. Therefore, this document is intended to provide elementary instruction for managers and bench-level staff members to simplify the complexities of laboratory cost accounting and provide a working document for improving control of costs and reporting of significant deviations from standard costs.

Designing a uniform cost-accounting system that is compatible with the needs of all laboratories is difficult because of the tremendous variation in their complexity, resource requirements, and the type of records and information that are readily available. Therefore, the techniques described in Section 4 were selected for their general applicability and simplicity of design.

The Area Committee on General Laboratory Practices currently has two cost management documents in development which will complement GP11. They are: *Cost Analysis at the Point of Care*, which addresses calculation of the cost of use, and the cost benefit of various testing methods and instruments used at the point of care; and *Total Cost Management,* which provides an overview of the basic principles of total cost management and guidance on planning and adjusting budget allowances in a capitated environment.

NCCLS welcomes constructive input and project proposals for new, specialized, cost accounting topics as well as those which may have software applications. Feedback from those working in a clinical services setting whose organizations may benefit from guidelines and standards that will help them provide more cost-effective services is welcome.

Basic Cost Accounting for Clinical Services; Approved Guideline

1 Cost-Accounting Principles

In the business world, cost accounting is the discipline that provides management with vital cost information without which informed decisions about choice of procedures, personnel policies, or capital equipment expenditures cannot be made. It is important to realize that cost accounting techniques are not ends in themselves, but are tools to provide the laboratory manager with guidance as they attempt to make well-informed, long-range financial decisions in the rapidly changing clinical laboratory environment. (See Section 5 for further discussion.)

1.1 Accounting Systems and Information Needs

Cost accounting data are only estimates. They provide managers with information on the cost of a product or operation in relation to the needs of laboratory business management. Costs, therefore, must be calculated and understood with regard to the purpose the cost accounting system is intended to serve. The uses and applications of cost accounting in the laboratory are discussed in Section 5.

The system may be as simple as a single-cost-per-test analysis or as complex as a computer-based, multivariate analysis comparing actual results to established standards. A sophisticated system may be more accurate than a simple one, but its enhanced accuracy may or may not improve decision making. As the degree of sophistication increases, so does the cost in both money and time. Computer hardware and software may need to be added or expanded, and more personnel time may be required to support the system.

Another important consideration is the availability of data from an institution's "feeder" information systems (e.g., financial statements, payroll system, time cards, and purchasing system). It is important to understand these sources of information as well as the data-collection practices that are employed to record laboratory workload and expenses.

Each laboratory, therefore, should evaluate its information needs and the costs of acquiring and maintaining the information before beginning a cost-accounting operation. Additionally, in the long run, each laboratory must achieve a balance or level of comfort between cost and benefit, and simplicity and complexity of its accounting system to ensure profitability and/or efficiency.

Cost accounting defines and quantifies inputs such as labor and materials, to establish relationships between them. These relationships allow the interpretation and evaluation of the financial performance of the clinical laboratory (see Section 5).

2 Definitions

"Cost accounting" is a generic term. Although everyone knows what a "cost" is, such descriptive prefixes as "fixed," "variable," "semivariable," "standard," "direct," "indirect," "overhead," or "allocated" cause confusion. A useful set of terms for laboratory cost accounting are defined in this section.

2.1 Basic Definitions of Global Cost Terms

Cost, *n* - The amount of money expended for supplies, labor, and overhead required to produce a test.

Capital costs, *n* - Monies expended for business assets such as physical plant and laboratory equipment. **NOTE:** The operating expense associated with capital costs of equipment that is owned can be shown as depreciation (See definition below). Alternatives to equipment acquisition are leases, rentals, or other similar arrangements. A lease or rental expense is that amount of money paid to the titleholder of the equipment for the period of use of the equipment.

Actual costs, *n* - Monies actually expended for labor, materials, and all other incidentals required to produce tests. **NOTE:** These costs are recorded in the hospital's general ledger accounting system and are based upon actual payroll and payment of invoices. The closer actual costs are related to the performance of individual tests or groups of tests, the more accurate the cost accounting data will be. They are identified by department or laboratory section (see Table 2).

Standard costs, *n* - Predeterminations or estimates of what specific elements of cost should be involved in carrying out a function or activity given the test method, the materials to be used, and the projected working conditions. **NOTE:** They are usually established cost elements, such as labor and materials, and represent the probable cost that must be used to produce one test. Standard costs serve as a measure of comparison to actual costs.

Variance, *n* - The difference between the standard cost and the actual cost. **NOTE:** Many variances can be calculated, and three key variances are labor usage, labor rate, and material efficiency variances. These are discussed in Section 5.5.

Depreciation, *n* - The loss of value of technical (and nontechnical) equipment assets due to wear and tear, the passage of time, obsolescence, technological change, and inadequacy. **NOTE:** Depreciation is typically quantified by taking original cost and allocating this cost in a systematic manner over the anticipated useful life of the equipment.

Relevant costs, *n* - Special, nonroutine decisions, such as "make or buy," acceptance of a special volume testing request, or replacement of equipment deal with decisions that are based on future costs. **NOTES:** a) Projected future costs may be based on historical costs and/or may include costs not yet incurred. Not all costs are important in evaluating these decisions; b) Expected future costs will differ under alternative scenarios. For example, if a laboratory is approached by an outside service agency that proposes to provide repair and maintenance service, the cost of supplies, repairs, maintenance, and indirect labor may be the relevant costs because they could differ due to services performed externally. Direct costs for labor and consumables to produce the test are unchanged under both scenarios and are not relevant to the decision. An application of relevant costs is noted in Section 5.1, Issue/Response #3 and #4, and is discussed in Section 5.6.

Full costing//total cost// absorption costing, n - The process of recording all laboratory-associated costs, including indirect costs, and applying them to a billable test. **NOTE:** Table 3 illustrates the components of full test cost, which includes both direct and indirect costs. A sufficiently long accounting period (at least one year) should be considered and evaluated when using a full costing approach. This is due to the periodic nature of some indirect costs, as well as full cost dependence and sensitivity to test volume fluctuations. Full costing's application to management decision making is limited in the laboratory. However, its major role is to evaluate operational profitability and provide overall perspective in evaluating pricing policy. (See Figure 5 and Section 4.4.)

Marginal costs, *n* - The costs associated with processing additional tests. **NOTES:** a) These costs are incremental or additive in nature and would not be incurred if the additional testing was not performed; b) An example of marginal costs is the decision of a hospital laboratory to perform testing for the physicians at a nearby medical office building. If the testing was performed without altering existing resources (i.e., manpower and equipment). The true marginal costs would be for additional reagents, disposables, and incidental associated costs, such as courier service, packaging, and similar items. Technologist costs would not be considered a marginal cost if the work was performed during routine hours. However, if overtime was involved or a technologist needed to be hired to accommodate the anticipated additional volume, then labor would also be considered a marginal cost. (Refer to Section 5.1 and Response to Issue #4 for an application of the marginal cost principle.)

Contribution margin//marginal income, *n* - The difference between sales (revenue) and the direct costs to produce the products (tests) associated with a specific laboratory section or the laboratory as a whole. **NOTE:** This method measures the contribution of a laboratory section (or the entire department) to meeting period (e.g., month, quarter) costs and/or to making a profit for the hospital/ corporation. A meaningful contribution margin is possible only when it can be controlled or influenced by the laboratory.

Allocation, *n* - The method (typically used by hospitals/institutions) by which indirect costs are applied to departments, cost centers, sections, or other divisions within the institution. **NOTE:** The common goal of all allocation methods is to strive toward applying costs based on the strongest correlation between the indirect cost and to what it is being applied (i.e., utilities based on departmental square footage; human resource costs on the basis of departmental head count).

2.2 Cost Categories

Costs can be classified within four major categories: the *behavior* of cost to input or activity; *traceability* to the billable test being costed; *management responsibility or control*; and *time period* for which costs are computed.

Cost behavior and traceability are most relevant to this discussion of definitions. Their relationship to each other is illustrated in Figure 1.

2.2.1 Cost Behavior

This category classifies costs by their degree of *variability* in relation to test production as fixed costs, variable costs, and semivariable costs.

Fixed costs, *n* - Costs which do not, for a given time period, vary with changes in the volume of tests or activities performed. **NOTE:** Fixed costs are only fixed in relation to the given time period and are only fixed within a relevant range of activity. Table 1 gives examples of some fixed costs.

Fixed costs are fixed through a relevant range of tests. For example, an instrument may perform from 1 to 100,000 tests. Therefore, this is the relevant range of workload to which fixed costs are assigned. In most cases, fixed costs will not change based on the number of tests performed in a budget year and, to some degree, can be controlled by the laboratory manager. The element of fixed cost may be *directly* related to the performance of a test (e.g., depreciation expense for a specific piece of equipment), but its total cost will not change with the actual number of tests performed.

Cost Behavior

Traceability	Variable		Fixed		Semifixed		**Total**
Direct	Other	$4,000	Other	$1,000	Salaries	$10,000	
	Supplies	5,000					$20,000
		$9,000					
Indirect	Employee Benefits	$150	Depreciation	$160	Maintenance	$250	
			Administration	500	Laundry	100	
	Housekeeping	100	Housekeeping	100			
		$250		$760		$350	$1,360
	Total	$9,250		$1,760		$10,350	$21,360

Figure 1. The **behavior** of cost is related to input or activity; cost **traceability** is related to the billable test being costed; Cost behavior and traceability characteristics also can be applied to the categories of direct (variable) and indirect (fixed) costs. The relationship to common laboratory expenses is illustrated. Reprinted with permission from Travers EM. *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989:73.

Table 1. An Example of Budgeted Expenses for a Laboratory

Categories of direct/indirect and variable/fixed costs:

I. Direct Costs (Expenses)($)	Total	Fixed	Variable
1. Salaries			
Professional fees (MDs)	625,000	600,000	25,000
Clinical scientist(s)	65,000	65,000	0
Technical FTE	1,600,000	1,200,000	400,000
Phlebotomists	223,992	150,792	73,200
Clerical staff	224,200	174,200	50,000
Autopsy Assistant/aides	37,500	30,200	7,300
2. Supplies/reagents	1,305,000	0	1,305,000
3. Cost of blood/components	310,000	0	310,000
4. Reference laboratory fees	325,000	0	325,000
Total Direct Costs	$4,715,692	$2,220,192	$2,495,500
II. Indirect Expenses			
1. Depreciation	169,995	169,995	0
2. Administrative/general	122,500	122,500	0
3. Employee health/benefits	72,500	24,500	48,000
4. Equipment maintenance/repairs	128,500	128,500	0
5. Building maintenance	62,400	42,400	20,000
6. Travel	19,998	7,000	12,998
Total Indirect Costs	$575,893	$494,895	$80,998
Total Costs			$5,291,585

EM Travers original, 1991. Used with permission.

Example: If the rent in the chemistry section is $300.00 per month, the total cost is $300.00. Therefore, the cost per test for the rent at a volume of 1,000 tests per month is $0.30, and the cost per test at a volume of 5,000 tests per month is $0.06.

Variable costs, *n* - Costs that change proportionately with changes in the volume of tests performed. **NOTE:** Consumable costs such as reagents and supplies that are directly associated with performing each test or activity are variable costs. As the number of tests and activities increase, the cost also increases by the same amount per test.

Example: A particular test requires 1 mL of reagent A. Reagent A costs $0.10 per mL. For 250 tests, the total cost of Reagent A is $25.00 and the total cost for Reagent A for 500 tests is $50.00. Therefore, variable costs change proportionately with changes in workload activity.

Semivariable costs, *n* - Costs that stay constant within a smaller relevant range of activity, sometimes described as step-variable costs. **NOTE:** An example is hiring an additional clerical person when overall department volumes exceed a certain level. Until that level is reached, that person is not hired.

2.2.2 Cost Traceability

Of all classifications of cost, traceability is the most basic. The major categories of costs classified by traceability are direct and indirect costs.

Direct costs, *n* - Test-specific costs which include supplies, disposables, and reagents, along with hands-on technical time and instrument costs that can be easily identified and traced back to specific tests or test groups. **NOTE:** Direct costs include costs for supplies; labor to perform tests (e.g., collect body fluids or blood and prepare serum; perform, record and transmit test results); and reagents (including wastage), standards, controls, and any repeats or duplicate tests required to produce a test result. The term is based on the principle that a cost can be directly traced to a cost object (a billable test produced).

Indirect costs, *n* - All expenses that cannot be directly assigned to a billable test but contribute to the production of a test and the provision of an adequate work environment (see Table 2). **NOTE:** The words "indirect" and "overhead" are often used interchangeably. They may have the same or different meaning depending upon how they are used and from whose perspective they are used. For the purpose of this document, these costs are referred to as indirects, and are differentiated into two categories: laboratory indirects and institutional/ corporate indirects.

Table 2. Components of Full Test Cost[1]

I. Direct Costs

Labor
- Variable (flexible technical personnel)
- Semivariable (nonflexible technical personnel)
- Fixed (supervisory, administrative, clerical personnel)

Consumables
- Supplies
- Reagents
- Disposables
- Quality controls/standards

II A. Indirect Costs - Laboratory

Laboratory Indirect Costs (section or laboratory-specific)
- Lease, rental contracts for equipment/services
- Service and maintenance contracts
- Depreciation (when applicable)
- Labor (management, ADP, support staff, and labor to perform proficiency testing, linearity, and quality management)
- Materials and supplies not used in test production (e.g., proficiency testing materials, clerical and maintenance supplies)
- Equipment depreciation (technical and nontechnical)
- Laboratory information system
- Licenses, fees, proficiency testing materials
- Professional costs
- Training
- Maintenance for physical plant
- Utilities
- Site preparation for installation/removal of equipment

II B. Indirect Costs - Institutional/Corporate

- Actual invoiced (physical plant, purchasing)
- Formula derived (housekeeping, building depreciation)
- Stepdown expenses (administration, medical records)

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Within the laboratory environment, some important classes of indirect costs follow:

- ***Laboratory section-specific costs***: Items that cannot be easily identified with a specific test, but can be identified with the specific section performing the test. (Refer to Section 4.3.)

- ***Laboratory-specific costs***: Items that cannot be easily identified with a specific section of the laboratory, but contribute to the overall operational functioning of the entire laboratory. (Refer to Section 4.3.)

- ***Institutional/corporate indirect costs***: Costs related to operations, physical plant, administration, fiscal, and other facets of institutional maintenance and management. (Refer to Section 4.3.)

2.2.3 Cost Behavior Versus Cost Traceability

The matrix in Figure 1 describes the major categories of laboratory costs, which are broken down into traceable and nontraceable elements. All costs must fall into one of the six cells in the matrix. However, it may be possible to categorize an aggregated cost category into more than one cell. In general, the term *cost behavior* applies to variable and fixed-cost categories, while *cost traceability* applies to direct and indirect cost categories. Table 1 illustrates the use of direct and indirect costs.

2.3 Product Costs

2.3.1 Labor Costs

Labor costs include the payroll for a department and, in most institutions, also include fringe benefits. Labor cost may be fixed, variable, or semivariable depending on the job grade level and laboratory staffing pattern. For example, the supervisor's salary is usually a fixed expense, the technologists' salaries are primarily fixed or semivariable and the salary of an hourly, flexible hour employee is variable. Labor costs may be direct (e.g., technologists) or indirect (e.g., laboratory manager). Section 4.1 provides techniques and formulas to estimate labor costs by a single test or test group.

2.3.2 Consumables Costs

These costs express the consumption of supplies and materials required for test performance. Consumables costs may be fixed (e.g., standards for daily instrument calibration); variable (reagents for tests); or semivariable (a reagent vial sufficient for 100 samples but, once opened, outdates in 24 h). An example of a direct consumable cost is a blood collection tube; while examples of an indirect consumable cost include tourniquets or blood collection tube holders. (Refer to Section 4.2)

2.3.3 Indirect Costs

These are defined in Section 2.2.2 and are discussed in Section 4.3.

2.4 Billable (Ordered) Tests

Billable tests (or ordered tests for laboratories that do not bill) are those performed and charged to a patient or physician account that generates revenue. The billable test is the focal point in laboratory cost accounting for laboratories that generate revenue. Refer to Section 3.2.1.1.

2.5 Cost-Accounting Systems

All cost accounting is an averaging process. Costs are accumulated in some fashion and divided by laboratory billable test procedures or total tests performed. Borrowing terms from manufacturing, the primary methods for developing costs per unit (test) are job order costing and process costing.

Job order costing refers to the accumulation of costs for a single specific test, or by batch if various degrees of resource consumption are readily identifiable. An example is the costing of a newly developed assay performed in batch mode. To facilitate economic and operational decision making, determination of the various potential number of patient samples to be run in the batch (i.e., least, optimum, or expected) and their associated inputs are necessary. This is accomplished by quantifying individual component costs of preparing the batch (i.e., controls, quality control (QC), labor, and consumables) and the individual component costs of each patient sample (i.e., labor and consumables).

Process costing in the laboratory is associated with high-volume testing of like or similar procedures with little materially distinguishable resource consumption. In general, costs are accumulated in the aggregate over a period of time and averaged by the number of billable (or total) tests performed during the same period. This most commonly occurs in the laboratory where high through-put equipment is involved. (Refer to Appendix D.)

Hybrid costing refers to the fact that both job order and process costing occur in the laboratory. More often than not, a hybrid of the two is employed where one approach is used for labor and the other for consumables. The decision as to which mechanism to choose is dependent on the nature of the test and the degree to which it facilitates the costing exercise.

3 Costs, Expenses, and Focusing Resources to Optimize the Benefits of Cost Accounting

Before costs can be accounted for, the laboratory manager should develop a functional model of the laboratory that shows its component work stations, cost centers, and expense classifications. Once this scheme is developed, the manager can initiate cost analysis. Proper classification at the macro-level is of key importance in developing a practical cost-accounting mechanism. The macro-levels referred to here are cost centers and expense classifications. It is here that costs begin to take on an identity, become segregated, and begin to be directed toward the laboratory work station within the formal scheme of financial reporting. This level is important for budgetary and control purposes to accumulate "like" costs and, also, so that they may be more readily applied to billable test procedures when test costing activities are undertaken.

3.1 Cost Centers

The proper identification and selection of cost centers is a most important early step in the development of a valid cost accounting system. To provide for a reliable classification of cost information, as well as to help facilitate the cost accounting process, a functional model of the laboratory should exist. This model should display the component working departments and sections of the laboratory cost centers. This should already exist to some extent in the accounting (general ledger) system and is commonly referred to in accounting language as a "cost center listing." (See Table 3.) In a small laboratory, the entire laboratory may be one cost center. In a larger laboratory, microbiology, chemistry, and other departments may each be a cost center. In a very large laboratory, virology, mycology, and other departments may be separate cost centers. These centers serve to accumulate costs associated with a particular section of the laboratory that provides a similar service. If a section not only accumulates costs but produces billable tests as well, it is referred to as a revenue center. In the laboratory, the revenue center matches the revenues of billable tests of similar services with the identifiable costs associated with these services (i.e., coagulation tests billed, with direct costs associated with producing coagulation procedures).

Table 3. Laboratory Medicine Example of a Cost (Or Revenue) Center Listing

	Cost (Or Revenue) Center		**Cost (Or Revenue) Center**
	Biochemistry		
01	Biochemistry Department	28	Donor Room
02	Enzymology03	29	Blood Component Preparation
	Lipid/Protein and Metabolic Disease	30	Transfusion Services
04	Toxicology and TDM*		
05	Quality Control		**Pathology**
06	Automated Chemistry	31	Pathology Department Office
07	Applied Clinical Pharmacology	32	Immunohistochemistry
08	Hypertension Laboratory	33	Electron Microscopy
		34	Histology
	Laboratory Hematology	35	Cytology
09	Laboratory Hematology Department Office	36	Autopsy
10	Manual Hematology	37	Neuropathology
11	Coagulation Laboratory	38	Anatomic Pathology Professional Fees
12	Automated Laboratory Hematology		
13	Molecular Hematology		**Immunopathology**
14	Platelet Laboratory	39	Immunopathology Department Office
15	Red Cell Study Laboratory	40	Flow Cytometry
16	Investigative Hematology	41	General Immunopathology
		42	Endocrine Immunology
	Microbiology	43	Tissue Culture
17	Microbiology Department Office	44	Histocompatibility and Immunogenetics
18	Bacteriology		
19	Serology	45	**Phlebotomy**
20	Mycology and Mycobacteriology		
21	Parasitology	46	**Laboratory Computer Systems**
22	Media Preparation		
23	Virology	47	**Laboratory Administrative Office**
	Blood Bank	48	**Laboratory Outreach Program**
24	Blood Bank Department Office		
25	Stem Cell Preparation	49	**Point of Care Testing Sites**
26	Therapeutic Plasmapheresis		
27	Antibody Identification	50	**Physicians Office Laboratory Sites**

* Therapeutic Drug Monitoring

It is in the laboratory's best interest to review and understand costs that are charged to a cost center. It is important for the laboratory to work directly with the institution's/ corporation's accounting department in establishing the appropriate cost/revenue center (and their relationship to one another) to serve the laboratory's information needs. As an ongoing and facilitating process for gathering cost-accounting data, an appropriate cost center structure is essential.

3.2 Expense Classifications

Expense classifications refer to an even more precise classification of costs in comparison to cost centers. Expense classifications refer to groupings of similar costs that are charged to a cost center. Examples of these costs are various labor classifications (i.e., hourly, monthly payroll); reagents; controls; disposables; equipment lease costs; and miscellaneous costs such as registration for seminars, travel, and subscriptions. As with cost centers, it is important for the laboratory to review and understand the flow of costs through these classifications. Here again, the laboratory manager will have to work with the accounting department to establish the optimal use of expense classifications. For cost-accounting purposes, the more detailed the expense classifications, the better (e.g., reagent costs associated with a specific piece of equipment). However, a determination must be made with regard to the facility's general ledger accounting system as to what is feasible, practical, and useful.

The greater the ambiguity in the laboratory's cost center structure and expense classifications, the more difficult the job of cost accounting becomes, and the more dependent the laboratory will become on primary source documentation such as invoices and payroll registers.

3.2.1 Workstation Analysis

This involves tracking costs to the workstation, which is an important level because here a manager can exert direct control over work production. Workstation analysis begins with the individual costs generated by each instrument/method. Methods for recording these costs can be manually generated on a standard cost-accumulation worksheet, or they can be entered into a personal computer with software programmed to analyze data entered and produce a cost-per-test-per-instrument. An example of a cost-accumulation worksheet is demonstrated in Appendix A, Figure A6.

3.2.1.1 The Billable (Ordered)[a] Test

It is important to recognize that at the workstation level, the actual goal of cost accounting is realized (i.e., the billable or ordered test). A billable test is a test result actually billed to a patient. This unit gives a more accurate portrayal of labor and supply utilization in a revenue-generating laboratory than the raw number of tests performed. The first decision to be made in cost accounting is to define the cost object or what is to be costed. In the laboratory, the billable test is the cost object. These billable tests are defined in the master list of charges as an individual billable item. Repeats, QC, and standards performed to create a billable test are not considered a cost object individually (refer to Section 3.2.1.2). However, collectively they must be accounted for as components of a billable test.

3.2.1.2 The Importance of the Raw (Total) Test Count

It is critically important to break down tests produced into categories of tests that can be reported for the purpose of being reimbursed, i.e., *billable tests*, or *ordered tests* for assessing the impact of laboratory resource consumption. The *nonbillable* element of test performance is also important (QC, standards, calibrators, calculation, employee health results, tests performed for teaching, and research) because these elements account for a large amount of the expenditure of personnel time and reagents/supplies; however, their cost must be absorbed because the laboratory/ hospital/corporation does not receive reimbursement for nonbillable procedures and tests. The sum of billable and nonbillable tests (or ordered and nonordered tests) is the raw total count. The raw total count allows the

[a] For those laboratories that do not charge, an ordered test is not billed, but the result is important in the laboratory's volume projections to estimate the cost burden of performing ordered tests.

laboratory manager to follow year-to-year trends, estimate the impact of seasonal variation on laboratory resources, to plan budgets, and allows for interlaboratory peer group comparison. These tallies are important to incorporate into cost accounting for labor, as well as consumables, and they are addressed in Sections 4.1 and 4.2.

3.3 A Conceptual Framework for Focusing Resources to Optimize Benefits of Cost-Accounting Activities

All laboratories must determine where to focus cost-accounting efforts. The fiscal objective of all test production in all laboratories is to generate revenue in excess of cost. In some small laboratories, it may be feasible to cost account for all procedures and give each the same level of attention. However, this may not always be practical. In larger laboratories, it is neither feasible nor practical. The manager must, therefore, determine which tests to pay particular attention to, using empirical methods such as the 80/20 rule.

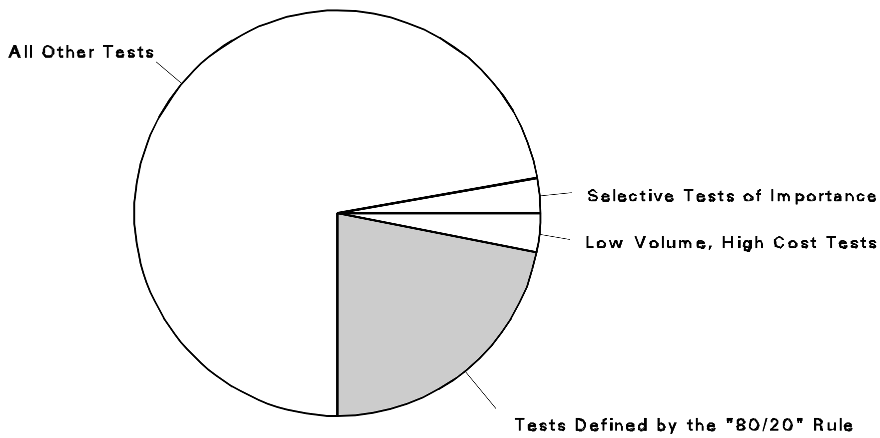


Figure 2. Laboratory Test Population

3.3.1 The 80/20 Rule (The Pareto Principle)

The 80/20 rule applies to all laboratory workload, (i.e., 20% of the laboratory's tests generate 80% of the revenue and volume). Therefore, tests and the sections and instruments that produce 20% of the laboratory tests should be studied closely (see Figure 2).

A test that generates a relatively high level of revenue for the laboratory affects laboratory operations much more than a procedure performed only a few times a year. Therefore, cost-accounting information for those tests that produce most of the revenues (or most of the costs in nonrevenue-generating laboratories) is most beneficial for decision making.

The 80/20 rule, which is used in many types of industries, identifies those units of production (tests) that are predominantly responsible for producing an entity's total revenues. The rule states that 80% of an entity's total revenues are produced by 20% of its products (see Figure 2). Identification of the tests that comprise that 20% is accomplished by creating a list of the tests performed by the laboratory, with the tests ranked by their total revenues generated per annum. The largest revenue-generating test is at the top of the list. The list is continued until the sum of the revenues of the tests listed comprises 80% of the laboratory's total revenues. This cut-off point should approach 20% of the tests performed in the laboratory. An example of one laboratory section's test volume and revenue relationship is presented in Appendix B, Table B2—Volume Analysis Cost Report (VACR).

3.3.2 Other Test Populations

Most of the tests identified by the 80/20 rule will be chemistry tests. However, the laboratory's needs should be evaluated to determine whether other sections should be included to a greater extent. The 80/20 rule (or some variation) can also be applied to a specific section of the laboratory that may be of interest, yet not adequately represented in the initial population of tests.

Another test population that can be identified are low-volume tests that have a perceived high reagent/disposable cost and/or are very labor intensive. Because these tests are low volume and probably do not reflect economies-of-scale, they might be candidates for "make or buy" decisions. Taking these steps will identify tests that warrant the expenditure of time and resources to specifically investigate their costs. This population should be minimized to ensure that data collection and maintenance is manageable. In Figure 2, approximately 20 to 25% of the test menu should be given specific job order cost-accounting attention in the cost-accounting process. The "all other" category is best handled by grouping similar procedures and approximating their costs using process costing. These approximations can be used until the laboratory believes it has the available time and/or needs to perform a job order cost-accounting of this group of tests.

Note that costing all tests is the ultimate goal. However, if this is not practical, the 80/20 rule offers a viable solution.

3.3.3 Frequency

It is recommended that an analysis of costs be conducted at least biannually and when new tests/instruments/methods are introduced or modified in a way that affects the cost.

4 Calculating Costs for Tests

It is important when calculating full test cost to include the following three major elements of cost:

(1) direct labor costs;
(2) direct consumables (materials) costs; and
(3) indirect costs related to the depreciation, amortization (for owned analyzers), or lease/rental costs (for leased/rented) of instruments.

Maintenance, site preparation, utilities, and many other items are also indirect costs associated with test production (see Table 2 and Section 4.3.)

The basic elements of full costing are discussed in Sections 4.1 through 4.4 with formulas and explanations. A completed example of a full costing method, the Instrument Cost Accounting Technique (ICAT), is presented in Appendix A.

4.1 Labor Costs and Their Development

Labor is the largest component of test cost and therefore must be carefully analyzed in test cost analysis on a test-by-test basis. Actual labor costs vary according to instrument utilization, prioritization policies of the laboratory, and salary and skill levels of individual technical staff members. Test costs for labor also vary by time of day, stat or routine test status, batching versus single tests, and other functional variations in the laboratory. As test volume increases, more labor (and supplies) are needed.[1] Regardless of how large, small, complex, or uncomplicated a laboratory may be, labor will still account for the major portion of total cost (see Figure 3).

The importance of the labor effort in the production of tests by whatever method–instrument or manual –cannot be overemphasized. In fact, it is estimated that labor costs for technical performance of tests in a medium-sized, acute care hospital account for 40 to 60% of total expenses.[2] In hospital laboratories in the Department of Veterans Affairs, labor costs are 55 to 70% of total expenses.[3]

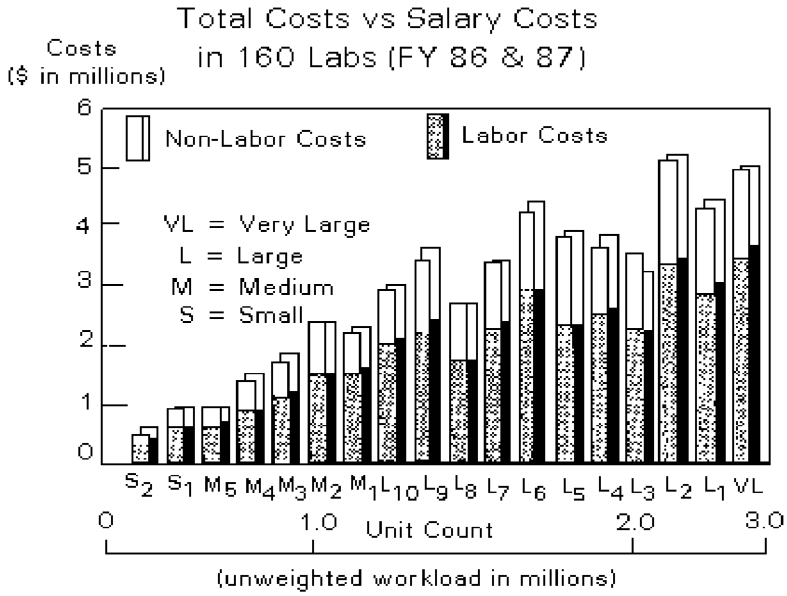


Figure 3. Total Costs Versus Salary Costs in 160 Laboratories (FY 86 & 87)

Staffing laboratory functions by institutional size or incremental changes in workload is not acceptable; instead, workload quantitation and labor effort quantitation are vitally important for accurate determination of actual costs for tests and for the development of standard costs.

4.1.1 Techniques and Formula for Developing Labor Costs

Many techniques are available for calculating or estimating labor costs associated with a specific test. Regardless of the technique employed, all "hands-on" time in the laboratory should be included. For example, incubation, evaporation, and shaking time should be included only to the extent that the time needed to perform these activities does not allow the technologist to perform other activities. In addition, a personal fatigue and delay factor (PFD) should be included in the time estimate because this accounts for the "human element." An additional 15% is typically added for this element (see Appendix A, Table A4).

Labor costs can be divided into three labor-intensive segments of test performance: preanalytical, analytical, and postanalytical time. Activities related to these segments are listed in Table 4.

Table 4. Activities Included for Calculation of Direct Labor Costs

Preanalytical	
(1)	Separate test requests
(2)	Record order results
(3)	Generate worklist
	Manual
	Automated (ADP)
(4)	Prepare materials for specimen collection
(5)	Collect specimen
(6)	Transport specimen
	Manual
	Automated
(7)	Centrifuge specimen
(8)	Separate specimen
(9)	Enter identification into ADP system
(10)	Perform start-up calibration and priming procedures
(11)	Prepare quality control and standards
Analytical	
(1)	Perform test dilutions, if necessary
(2)	Perform test
(3)	Record result
	Manual
	Automated
(4)	Calculations and checking results
Postanalytical	
(1)	Sort and file results
(2)	Telephone urgent results
(3)	Perform shut-down procedures
(4)	Perform preventive maintenance and cleaning
(5)	Perform workload recording procedures
(6)	Perform accounting procedures

Preanalytical time includes the time needed to gather specimens from laboratory central receiving and time for all the steps up to the actual testing procedure, such as specimen collection, worklist and label preparation, start-up, sample-cup preparation, and preparation of daily quality controls and standards for this instrument. Preanalytical time does include phlebotomy, centrifugation, and separation of the specimen.

Analytical time includes time for the labor effort required to analyze the specimen or specimens and to perform all routine procedures up to reporting of results. For the purpose of cost-per-test determination, it does include calculation(s) checking.

Postanalytical time includes time for the labor effort required to report results manually or to enter results into a computer system, as well as the sorting, filing, and telephoning related to final reports. Routine, daily maintenance time and shut-down time are also postanalytical efforts.

The formula for determining labor costs per test or profile is as follows:

Labor Costs = (1)

$$\left(\frac{\text{SalaryCost}}{\text{1 Year}}\right)\left(\frac{\text{1 Year}}{\text{2080Hours*}}\right)\left(\frac{\text{1 Hour}}{\text{60 Min**}}\right)\left(\frac{\text{\# Min}}{\text{Test}}\right)\left(1.18^{***}\right)$$

where *2,080 hours represents the ideal (paid) productivity (52 x 40 hours/week). A laboratory may use a different number of hours (fewer) depending on the philosophy/policy of the institution used to calculate productive hours/FTE.[4]

** Justification for use of 60 minutes of Labor Cost Formula[3]:

This method measures costs for a solitary instrument/ method, not a section or a department. It is assumed that during a cost-analysis evaluation period, only labor effort that is 100% productive will be timed and accumulated.

*** Fringe Benefit Factor (will vary in each laboratory/hospital): This factor (a percentage) can be obtained from the hospital's/ corporations's fiscal department.

Labor estimation techniques range in difficulty and cost from easy and cheap to expensive and difficult. The corresponding accuracy and credibility of the estimate varies with the amount of time, effort, and skill expended in determining it. The choice of technique, or combinations of techniques, should be influenced by the expected end use of the estimated labor cost and its relative financial importance. The techniques include expert opinion, batching, logging, and direct observation.

Actual examples of labor cost accumulation and calculation are given in Appendix A, Tables A4 and A5.

4.1.1.1 Expert Opinion

This technique, by far the simplest and cheapest, involves the estimate by one or more "experts" of the labor time and skill level required to perform a specific task or procedure. This technique is useful in smaller, clearly defined tasks, but it is less accurate for more complex procedures or tasks. It is also very helpful in estimating labor time of like procedures where one procedure has been time studied and the other has not.

4.1.1.2 Batching

Batching is a distribution of a known quantity of work in a controlled environment by a supervisor or data gatherer. This person monitors the time and relative skill level involved to complete a given amount of assigned work.

The shortcoming of the technique is that it disrupts the normal work flow to some degree and, because no direct observation is involved, the employees receiving the batched work to complete may tend to skew the results in anticipation of their future use in monitoring productivity. Also, the subtasks involved in an entire procedure are generally indeterminable by using this technique.

4.1.1.3 Logging

Logging generates information concerning tasks and groups of tasks performed in completing a procedure. It also generates large amounts of data with less disruption than batching. A log that breaks down the test procedure into a series of tasks is kept by the technologist. The time to perform each task is recorded by the technologist as the test is performed. The shortcoming of logging is that it may lack objectivity if accurate completion of the log is left solely to each employee. It is essential that supervisors verify worksheet data for reasonableness. This technique can be time consuming. Figure 4 provides an example of this technique. An example of how data from this format is applied to develop labor time is presented in Appendix A, Figure A4. Table 5 provides instructions for this activity.

Instructions: Use the worksheet below to accumulate labor costs; divide into preanalytical, analytical, and postanalytical totals; enter totals in Section III of the ICAT Worksheet (Appendix A, Figure A6).

Department: **Clinical Pathology**	Study:	Page 1 OF 1
Section: **Biochemistry**		Date: 8/18/93
Procedure: **5-H1AA (5-Hydroxy Indole Acetic Acid)**		
Equipment/Model: **HPLC**		
Technologist: **Mike**	Observer: **N/A**	
Batch Size: Patients - **4** Controls - **2**	Standards - **1**	Repeats: **10 %**

#	Element Description	Time	Cum. Time	Freq.	Base Time7
A.	B.	C.	D.	E.	F.
PA 1	**Prep. Get samples and controls, set up tubes**	**4.0**	---		
PA 2	**Prep. start instrument, make mobile phase, flush**	**22.0**	**26.0**		
PA 3	**Mix samples, add internal standards and H_2O transfer**	**4.0**	**30.0**		
A1	**Run standards, controls, patients**	***1.0**	**31.0**		
A2	**Review peaks, retention time**	**5.0**	**36.0**		
PO1	**Worklist, get creatine results and calculate**	**5.0**	**41.0**		
PO2	**Report results**	**2.0**	**43.0**	**1.10/4**	****11.8**
Remarks			Total Base Time		**11.8**
***Other patients done while analysis is running.**					
****43.0 x 1.10/14 = 11.8/billed test**			P.F.D. Allowance 15 %		**1.8**
			Standard Time for Billable Procedure		Minutes **13.6**
Approved (Signature) Date:					Hours

Figure 4. Example Labor Time Accumulation Worksheet

NOTES: PA = preanalytical; A = analytical time; PO = postanalytical.
Totals: Pre-analytical time ÷ 30 min; analytical time-6; postanalytical time-7 min.
See Appendix A, Figure A6, Part III, Test Labor, to enter data.

Table 5. Time Study Procedure Outline

- Divide the test procedure into tasks. A basic framework is to consider preanalytical, analytical, and postanalytical elements (refer to Figure 4). Consider logical stopping points in defining these tasks. Do not be overly detailed. The purpose of determining these tasks is only to facilitate the recording and verify the recorded time elements. Number the tasks using column A and insert a brief description of the task in column B. Complete before performing the test.
- Note the time in minutes, using column C, as each task is completed.
- Use column D to record the cumulative time as each additional task is performed. This should be completed after the test is performed so as not to interfere with the timing process or hinder the performance of the test. This column is used to facilitate verification of the reasonableness of the data.
- Use column E to establish a frequency factor to adjust the timings to a base-time equivalent to a billable test. (For example, if the timing is performed on a batch containing four (4) tests, each of which will be billed to a patient, a factor of 1.00/4 should be recorded; if this same batch has a repeat factor of 10%, a factor of 1.10/4 should be recorded; if the timing pertains to a single billable test with no repeats, the factor is merely 1.00)
- Column F is the total cumulative time from column D multiplied by column E. This equates the timing into the time it takes to perform a billable patient test. This should be recorded at the end of the process, not as each individual task is performed.
- A personal, fatigue, and delay factor (PFD) may be added to the timing to capture the "human element." This is an allowance of up to 15%, which is used by management engineers to recognize the fact that tasks performed by humans are not performed with machine-like consistency.
- For costing purposes, usually two or three cycles are timed as in Figure 4. If the variance between cycles is not great, average times are obtained to develop the time standard. Verification of the data's reasonableness, as well as establishing the time standard based on average times, should be completed by the supervisor.
- For purposes of productivity, the above procedure should be followed using three to ten cycles.

NOTE: Figure 4 displays a completed worksheet example. Appendix A, Table A4 provides a blank worksheet for the user.

4.1.1.4 Direct Observation

This technique requires a trained observer versus a technical employee doing their own logging. The trained observer will be able to *pace-rate* the employees observed as they perform specific tasks involved in the completion of a known number of procedures. This level of observation is beyond the simple verification of a batching or logging exercise and is the most difficult, time-consuming, and costly technique available. However, it is the most accurate. Because this process is typically administered by persons trained in managerial engineering concepts, a technical explanation is beyond the scope of this guideline. The laboratorian's involvement in the process is limited to the verbal input of the technologist performing the procedure. Figure 4 can also be used here.

4.1.1.5 Preferred Technique(s)

The approach endorsed in this guideline for developing estimated labor costs for individual instruments and methods in the laboratory is a detailed time-study analysis. The time-study analysis can use any of the techniques mentioned in the previous section, depending on available time and resources. Considered in the aggregate, however, time studies should be performed using the 80/20 rule (Section 3.3.1) for chemistry and other tests that produce significant revenue. The major exceptions to the rule are very labor-intensive tests of relatively low volume and those tests to be marketed outside the institution.

4.2 Developing Consumables Costs

Generally, consumables in the laboratory refer to items such as reagents, disposables, supplies, quality controls, and standards. They are also known as materials in some references. A worksheet with a detailed list of consumables[b] is provided in Appendix A, Table

[b] The user may wish to modify this list to suit individual needs.

A3. Additional worksheets, formulas and examples can be found in Appendix A, Figures A2, A3, A6, and Appendices C and D. In the cost-accounting process, the costing of a test's consumables can easily become a disproportionately time-consuming endeavor. Following are the two main reasons for this:

(1) the translation of the cost data from the accounting or purchasing feeder systems to the test procedure level, and

(2) the complexities and number of inputs required to perform the procedure.

It is imperative that ease of identifiability remain a key concept when developing consumables costs, as well as the materiality of the input's cost relative to the total cost of the billable test.

The actual cost of consumables can be obtained from vendor invoices to ensure that the correct costs are being applied. Note that when reviewing invoices, costs may vary per order due to volume discounts or inflationary increases. Shipping charges, if incurred, must also be included in the overall costs. Alternatively, data may also be available by analyzing the general ledger system. This is predicated upon the degree of sophistication and detail of the accounting system and the costing methodology employed.

4.2.1 Developing Consumables Costs for Test Performance

Consumables costs are those attributed for all supplies and materials required for test performance, including QC and standard materials.

The cost of consumables can be determined retrospectively or prospectively. Each method attempts to equate the cost of materials to the number of *billable results* generated from those materials, thereby achieving a cost per billable result. The historical (*retrospective*) method, (Appendix C) is used when monitoring the cost of *existing* equipment and/or methods. The *prospective* method (Appendix D) is used to evaluate the *potential* cost of equipment and/or methods before making acquisition decisions or changes to the existing protocol.

These methods can be applied to all laboratory systems and procedures. The critical need is to determine the cost of consumables for the system as it will be or has been used in a specific situation. All examples that follow relate to the consumables cost of clinical chemistry analyzers; however, the examples can also be applied to automated analyzers (and methods) in other laboratory sections.

4.2.2 Calculating Costs of Calibrators, Standards, and Controls Per Billable Test

The cost of running quality control tests is included as part of the cost of consumables, plus the cost of technical time spent to prepare the consumables, perform the analysis, and evaluate the results (see Table 6). Because a cost-accounting system is used to determine the cost-per-patient billable test, QC costs should be included and allocated back to the billable test.

Because calibration costs tend to be fixed, whereas costs of controls and standards tend to be variable or semivariable, it is helpful for decision-making purposes to calculate these costs separately when planning budgets.

Costs should be calculated based on actual quantities used, rather than on the quantities defined in the test procedure. These actual costs will be more reflective of true operations and will allow for the following variables:

- instrument start-up and shut-down;
- reagent stability and shelf life;
- package size; and
- wastage.

Table 6 gives an example of how QC costs per test may be calculated separately. Some laboratories add the costs of QC into consumables costs (see Appendix A, Table A3). Following are the two direct QC costs:

(1) actual labor expense of running the QC procedure, and

(2) expenditure for QC consumables.

Table 6. Examples of Calculating Quality Control Costs Per Test

Assume that the blood cell counter in the laboratory of a 500-bed hospital yields 60,000 cell profiles per year made up of seven results each, the number of QC tests performed per year numbers 2,400, and the total direct labor cost is $1.50/test. The cost for a year's supply of QC reagents is $3,000.00.

- To calculate the QC direct labor cost per test:

$$\frac{(2{,}400 \ x \ 1.50)}{60{,}000} = \$0.06/\textit{profile}$$

- To calculate QC consumables costs:
  QC consumables cost per profile:

$$\frac{\$3000.00}{60{,}000} = \$0.05/\textit{profile}$$

Adapted with permission from Whitehouse, CR. An On-Line Cost Analysis System. *Medical Laboratory Observer*. Montvale, NJ: Medical Economics Co., Inc., 1984:116-120.

However, these calculations become complex when dealing with discrete analyzers and QC materials with many components. Referring to Table 6, in general, the percentage of total patient profiles (60,000) accounted for by the particular test is applied to the total number of QC tests (2,400) and then multiplied by the direct labor cost per test ($1.50) to obtain the direct QC cost per test. To calculate QC *consumables* costs, first compile the total number of patient results for which the material was used over a 12-month period. From this total usage (60,000) and the annual consumables cost ($3,000.00), the cost per profile is calculated. To obtain a QC cost per test in each profile, divide the cost per profile by 7. The most satisfactory costing system for a laboratory is to calculate average QC costs per patient billable test using process costing rather than job order costing (see the definitions in Section 2.5). The length of the time period that should be used to measure the time and consumables expenditure depends on the particular test procedure and volume. The time period should include both high- and low-volume periods. The total quantities used should be divided by the number of patient billable tests performed during the same period. If test volume substantially increases or decreases, or if the procedure is changed, usage should be recalculated.

Although the laboratory may have pre-established requirements for maintaining specified minimum levels of quality, it is important to systematically monitor and re-evaluate the cost components of the laboratory that are related to accuracy and precision. While calibrators, standards, and controls are essential to quality laboratory results, laboratory professionals must weigh the costs of accuracy and precision against the benefit derived for the patient.

4.2.3 General Formula for Determining Consumables Costs

The general formula used to calculate consumables costs per test/profile is:

(2)

$$\frac{\text{Cost of Reagents} + \text{Cost of Test-Associated Supplies \& Parts} + \text{Cost of Equipment Related Disposables}}{\text{\# of Tests or Profiles}} = \text{Consumables Costs (Test or Profile)}$$

Appendix A provides detailed worksheets and instructions for identifying and accumulating costs for each of the categories in the numerator (see Appendix A, Figures A2, A3, A6 and Tables A1 and A3). To compare alternative costs between methods/analyzers, see Appendix B, Table B3—Contribution Margin Benchmarks (CMB).

4.3 Indirect Costs of Test Production

Indirect costs are all costs of test production not traceable to a test. Indirect costs include those of selected consumables, indirect labor, and all other expenses of test production that cannot conveniently be identified with test production. Also included in this category are the laboratory computer system, licenses, and training and proficiency testing materials, among others.

Within the laboratory environment some important classes of indirect costs are as follows:

Section-specific costs: Include items that cannot be easily identified with a specific test but rather the specific section performing the test. These items include supervisory salaries, general QC, maintenance, service contracts, lease or rental costs, miscellaneous supplies, education, and travel.

Laboratory-specific costs: Include items that cannot be easily identified with a specific section of the laboratory but, instead, contribute to the overall operational functioning of the entire laboratory.

Examples of laboratory-specific costs are administrative, nontest-related supplies and personnel, laboratory computers, utilities, building maintenance, and security.

Institutional/corporate indirect costs: Costs related to operations, physical plant, administration, fiscal, and other facets of institutional maintenance and management. Table 2 outlines three indirect cost allocation methods that might be used and gives examples of selected items used in direct-cost estimates.

Examples of hospital-allocated expenses include library, cafeteria, housekeeping, dietary, hospital administration, and house staff costs. All such hospital indirect expenses allocated to the laboratory are not within the control of laboratory management and are unrelated to the volume of testing.[1]

Indirect costs are added to the direct cost based on a multitude of factors that are part of hospital or corporate operations. Some items of indirect cost are listed in Table 2 and defined above. The laboratory manager must work closely with the hospital's (or corporation's) fiscal department to estimate the *laboratory's* indirect costs and apply these to the direct cost of tests.

The laboratory manager usually does not actively participate in the calculation of hospital indirect costs as applied to the laboratory, and the hospital/corporation adds in a factor to the total test charge or price to recover these costs (see Appendix A, Table A5, Formula 6).

4.3.1 Allocating Expenses That Cannot be Assigned to Direct Costs for Test Production

Full test cost analysis delineates all elements of cost involved in performance of laboratory procedures and is achieved by adding labor, consumables, and laboratory- and institution-allocated indirect costs. Table 2 shows the components of full test cost.

Allocated costs may not always be based on such strong correlations, but they may at times be ambiguous. In theory, hospital/institutional indirect costs are allocated first by their various functional correlation to specific cost centers or sections of the laboratory by the accounting department. To further allocate these costs to the billable test level, a single rate or percentage is developed given a certain base. The rate is most commonly stated in terms of dollars per test or as a percent of direct costs (see Appendix A, Table A5, Formula 6).

4.3.2 Formulas for Estimating Indirect Costs

Although they are not the only factors that determine indirect costs, instruments and instrument-related factors account for a large portion of laboratory indirect cost. (Other noninstrument factors are also considered and are listed in Figure 5). Instructions, formulas and examples for indirect cost calculation are given in Appendix A, Tables A1, A2, and A6. A laboratory's total indirect cost percentage varies in each laboratory/hospital based on the total of factors that are used in calculating indirect costs. The *general* formula for indirect costs is as follows:

$$ID = (L + C + IC) \; X\,\% \qquad (3)$$

where:

ID = Indirect costs
L = Labor
C = Consumables
IC = Instrument cost
$X\%$ = Percentage factor multiplier (obtained from the fiscal department). It is variable and may be as large as 148% in some hospitals or laboratories;
$L + C + IC$ = Direct Costs.

Note that instrument costs can be handled as direct or indirect, depending on institutional practice and the type of institution/corporation. For example, a large throughput chemical analyzer might be treated as a direct cost, whereas microscopes in a microbiology laboratory would be treated as indirect. Detailed discussion of indirect cost concepts and lists of line items can be found in laboratory cost-management textbooks.[3,5]

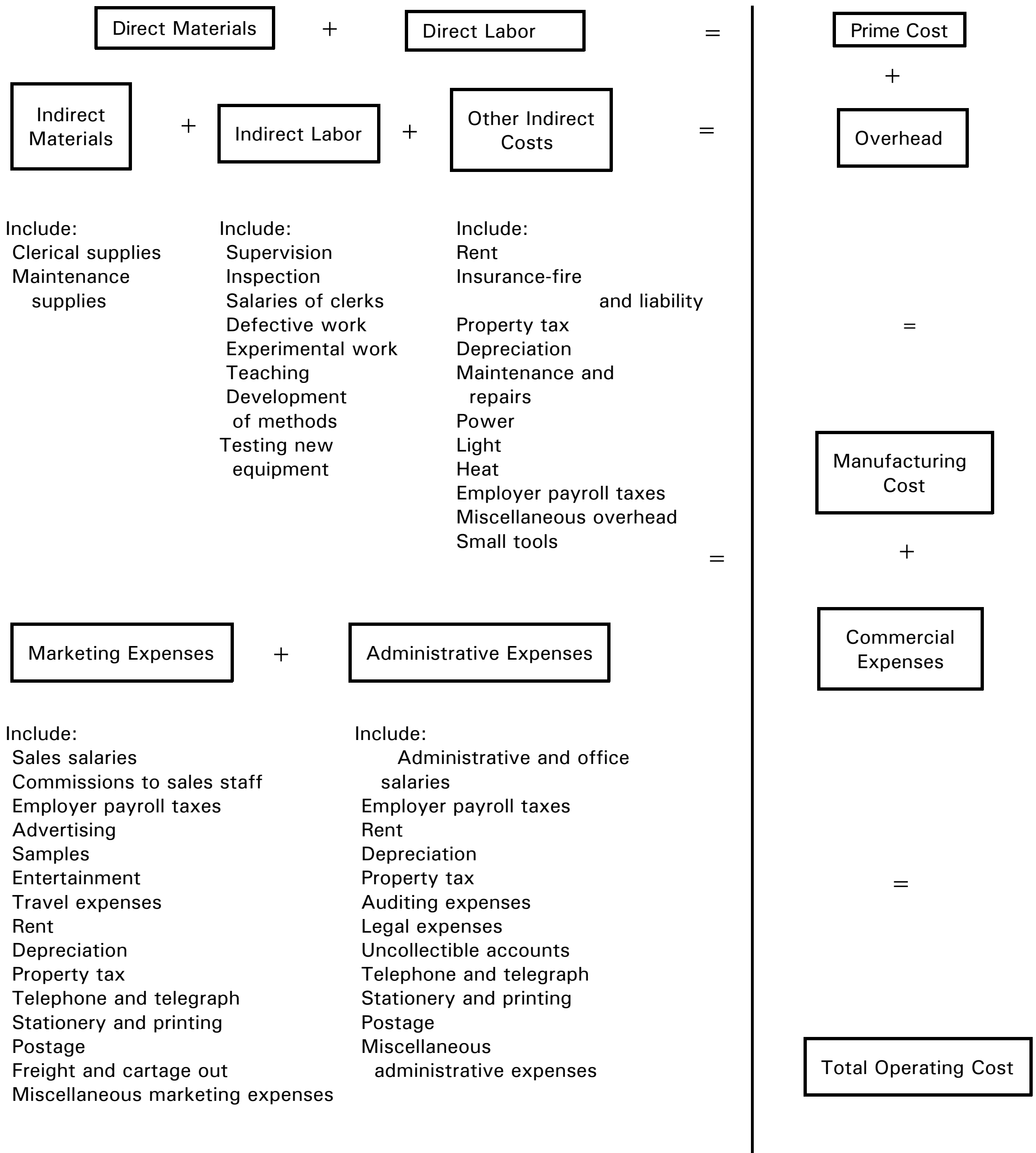


Figure 5. Analysis of Total Operating Cost. Examination of total expenses for a laboratory will also reveal hospital or corporate overhead expenses charged to cover the laboratory's share of building depreciation, general maintenance, utilities, hospital administration, if applicable, and general capital equipment expenses, among other things. Reprinted with permission from Travers EM. *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989: Exhibit 7-1.

4.4 Calculation of Total Cost Per Test[6]

The total cost per test is derived by adding the totals for each of the categories below. The data obtained from the formulas in Sections 4.1.1 and 4.2.3 and Appendix A, Table A5, is used for calculation of total costs.

The total cost derived here will only include the laboratory's indirect cost and not the hospital's/corporation's indirect costs. Because this latter factor may be large in hospitals (and corporations), some managers may choose to work with their fiscal departments to add hospital indirect costs to the total costs, if total cost is to be used to set charges or establish prices.[6] (See Section 4.3.1 for discussion.) A completed total cost example is given in Appendix A, Table A6.

4.5 Differences in Complexity of Test Costs

There are great differences in the complexity of laboratory tests/procedures between laboratory sections (Figure 6). This influences the accumulation of costs, which will also differ in their degree of complexity (Figure 7). For instance, costs for most chemistry, therapeutic drug monitoring, hematology, coagulation, and urinalysis tests are usually one-step/one-result/one-cost procedures, while microbiology, toxicology, immunology, and other complex procedures require multiple steps, multiple results, and multiple costs. Figure 7 illustrates the levels of cost generated by a complex toxicology procedure. It is important to note that, for multiple step costs, individual costs must be added together for each of the steps required to provide a final total cost. Another example is given with the diagnostic testing algorithm in Figure 8, where the complexity of the steps for a microbiology work-up for urethritis is illustrated. Costs for each step in the process of establishing a definitive diagnosis must be established and will vary, depending on whether the culture is positive or negative. Figure 9 points out that costs associated with a positive culture are greater than costs for a negative culture, primarily due to the additional labor required for the positive culture.

Sections Producing One Result/One Cost	**Sections Producing One Result/Multiple Costs**
Routine Chemistry Therapeutic Drug Monitoring	Special Chemistry Immunochemistry Endocrinology Toxicology
Routine Hematology Routine Coagulation	Manual Urinalysis Blood Bank Immunology Microbiology Mycobacteriology Mycology Virology
Automated Urinalysis	Immunopathology Surgical Pathology Cytology Autopsy Electron Microscopy
Reportable Result = One Cost	Preliminary Result (Cost 1 + Interim Result Cost 2 + Final Reportable Result Cost 3 = Total Cost) NOTE: There may be more than one interim result, depending on method.

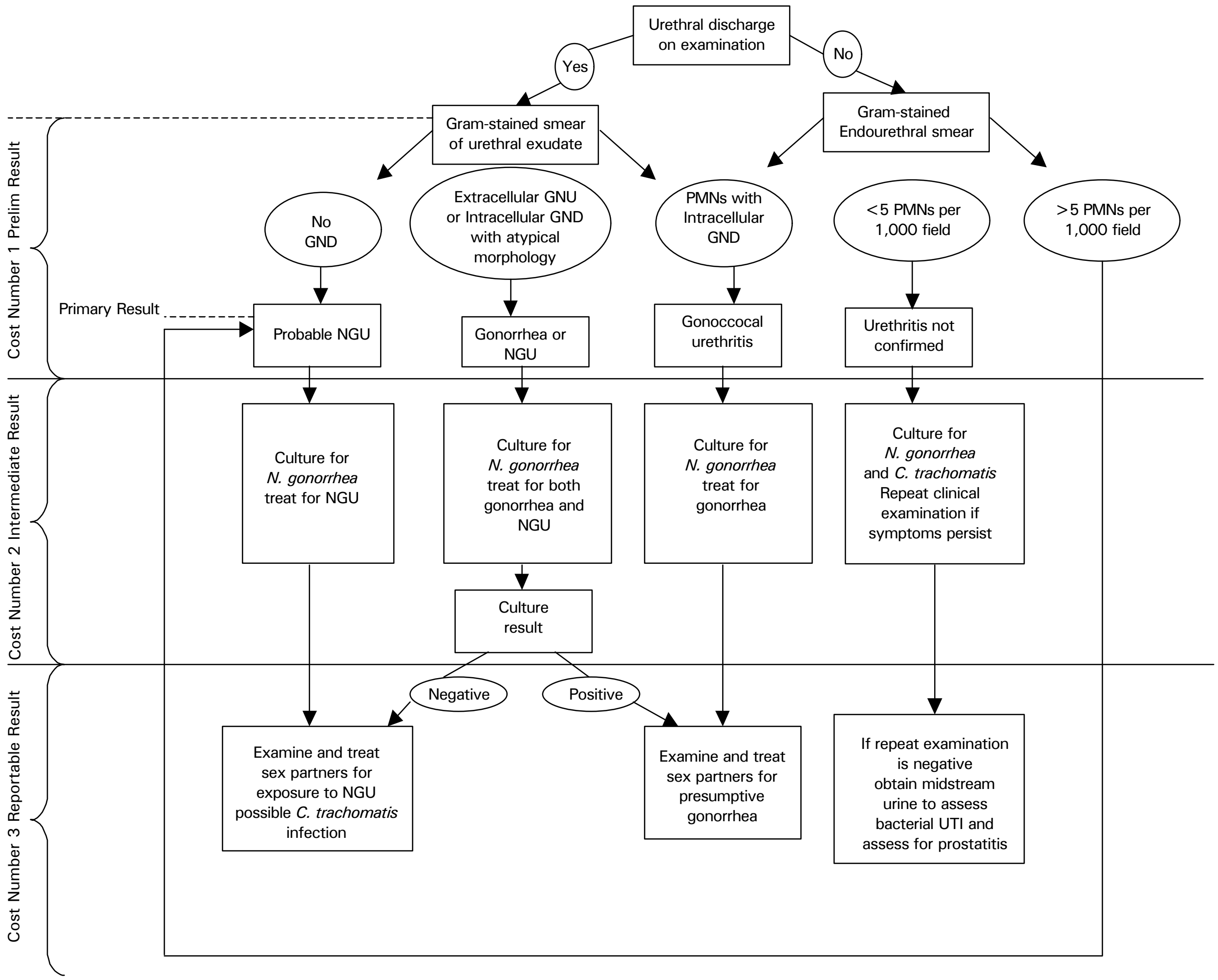
Figure 6. Difference in Complexity of Testing Procedures Between Laboratory Sections

Preanalytical	**Cost 1**	**Sample Preparation**
	+	↓
	Cost 2	**Sample Introduction or Application**
	+	↓
Analytical	**Cost 3**	**Separation**
	+	↓
	Cost 4	**Detection**
	+	↓
Postanalytical	**Cost 5**	**Quantitation and Interpretation and Reporting**
		↓
	Total Cost	**Test Result**

Figure 7. Steps in Cost Accumulation for a Chromatographic Procedure

NOTE: The chromatographic process is composed of a series of distinct operations, each of which has its own cost. Adapted from Binder, SR. *Clin Lab Med*. 1987;7:336.

Figure 8. Algorithm Illustrating the Levels of Cost Generated by Complex Procedures. Another example of



differences in test complexity is given with the diagnostic testing algorithm; the complexity of the steps for a microbiology work-up for urethritis is illustrated. Costs for each step in the process of establishing a definitive diagnosis must be established and will vary, primarily because of the additional labor required for the positive culture. Adapted with permission from Smith, JS, ed. *The Role of Clinical Microbiology in Cost Effective Health Care.* © College of American Pathologists; 1991:221.

I. Test Instrument Indirect Costs (Use Appendix A, Table A2)

Name:	Blood Cultures	Life expectancy in years:	5
Model number:	46	Annual maintenance cost:	$1637.00
Manufacturer:		Site-preparation cost:	NA
Purchase price:	$32,006.00	Evaluation period in days:	9/26/85
		Starting date:	
		Completion date:	

II. Direct Test Materials

Name of Test/ Profile A	Total No. Tests/Profile s B	Per Test/Profile in Evaluation Period $ Reagents C	$ Test-Related Disposables D	$ Equipment-Related Disposables E
1.				
2. Blood Culture Negative	847	$3.60	$0.14	$1.78
3.		847 x $3.60 = $3409	847 x $0.14 = $118.58	847 x $1.78 = $1507.66
4.				
5.				
6. Blood Culture Postive	392	$11.85	$0.27	$1.78
7.		add these costs --> to costs of negative		
8.		392 x $15.45 = $6056	392 x $0.41 = $160.72	392 x $3.56 = $1395.52
9.				
10.	Neg Pos	Neg Pos	Neg Pos	Neg Pos
Totals	847 392	$3049 $6056	$188.58 $160.72	$1507.66 $1395.52

III. Test Labor

Testing Phase	Total FTE Minutes/ Procedure Neg. Cult.	Pos. Cult.	Annual Salary Plus Benefits
Preanalytical Access/Prep. vials	3.65	3.65	$29,344
Analytical Gm.St./Subcult/I&S	N.A.	18.06	"
Postanalytical Report/Disp. vial	1.64	1.64	"
Total Labor and Cost/Culture	5.29 min.	22.29 min.	Negative $1.05/culture; Positive $4.45/culture

Figure 9. Instrument Cost-Accounting Technique Worksheet (See Appendix A). Reprinted with permission from Travers EM. *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989.

5 The Uses of Cost Accounting in the Laboratory

This section illustrates the role of cost accounting in the laboratory environment to assist managers in decision making. Table 7 illustrates some of the general uses of cost accounting in the laboratory.

Table 7. General Uses of Cost Accounting in the Laboratory

- Identifies costs for budget control.
- Helps managers to decide if tests should be done "in-house" or sent to reference laboratories.
- Analyzes specific functional, production, and service activities of laboratory instruments, work stations, sections, and ultimately the laboratory's function and production efforts.
- Localizes the cost performance of the highest and lowest cost areas of the laboratory, which facilitates cost control and planning.
- Enhances communication between work station, section, and departmental staff.
- Motivates management to evaluate how efficiently employees work.
- Provides actual data to aid in recognition of cost overruns and
  compares instruments and methods to become more cost effective.
- Defines elements of the productivity equation (e.g., costs for labor, consumables, reagents, and indirects).
- Provides a basis upon which to set charges or prices.
- Monitors the financial performance of the laboratory, in the form of variance analyses calculated between actual performance, expected performance at standard costs, and planned activity compared to a budget projection.

From a broad, functional viewpoint, the total laboratory cost-accounting system consists of the following components (see Figure 10):

- general functions
- variance analysis; and
- selling and pricing functions.

This guideline deals only with a portion of the general functions of cost analysis, with a brief discussion of variances (Sections 5.5.1 - 5.5.3).

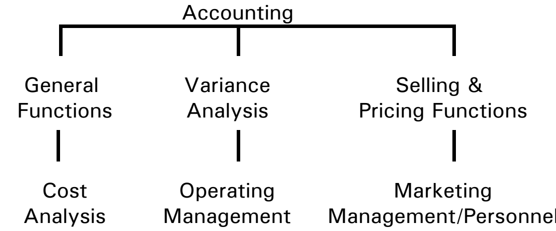


Figure 10. A Functional View of Accounting[5] Gaither JF, and Resinger HE. *Cost Accounting in the Laboratory*. Mundelein, IL: American Pathology Foundation; 1981.

Cost accounting provides a mechanism to assess the expenses or "business" costs of the laboratory. The "business" of the laboratory is providing medical information to physicians in the form of measures of biochemical, metabolic, microbiologic, immunologic, and morphologic changes in patients. This constitutes the laboratory's output. Figure 11 demonstrates the relationships between input (labor, consumables, overhead); output (tests produced); revenues; and expenses of the laboratory.

Therefore, one of the objects of a cost-accounting management system is to link the operating or production side of the business with the financial statements.

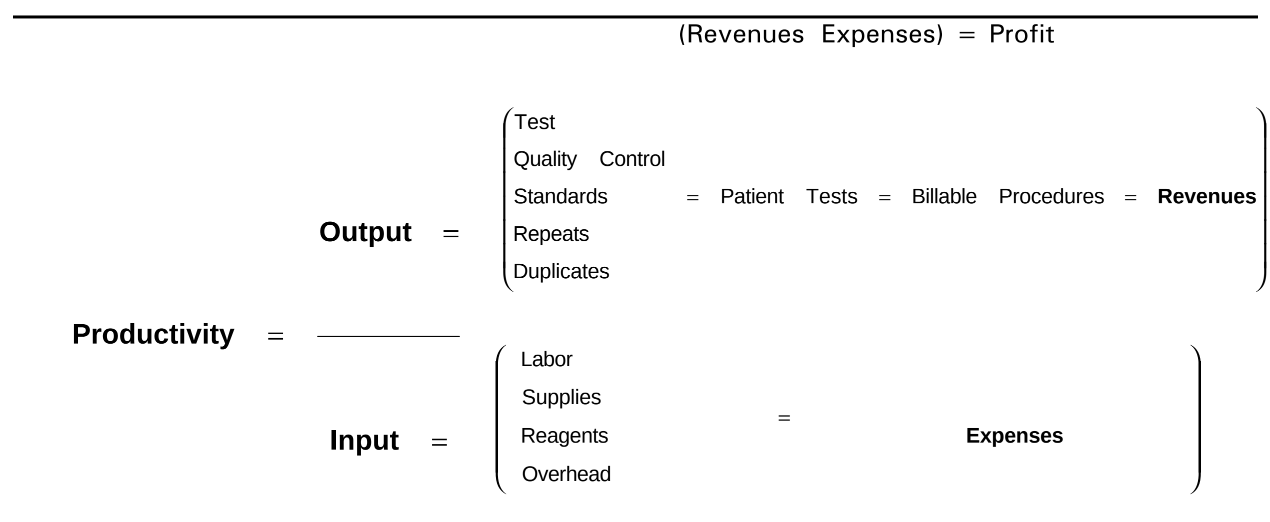


Figure 11. Linking Operations with Production and Financial Functions[3] Reprinted with permission from *Medical Laboratory Advisor*. Montvale, NJ: Medical Economics Company; 1985:2-8.

5.1 Cost Accounting as a Fiscal Decision-Making Tool

Cost analysis is necessary in laboratory operations. It provides a fiscal foundation to better identify economic batch sizes, to justify the addition of new procedures, to determine how frequently tests should be run, to develop departmental objectives, and to analyze the performance of staff and the efficiency of instrumentation. As laboratory methods change, cost analysis is useful in selecting cost-efficient procedures and allows the test-pricing structure to be more responsive to changes in testing procedures. Laboratory budget programs also become more effective when cost analysis is used. Data related to costs and workload allow managers to predict the effect of added tests on personnel utilization.[3,5,6]

Developing cost information and understanding its relationship to the individual test procedure and the laboratory section as a whole facilitates and supports both routine and nonroutine decision making and planning. Understanding of these relationships is greatly enhanced when the link is developed between individual procedure costs and the financial operating statements.

Three simple spreadsheets can be developed that convert all financial operating statement data into cost-per-test data using the techniques described in the previous sections. Appendix B, Table B1— Procedure-Analysis Cost Report (PACR) represents all the tests performed in a single section (parasitology), a revenue center (see Table 3) of the laboratory, and shows the direct costs (test-specific costs) associated with performing the test. It also shows all other indirect costs (laboratory-specific costs) allocated back to the test, which were originally charged to the section, department, division, and the institution or corporate area. Finally, it shows total test cost and net profit margin.

Appendix B, Table B2—[VACR] uses this same information but incorporates test volume to determine the magnitude of individual test profitability and its relationship to the entire section's profitability. This exhibit more clearly represents the relationship of cost accounting to the financial statements as the total direct costs of $91,749.00, plus the indirect section costs of $7,666.00. The total direct plus indirect cost is $99,415.00 for the section for an entire year. (Historical costs or the annual budget may be used.) The other indirect cost totals represent that portion of their financial statement that is allocated to the section.

Development of these schedules on a section-by-section basis provides the laboratory with a basic tool for effective fiscal management. Following are examples of some issues that can be addressed and concepts that can be better understood by the development of this type of format:

Issue #1: Average cost versus cost accounting, which is more valuable?

In discussing the appropriateness of a cost-accounting system in the laboratory, the following argument was made:

"The use of an average test cost for each laboratory section is just as useful for cost analysis as a detailed study of labor and materials. It would be far better utilization of our time in the laboratory and much easier to implement. Such a mechanism would entail allocating appropriate departmental and divisional costs back to the section level and calculating the average cost per test based upon the total volume of tests in the section."

An example of this is as follows (from Appendix B, Table B2—[VACR]):

Section costs	99,415.00	Total direct costs ($91,749.00) + indirect ($7,666.00)
Department-allocated costs	12,776.00	
Division-allocated costs	15,332.00	
Institution-allocated costs	33,218.00	
Total costs	$160,741.00	
Average cost per test equals:	$160,741.00/10,221 tests = $15.73	

Response to #1:

When reviewing the data associated with Appendix B, Tables B1 and B2, a comparison reveals a wide range of test costs with much variability from the simple average. *Management decisions based on an average offer no reliable information for a given specific test for decision making*. For example, the $15.73 cost/test above varies widely from each of the total test costs in column 12 of Table B1—(PACR). Therefore, cost accounting is more valuable than average cost determination.

Issue #2: Should total cost or direct cost be the threshold for setting price (charge)?

Upon review of Table B1—(PACR), an administrative pricing committee determined that prices should be increased to such a level that each individual test has a positive margin, thereby "covering" its individual total cost. This argument was refuted by a dissenting committee member who pointed out that only those tests that have a negative contribution margin (negative contribution margin is indicated by parentheses in column 6 of Table B1—(PACR)) need to be adjusted. When this was communicated to laboratory staff members, there was an outcry from the medical director who believed that laboratory prices in the institution were already significantly higher than in neighboring institutions and that any further increases would be irresponsible.

Response to #2:

These three different perspectives illustrate the issues related to total cost, direct cost, and margins within a pricing theory concept. The total cost advocate is taking a conservative approach by saying that the price of each individual test must cover the fully absorbed costs of the entity. Therefore, each test is "profitable." However, within this approach, two aspects were apparently not fully considered or understood:

(1) In a competitive environment there is always a product (test) mix. Some products possess high margin, some low, and some are loss leaders. This is a result of both cost and market conditions.

(2) Fully absorbed (total) costs result from an allocation of all conceivable costs.

The correlations of the allocated costs may be significant at the department or possibly the section level. However, these correlations become, at best, obscure when an attempt is made to allocate them to a single laboratory test. This degree of subjectiveness can make for poor management decisions about specific tests based on the decision as to how the indirect allocations to the tests are made. In the following example, test code 021 (Antigen Detection - Rotavirus extracted from Table B1—(PACR) using a straight line allocation method) is compared to the same test with indirect costs allocated on a percent-of-direct-cost basis. This displays potential discrepancies in total cost based on differing assumptions as to the appropriate allocation methodology. Is the test profitable or not?

For Example:

1) **Using Straight Line Allocation**

Test Price	Total Direct Test Costs	Section	Dept.	Division	Institution	Net Margin
		Allocated Indirect Costs				
$41.00	$27.65	$0.75	$1.25	$1.50	$3.50	$6.60

This method produces a positive net margin.

2) **Using % of Direct Cost Allocation**

Test Price	Total Direct Test Costs	Allocated Indirect Costs: Section	Dept.	Division	Institution	Net Margin
$41.00	$27.65	$2.32	$3.84	$4.61	$10.78	($8.20)
		8.4%	13.9%	16.7%	39.0%	

This method produces a negative net margin indicated by parentheses above. Therefore, the "direct cost" advocate apparently understands the pitfalls inherent in the proposal of the total cost advocate. The important point demonstrated here is that *total cost should not be the minimum threshold for setting price; direct cost should be the threshold*. In other words, in general, the price of a laboratory test should be no less than the direct, "hands-on" cost of performing the test. This is naturally a much more aggressive approach. The pitfall with this approach is that if *all tests* are priced this aggressively there is no profit margin to cover the indirect costs and the laboratory ultimately attains financial disaster.

Straight line allocation takes the total cost of allocated indirect section, department, division, and institution costs and divides it by annual test volume. See Table B2—(VACR) for an example:

$$\frac{\text{Total Annual Section Costs}}{\text{Annual Test Volume}} = \frac{\$7{,}666.00}{\$10{,}221.00} = \$0.75 \quad (4)$$

The last person in this scenario, the laboratory manager, advocates no price increase because prices are already too high. This is a "market-based" approach to the question because the laboratory is compared to the rest of the community. However, there is no indication that the laboratory manager has considered costs.

The proper perspective in this scenario incorporates each of these viewpoints. To assure profitability, in reviewing the pricing policy of the laboratory, full costs must be addressed. However, there must be sensitivity to the fact that prices are predicted on many variables other than cost alone. Market factors, such as competitors' prices, level of service, availability, and quality, are examples of other issues that must be considered, not the least of which is a plan as to what the pricing policy is to communicate to the consumer of services. In general, costs should not determine price; costs should determine profitability. This can most easily be understood by the use of Table B2(VACR) and Table B3(CMB) (a variation of Table B1[PACR]). Table B3(CMB) encourages a focus on the contribution margins generated by direct costing. This allows flexibility of pricing based on market factors and establishes direct cost as an absolute floor or minimum price. By incorporating Table B3 (CMB) and introducing annual volumes, the total contribution margin generated (taken from the bottom line of Table B2 [VACR]:$149,825.00) to cover all indirect costs ($68,992.00 [sum of columns 7-10, bottom line]), Table B2 [VACR]) and the desired profitability ($80,833.00) (column 11, Table B2 [VACR]) can be modeled. This is done within the framework of a cost-volume-profit analysis. This schedule also displays the relative financial importance of each test to overall section profitability. Test volume and mix are critical variables in this approach.

Issue #3: "Make or Buy" Decisions

A review of the data in Table B1—(PACR) revealed that test code 019, "Occult Blood," is priced at a loss of $2.85 each time the test is performed. There are 953 tests (Table B2—[VACR]) performed annually, which compounds this loss to $2,716.05. Because this test code represents billing to other laboratories, the decision was made to discontinue performing this test in-house. As an alternative, the test would continue to be offered but would be purchased from another laboratory at a cost of $6.00 (but would continue to be priced at $8.00), thereby creating a per-test profit of $2.00 per test by sending it outside.

Response to #3:

The logic in this scenario is not valid. Not all costs of performing this test are relevant costs (see definitions section) for this decision-making process. The relevant costs are the test-specific direct costs of $4.10. These will be the only out-of-pocket cost savings if the test is no longer performed in-house. A purist may argue that labor is not a savings because, in all likelihood, the technologists will remain on staff. For purposes of this example, labor is assumed to be truly variable and a savings. The appropriate perspective is as follows:

Continue	**Begin In-House Testing**	**Purchase Testing**
Price	$8.00	$8.00
Direct costs	4.10	6.00
Indirect costs	Not relevant	Not relevant
Margin	3.90	2.00

The $6.00 purchase price, if the test is sent out, causes an out-of-pocket increase in cost of $1.90 per test above the savings in direct costs of $4.10. Indirect costs are not affected by this decision and should not be considered. Therefore, the test should continue to be performed in-house because the margin is greater.

If the assumption as to the labor component is changed and is considered not variable (the technologist would remain on staff), then labor would no longer be a relevant cost and the economies of continuing to do this test in-house would become even stronger.

Issue #4: Managerial costs and excess capacity: Can you afford to take on additional tests?

A local laboratory calls to inquire as to the possibility of your laboratory contracting to perform 1,000 qualitative parasitology tests (Table B1—(PACR), code 029) over the next six months. They offer to pay $6.00 per test. You are sure that you have the available capacity to perform these tests with existing resources. However, you tell them you must first review your costs before making a decision to accept the offer.

Response to #4:

After reviewing Table B1—(PACR), you find that the current price for code 029, "Qualitative Parasitology," is $11.00 and direct costs are $4.55. After indirect costs are fully applied, a loss of $0.30 is represented. Once again, indirect costs are not relevant to this isolated question because they are unaffected by the decision. The main factor in this decision is to determine the marginal, or "incremental," cost of producing these additional 1,000 tests (i.e., what additional out-of-pocket costs will be incurred)? If this work is accommodated during regular working hours without incurring additional labor costs, the true marginal costs may be the nonlabor direct cost component of $4.55 (total direct cost) $2.98 (labor) or $1.57. Under this assumption, the potential profits are $4,430.00, calculated as follows: $6.00 (price) $1.57 (marginal cost) x 1,000 tests. However, if this assumption is too aggressive and the feeling is that additional labor hours will be required consistent with the labor component of this cost analysis, the marginal cost of producing the additional tests would be the total direct cost of $4.55. Under this assumption, the potential profits are calculated as follows: ($6.00 $4.55) x 1,000 tests = $1450.00.

The other key variables in this decision are: a) capacity and b) length of time associated with this commitment. The manager must first determine if there is excess capacity (i.e., are the existing personnel and equipment capable of handling this volume in the short run without interfering with the routine workload?) Secondly, is the commitment for a short period of time? Long-term commitments are associated with capacity issues: pricing relative to current in-house users, comparative pricing with ongoing purchasers of the services, or possible conflicts with overall general pricing policy (regardless of whether it is based on a contribution-margin approach or a total-cost-per-test approach) in assuring coverage of indirect costs.

If the manager does not see operational conflict, is comfortable with utilizing what otherwise would be idle time, and believes that the additional profits are worthwhile, the economics of a $6.00 price, under these circumstances, is plausible. However, if capacity is not available or the proposal is for an indefinite amount of time, serious consideration cannot be given to this proposal and it should be refused.

Issue #5: Using incremental costs to benefit you and your institution.

A researcher from your hospital calls you to complain about the cost of a test you are performing. He has a grant of $10,000.00, which entails requisitioning a blood parasite test (Table B1—(PACR), code 024) for 250 patients at the beginning of the study. At the current charge of $24.00 (Table B1—(PACR)) this would wipe out $6,000.00, or 60% of the grant. The residual will not support completion of the study. Because this study is important to him, his only alternative is to send the test to the commercial laboratory down the street. Their charge is $8.00 (thereby consuming only 20 % of his grant).

Response to #5:

The assumption is that the researcher and the laboratory are part of the same institution. If this is the case, the challenge becomes to keep as much of the grant monies within the institution as possible (assuming it is financially feasible). Direct costs account for $9.19 (Table B1—(PACR), column 5) when doing this test. Labor amounts to $7.65 (column 2) and nonlabor (indirect cost) is $1.54 (column 4). This appears to be a case where using the other laboratory may be best because their costs fall below the direct costs of producing the test. However, an aggressive manager may want to look at the incremental or marginal cost of supporting this project. If arrangements can be made with the researcher to schedule this testing at the laboratory's discretion, during otherwise idle time during the day (so as not to incur incremental salary expenses, i.e., overtime), an economic opportunity may exist.

To envision this perspective, think in terms of the cost-accounting schedule as a segmentation given an expected volume and mix of tests. If this proposed work can be done during otherwise idle time, the effect is to add $8.00 in revenue, add $0 in salaries, add $1.54 in expenses, and $6.46 in contribution margin for each of the 250 tests performed, thereby increasing the profitability of the section. In addition, it ensures that $6.46 per test stays within the institution rather than $8.00 per test from the grant going to an outside laboratory.

Note that an appropriate pricing policy regarding research service support should be adopted to address the majority of requests. However, creativity in analyzing costs should be adopted to insure profitability, not only from the laboratory's perspective but for the institution as well.

5.2 Measuring Contribution

Contribution is computed by deducting the costs (developed through cost accounting) for which the laboratory is responsible (both direct and laboratory indirect) from the revenues gained by charging for the tests generated by the laboratory.[3,5] Contribution for the hematology section would be computed by taking all direct and laboratory indirect (fixed and variable) costs that are the responsibility of the hematology section, and deducting them from the revenue generated in the hematology section during the period in which the cost was incurred. Contribution computations allow managers to decide how to increase workload, or shift personnel to improve productivity. In Section 5.1, issues #2 and #3 provide examples of the use of contribution in managerial decision making.

5.3 Developing Costs for Disease-Specific Tests

Cost accounting can be used to develop actual costs for the tests specific for disease categories within diagnostic-related groups (DRGs).[3] Disease categories within selected DRGs can be chosen, senior physicians in the hospital system can select the most specific tests required for these diseases, and test groups can be merged with their own test costs. An example of the total, direct, and indirect costs incurred for one hospital treating a new admission with suspected diabetes is demonstrated in Figure 12. A cost-accounting system permits any hospital to follow the format to calculate its own costs per disease category.[3]

Major Diagnostic-Related Group 294.MDC 10M. Diabetes 36
Principal diagnosis: 250.40 Adult-Onset Type Diabetes Mellitus with renal manifestations/noninsulin dependent
Patient status: New admission—stable
Frequency of test(s) ordered: Order once on admission only

			Cost Per Test					
			Direct			Indirect		
Test Total Cost	**Value of Test(s)**	**Equipment**	**Reagents/ Supplies**	**Instrument**	Labor **GS-9 GS-7**	**Indirect**	**Frequency**	**Total**
BUN	Highly valuable	Demand	$0.13					
Potassium	Highly valuable	"	0.22					
CO_2	Highly valuable	"	0.21					
Chloride	Highly valuable	"	0.22					
Creatinine	Highly valuable	"	0.09	$0.04	$7.01	$0.79	1	$9.45
Sodium	Highly valuable	"	0.13					
Glucose	Highly valuable	"	0.13					
24-hour creatinine	Highly valuable	"	0.09					
Protein	Highly valuable	"	0.15					
Cholesterol	Moderate value	"	0.24					
Urine microscopic	Highly valuable	Manual	0.15	0.03	1.55	0.19	1	1.92
Hematocrit	Moderate value	Coulter						
Hemoglobin	Moderate value	S + IV	0.27	0.36	2.09	0.30	1	3.02
TOTAL COST/LDRG/NEW ADMISSION			$2.03	$0.43	$10.65	$1.28	1	$14.39

Figure 12. An Example of a Diagnostic-Related Group Cost-Analysis Worksheet [3] Reprinted with permission from Travers EM. *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989.

Note: Labor costs are the most expensive component of test cost.
BUN: blood urea nitrogen

5.4 Comparison of Test Costs Between Analyzers and Laboratories

Cost accounting makes it possible to develop comparative data between laboratories performing the same test on different analyzers. In one study, over 70 different medical center laboratories were compared, revealing vast differences in test costs.[6] For instance, the same test (e.g., creatinine) performed in different hospitals ranged in cost from $0.07 to $5.88. These differences were primarily due to the number of minutes of labor and the salary paid to the technologist(s) but they were also dependent on the type of analyzer used and reagent and supply costs. The study showed that even laboratories in the same major city performing the test on the same analyzer will have different test costs, depending on how efficiently they use their labor component to operate them.

This evidence leads to the general conclusion that each hospital or corporate laboratory has its own unique test-cost profile because each has different salary scales, different workflow configurations and efficiencies, and varying discounts for reagents and supplies. This makes the significance of cost accounting even greater because pricing tests, calculating contribution, or determining breakeven points can be erroneous if the laboratory manager uses test-cost values provided by equipment vendors, instead of performing actual test costs. Using the same cost-accounting format within a system of laboratories (i.e., a group of laboratories owned and operated by a corporation) allows top management to compare costs between peer laboratories, determine the most cost-effective laboratories within the group, and develop historical test-cost databases to remove less efficient, labor-intensive instrumentation.

5.5 Measurements of Fiscal Efficiency

Cost accounting also measures efficiency by combining actual cost (see Section 2) as recorded in the general ledger, with standard cost (see Section 2). Together, they monitor the financial performance of the laboratory. This monitoring most frequently takes the form of variance analyses (Section 2.1) calculated between actual performance, expected performance at standard cost, and planned activity compared to a budget projection. Many variances can be calculated. Substantial coverage of this subject can be found in texts on laboratory cost management.[3,5] The capabilities of a cost-accounting system and the capacity of a general ledger system determine how deeply one can analyze variance.

However, the laboratory manager is concerned with at least three key variances: labor- usage variance, labor-rate variance, and material-efficiency variance.

5.5.1 Labor-Usage Variance

The usage variance is the most descriptive single indicator of the performance of a laboratory and a laboratory manager. It measures how efficiently the laboratory used its resources to build its service units.

5.5.2 Labor-Rate Variance

The labor-rate variance measures how well a laboratory or laboratory manager controlled actual labor rates for the period. The laboratory manager has less control over this factor than the efficiency factor because labor rates are often fixed by union contracts and grade and wage tables. However, the laboratory manager still has the authority to promote employees and to authorize overtime, both of which affect the actual rate.

5.5.3 Material-Efficiency Variance

This variance describes the differences in dollars of what would have been spent for material at actual service unit volume using standard material cost and what was actually spent for material in the department.

5.6 Managerial Decision Making and Management Control

Cost analysis is related to management objectives in the following ways[5]:

- Analysis of specific functional, productive, and service activities allows more reasonable and accurate assignment of costs.

- The more accurate the costing of each function or operation, the more accurately test costs can be determined because total test cost is the sum of the cost of multiple actions or functions.

- Cost control is aided by localizing the cost performance of the various persons who spend the laboratory's money through carrying out their activities. Thus, *cost behavior* can be studied and thereby facilitate cost *control* and *planning*.

An important part of managerial decision making is isolating or defining specific relevant costs (see Section 2). Cost calculations express the net effect of many factors and help to reduce the number of factors involved in the final judgement. Cost figures are always estimates and are subject to a margin of error. The manager's role is to decide how wide the margin of error is and to set boundaries to establish the net influence of factors that operate together to establish costs.

The laboratory business is a complex activity whose elements include personnel, money, space, equipment, goals, ethics, incentives, materials, and policies. No manager has all of the information on each of these elements, and many decisions must be made within an environment of uncertainty using good judgment. Furthermore, not all accounting figures are relevant to the problem at hand, and few management problems can be solved solely by collecting and analyzing figures. Cost accounting is not an end in itself and, ultimately, any accounting system must result in human action. The system is useless if it is not used. A cost-accounting system, if overused, could be detrimental if overemphasis on the importance of figures replaces, rather than complements, good managerial judgement.

References

1. Tirabassi CP, Winkelman JW. Incremental cost basing of laboratory test bid proposals. *Lab Med.* 1988;19:111-115.

2. Sharp JW. Cost accounting systems targets to DRGs. In: *Medical Laboratory Observer*. Oradell, NJ: Medical Economics Co., Inc., 1985:2-8.

3. Travers EM. *Managing Costs in Clinical Laboratories*. New York: McGraw-Hill Information Systems Co., 1989:109-159.

4. *Manual for Laboratory Workload Recording*. Skokie, IL: College of American Pathologists, 1990: 175.

5. Gaither J, Resinger H. *Cost Accounting in the Laboratory*. The American Pathology Foundation, 1981:56.

6. Travers EM, Krochmal CF. A new method for instrument cost analysis. In: *Medical Laboratory Observer*. Oradell, NJ: Medical Economics Co., Inc., 1988:24-62.

Appendix A. The Instrument Cost-Accounting Technique©[3,6]

The instrument cost-accounting technique (ICAT) is a universal, generic, full-costing technique that may be used for any test performed in the laboratory. The preceding text developed general concepts and guidelines for the method that follows. Although it is not the only approach to cost accounting, it is a comprehensive full-costing technique that incorporates the essential components of labor, consumables, and indirect costs. The three prime cost aspects of analysis are considered:

instrument-related costs;
direct consumables costs; and
labor costs.

Because no two laboratories are alike in their instrumentation configuration, ICAT was designed to be generic so that it can be used in any laboratory.

By dividing all test production activities into three major work-effort segments, ICAT allows managers to estimate which segment of the test-production process has the greatest impact on manpower and, subsequently, on compensation costs.

Based on standard cost-accounting techniques, ICAT is derived from the standard literature and generally accepted accounting principles (GAAP) within the field of accounting.

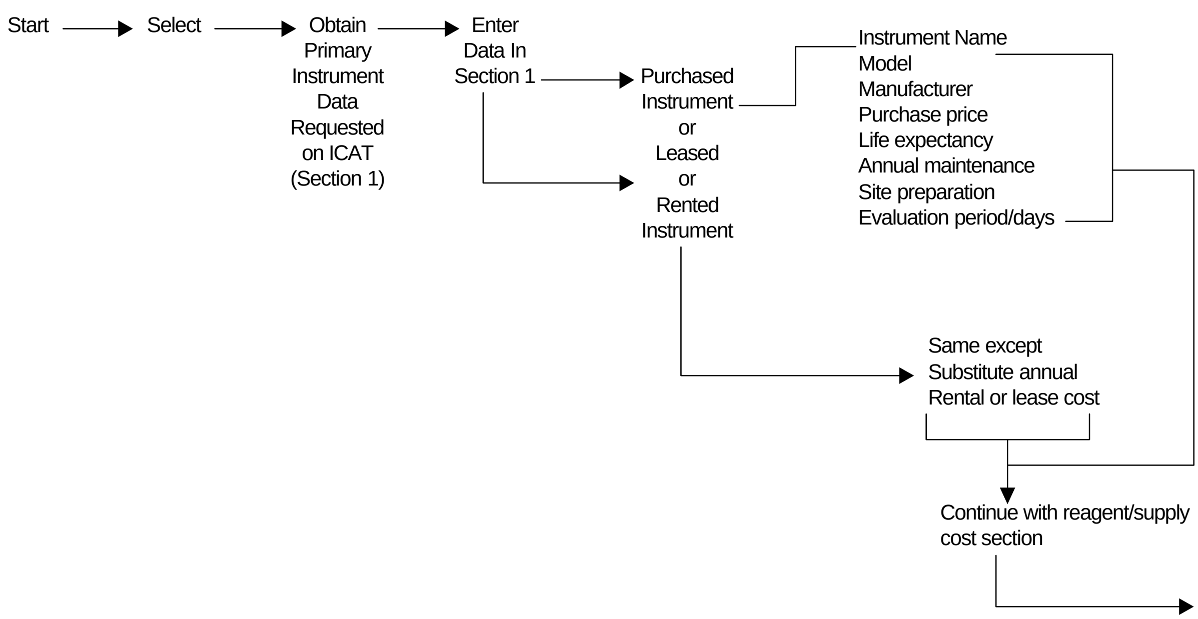
The ICAT technique can be used for accumulating costs for manually performed tests or tests performed with an instrument. If no instrument is used, then the section on indirect instrument costs (Section 1 of the ICAT Form) (Figure A6) is left out, and the remaining sections are completed. The ICAT worksheet (Figure A6) is used to accumulate costs; instructions for completing each major section of the ICAT appear in Table A1. Examples and algorithms for actual cost analysis of a test procedure are presented in the figures and tables that follow.

Instructions: Use the algorithm below to complete Section I on indirect cost.

I. Test Instrument Indirect Costs:

Name:______________________
Model number:______________
Manufacturer:______________
Purchase price:______________
Annual lease/rental cost:______

Life expectancy in years:____________
Annual maintenance cost:___________
Site-preparation cost:______________
Evaluation period in days:___________
Starting date:______________________
Completion date:___________________



Phase II. Data Entry—Direct Instrument Costs:

Figure A1. Indirect Cost Algorithm and Data Entry Form. Adapted with permission from Travers EM. *Workbook for Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies, 1989, and Travers EM, *Managing Costs in Clinical Laboratories*. Appendix, "Sample ICAT Worksheet." New York: The McGraw-Hill Companies, 1989:126.

Instructions: Use the algorithm below to complete Section II, Consumables Costs.

II. Direct Test Consumables

Name of Test/Profile	Total No. Tests/Profiles	Per Test/Profile in Evaluation Period:		
		$ Reagents	$ Test-Related Disposables	$ Equipment-Related Disposables
A	B	C	D	E
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
Totals				

Start

Enter Names of Tests Performed on Instrument in Section II, Part A

Enter Number of Patient Tests Performed in Part B Next to Test Name

Enter Cost of Reagents Used Per Test in Part C

Enter Cost of Test-Associated Disposables Per Test in Part D

↓

Enter Cost of Instrument-Associated Disposables Per Test in Part E

Phase II. Data Entry (Continued)—Direct Consumables Costs:

Figure A2. Consumables Cost Algorithm And Data Entry Form. Adapted with permission from Travers EM. *Workbook for Managing Costs in Clinical Laboratories*. Appendix, "Sample ICAT Work Sheet." New York: The McGraw-Hill Companies, 1989, and Travers EM, *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies, 1989:127.

Instructions: Use the algorithm below to complete calculation of consumables costs.

Start → Begin Cost Calculation for Each Test Entered in Section II by Adding Costs Together → Cost of Reagents (Part C) → Cost for Test-Associated Disposables (Part D) → Cost for Instrument Associated Disposables & Supplies (Part E) = Total Cost/Test for Reagents

↓

Proceed with Labor Costs →

Calculation

Phase III: Calculation of Direct Individual Costs for Reagent/Supplies and Instrument-Related Disposables-

Part I: Calculation of Reagents/supply Costs:

Figure A3. Algorithm for Calculation of Consumables Cost. Adapted with permission from Travers EM. *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies, 1989:128.

Instructions: Use the algorithm below to complete Section III, Labor Costs.

III. Test Labor

Time Segment Per Test/Profile	Total FTE Minutes/ Procedure	Annual Salary & Benefits
Preanalytical		
Analytical		
Postanalytical		

Phase II: Data Entry (Continued)—Direct Labor Costs.

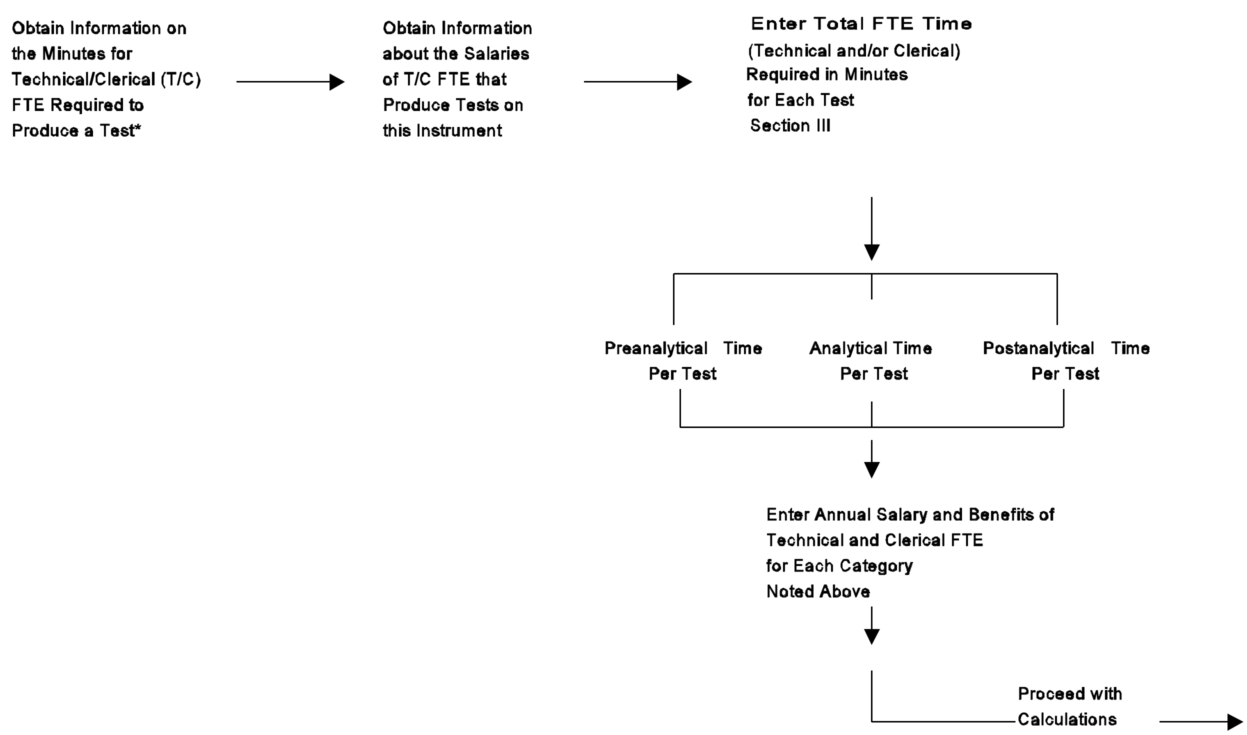


Figure A4. Algorithm and Data Entry Form for Labor Costs. Adapted with permission from Travers EM. *Workbook for Managing Costs in Clinical Laboratories*. Appendix, "Sample ICAT Work Sheet." New York: The McGraw-Hill Companies, 1989, and Travers EM, *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989.

*Involves all phases of production, starting with specimen collection and ends with delivery of test results to user.

Instructions: **Use the algorithm below to calculate total cost per test.**

Start

↓

Total Labor Costs (Section III)	Add to	Total Direct Material Costs (Section II)	Add to	Instrument Costs (Section I)		Total Direct Lab Cost/Test	Multiply by Lab Indirect Cost Percentage	Lab Total Cost per Test	Add to	Hosp./Corp. Indirect Cost	Total Cost/Test

Phase III, Part 2: Calculation of Direct Labor Cost and Summary Sheet.

Figure A5. Calculating Total Cost per Test. Adapted with permission from Travers EM. *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989:128.

Instructions: Enter values in Sections I-II using data from Tables A2, A3, and A4. See Table A1 for instructions. (See Figure 9 in the text for a completed example.)

I. Test Instrument Indirect Costs (Use Table A2)

Name:____________________

Model number:____________________

Manufacturer:____________________

Purchase price:____________________

Annual lease/rental cost:____________________

Life expectancy in years:____________________

Annual maintenance cost:____________________

Site-preparation cost:____________________

Evaluation period in days:____________________

Starting date:____________________

Completion date:____________________

II. Direct Test Materials (Use Table A3)

Name of Test/Profile A	Total No. Tests/Profiles B	Per Test/Profile in Evaluation Period		
		$ Reagents C	$ Test-Related Supplies & Parts D	$ Equipment-Related Disposables E
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
Totals				

III. Test Labor (Use Table 5 and A4)

Testing Phase	Total FTE Minutes/Procedure	Annual Salary Plus Benefits
Preanalytical		
Analytical		
Postanalytical		
Total		

Figure A6. ICAT Cost-Accumulation Worksheet. Complete ICAT worksheet showing cost accumulation for GC/MS procedure. See Table A1 for instructions. Adapted with permission from Travers EM. *Workbook for Managing Costs in Clinical Laboratories*. Appendix, "Sample ICAT Work Sheet." New York: The McGraw-Hill Companies; 1989.

Table A1. Instructions for Completing the ICAT Worksheet

In Part I Indirect Costs, do the following:

1. Enter the trade name of the instrument.

2. Enter the instrument model number, if applicable.

3. Enter the manufacturer's name.

4. Enter the purchase price of the equipment.

5. Enter the anticipated life expectancy of the equipment in years.

6. Enter the annual maintenance cost of the equipment.

7. Enter the site-preparation cost.

8. Enter the evaluation period (in whole days) and the starting date of the evaluation period.

In the grid portions (II and III): Consumables (II) and Labor (III), do the following:

9. Enter the name or designation for each test or panel that will be performed on the instrument. If the instrument performs both discrete and batch testing, do this analysis for both modes of operation and duplicate this form if necessary (Part A).

10. Enter the total number of tests or profiles performed on this instrument during the evaluation period (Part B).

11. Based on reagent costs incurred during the evaluation period, enter the reagent cost per test profile (Part C).

12. Based on cost of disposables used during the evaluation period, estimate the test-associated disposable cost per test/profile (Part D).

13. Enter the cost of any other equipment-related disposables per test/profile used during the evaluation period (Part E).

14. Continue with the labor analysis section and enter:

15. Preanalytical time—Include time to collect specimens from patients and laboratory central receiving. This includes all steps up to the actual testing procedure, such as work-list gathering, start-up, sample cup preparation, and preparation of daily quality controls and standards for this instrument. Phlebotomy or centrifugation is included.

16. Analytical time—Include labor to analyze the specimen(s) and to perform all routine procedures up to reporting of results. This includes calculation(s) and checking but does not include repeats.

17. Postanalytical time—Include labor to manually report results or to enter results into a computer system. This includes sorting, filing, and telephone calls related to the final report(s). Routine, daily maintenance normally performed and shut-down time must also be included.

When all blocks have been completed, provide totals where indicated and proceed to Table A5 Formulas for ICAT.

Reproduced with permission from Travers EM. *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989:112.

Table A2. Worksheet to Accumulate Indirect Costs

Instructions: Use worksheet below to accumulate indirect costs, then enter these into formulas in Table A5.

Equipment Indirect Cost Worksheet Summary

Equipment		**Annual Cost**
Depreciation	$	***90,000.00/5 yrs; 18,000.00/yr***
Lease fee		***Included in purchase price***
Rental fee		________
Maintenance		***$9,000.00 service contract; $442.00 technical labor (2 hrs/mo)***
Service parts kit		________
Service contract		***Included in maintenance cost***
Interface		____________
Accessory equipment		____________
Other (see Table 3)		____________
Subtotal	$	***27,442.00/yr***
Initial and Relocation Set-up Costs		
Heating/air conditioning	$	____________
Water systems		***$ 500.00***
Drain		***$500.00***
Power		***$500.00***
Remodeling		***$500.00***
Correlation studies		____________
Start-up kit		____________
Other	$	____________
Subtotal	$	***2,000.00/5 yrs; $400.00/yr***
Laboratory Indirect Cost Total	$	***27,842.00***

Adapted with permission from Travers EM. *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989:112-115, and Travers EM, *Workbook for Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989:56.

Table A3. Laboratory Consumables Cost Worksheet Summary

Consumables	Quantity per 30 tests	Cost per run
Fluids		
Reagents		$27.57
Diluents		
Calibration material		$140.00
Reference fluids		
Linearity standards		
Control fluids		
Rinse/wash solutions		
Cleaning solution		
Deionized water		
Analyzer-specific solutions		
Other		
Subtotal		
Supplies*		
Chemicals		$10.46
Gasses		
Paper	1	$50.00/yr; $(0.02/test x 30) = $0.60/run
Labels		
Ribbons	1	$60.00/yr; $(0.03/test x 30) = $0.90/run
Water		
Cartridges and filters	1	$56.00/yr; $(0.03/test x 30) = $0.90/run
Other		
Subtotal		
Parts*		
Syringes	1	$600.00/yr; $0.29/test x 30) = $8.70/run
Tubing		
Membranes		$20.80/yr; $(0.01/test x 30) = $0.30/run
Valves		
Reagent caps		
Seals		
Reagent vessels		
Cuvettes		
Vials		
Lamps		
Needles		
Probes		
Electrodes		
Filters		
Detectors		
Reaction chambers		
Other		
Subtotal		$9.00/run
Disposables*		
Sample cups (test tubes)	50	$60.00/yr; ($0.04/test x 30) = $1.20/run
Sample caps	50	$30.00/yr; ($0.01/test x 30) = 0.30/run
Pipette tips	50	$30.00/yr; ($0.01/test x 30) = 0.30/run
Glass tubes	50	$75.00/yr; ($0.04/test x 30) = 1.20/run
Bar Code labels		
Micro Inserts/cups		
Cuvettes		
Other		$10.00/yr ($0.005/test x 30) = $0.15/run
Subtotal		$3.13/run
Total		$432.28/run

*Cost estimates for supplies and parts based on 2,080 tests per year. Adapted with permission from Travers EM. *Managing Costs in Clinical Laboratories.* New York: The McGraw-Hill Companies; 1989:237-238.

Table A4. Labor Cost Accumulation Worksheet

Instructions: Use the worksheet below to accumulate labor costs; divide into preanalytical, analytical, and postanalytical totals. Enter totals in Section III of ICAT Worksheet, Figure A6. Instructions for this worksheet are in the text in Table 5. A completed example appears in the text in the text in Figure 4.

Department:	**Study:**	**Page___ of ___**
Section:		**Date:**
Procedure:		
Equipment/model:		
Technologist:	**Observer:**	
Batch Size: Patients - Controls -	**Standards -**	**Repeats:**

#	Element Description	Time	Cum. Time	Freq.	Base Time
A.	**B.**	**C.**	**D.**	**E.**	**F.**
Remarks			**Total Base Time**		
			P.F.D. Allowance______%		
			Standard Time for Billable Procedure		**Minutes**
Approved (Signature) **Date:**					**Hours**

Table A5. Formulas Used for Test Cost Calculation for Laboratory Tests

Instructions: Following are six basic formulas that must be used to calculate materials, labor, and indirect costs for test production. Transfer the information accumulated on the ICAT worksheet (Figure A6) to each of the formulas that appear in this table.

After solving all of the formulas, enter the totals on the test cost-determination summary sheet (Table A6) and subtotal. Multiply the subtotal by the indirect cost percentage for the hospital/corporation to provide a cost-per-test total.

1. $$\text{Consumable Materials Costs (Test or Profile)} = \frac{\text{Cost of Reagents} + \text{Cost of Test-Associated Supplies and Parts} + \text{Cost of Equipment-Related Disposable}}{\text{\# of Tests or Profiles}} = \frac{407.57 + 21.56 + 3.15}{30 \text{ Tests}} = \frac{\$432.28 \text{ Run}}{30 \text{ Tests}} = \frac{\mathbf{\$14.40}}{\textbf{Test}}$$

2. $$\text{Labor Costs (Test or Profile)} = \frac{\text{Salary Cost}}{\text{Year}} \times \frac{1 \text{ Year}}{2080 \text{ Hours}} \times \frac{1 \text{ Hour}}{60 \text{ Min}} \times \frac{\text{\# Min}}{\text{Test or Run}} = \frac{\$38{,}284.00 \times 1 \text{ Year} \times 1 \text{ Hour}}{1 \text{ Year} \times 2080 \text{ Hours} \times 60 \text{ Min}} \times \frac{38284}{124800} = \frac{\$0.31}{\text{min}}$$

$$\frac{\text{Cost}}{\text{Run}} = \frac{\$0.31}{\text{Min}} \times 369.2 \text{ Min} = \frac{\$114.45}{\text{Min}}$$

$$\frac{\text{Cost}}{\text{Test}} = \frac{\$114.45/\text{Run}}{30 \text{ Tests}} = \$3.82$$

3. $$\text{Instrument Depreciation Costs}^{\dagger} \text{ (Test or Profile)} = \frac{\text{Instrument Purchase Price}}{\text{Anticipated Instrument Life Expectancy (in Years)}} \times \frac{1 \text{ Year}}{365 \text{ Days}} \times \frac{\text{\# Days in Evaluation Period}}{\text{\# Tests in Evaluation Period}} = \frac{\$90{,}000.00 \times 1 \text{ Year} \times 1 \text{ Day}}{5 \text{ Years} \times 365 \text{ Days} \times 30 \text{ Tests/Paid}} = \frac{\$90{,}000.00}{54{,}750} = \frac{\mathbf{\$1.64}}{\textbf{Test}}$$

Benefits at 13% rate are included in salary costs; (see Figure A6) if benefits are not included in salary cost, then a factor must be added to this equation to multiply the result by 1.13 if benefits are 13%.

† If the instrument is not owned but rather rented or leased, the formula is modified as follows:

$$\text{Annual Rental/Lease Costs} \times \frac{1 \text{ Year}}{365 \text{ Days}} \times \frac{\text{\# Days in Evaluation Period}}{\text{\# Tests in Evaluation Period}} = \text{Rental/Lease Cost/Test}$$

Table A5. (Continued)

4\. *Maintenance Costs* $= \dfrac{\textit{Total Cost for Maintenance, Services, and Repairs}}{\textit{Anticipated Instrument Life Expectancy (in Years)}} \times \dfrac{1\ \textit{Year}}{365\ \textit{Days}} \times \dfrac{\#\ \textit{Days in Evaluation Period}}{\textit{Tests in Evaluation Period}} = \dfrac{\$47{,}210.00 \times 1\ \textit{Year} \times 1\ \textit{Day}}{5\ \textit{Years} \times 365\ \textit{Days} \times 30\ \textit{Tests/Paid}} = \dfrac{\$47{,}210.00}{54{,}750} =$ **\$0.86/*Test***

5\. *Site Preparation Costs (Test or Profile)* $= \dfrac{\textit{Costs to Install Instrument}^{\ddagger}}{\textit{Anticipated Instrument Life Expectancy (in Years)}} \times \dfrac{1\ \textit{Year}}{365\ \textit{Days}} \times \dfrac{\#\ \textit{Days in Evaluation Period}}{\#\ \textit{Tests in Evaluation Period}} = \dfrac{\$2{,}000.00 \times 1\ \textit{Year} \times 1\ \textit{Day}}{5\ \textit{Years} \times 365\ \textit{Days} \times 30\ \textit{Tests/Paid}} = \dfrac{\$2{,}000.00}{54{,}750} =$ **\$0.04/*Test***

6\. *Indirect Costs* = (*Consumables* + *Labor* + *Depreciation* + *Maintenance* + *Site Prep*) *x* 60%§
= (\$14.40 + 3.82 + 1.64 + 0.86 + 0.04) *x* 0.60§ = **\$12.46/*Test***

Proceed to Table A6.

‡Electricity, plumbing, air conditioning, and construction.

§Percentage will vary in each laboratory/hospital. See Fiscal Services for rates.

Adapted with permission from Travers EM. *Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989:227–228.

Table A6. Test Cost-Determination Summary Sheet

Instructions: Enter totals from Table A5 into appropriate categories.

Direct Costs		
1. Consumables (reagents/supplies) Cost	$ 14.40	(Formula 1), Table A5
2. Labor Costs a. Preanalytical b. Analytical c. Postanalytical	$ 3.82*	(Formula 2), Table A5

Indirect Instrument Costs		
1. Depreciation costs (or rental/lease costs)	$ 1.64	(Formula 3), Table A5
2. Maintenance costs	0.86	(Formula 4), Table A5
3. Site-preparation costs	0.04	(Formula 5), Table A5
Subtotal	$	
x (60%) Indirect Costs†	$ 12.46	(Formula 6), Table A5
= **Total Cost per Test**	$ 33.22	

*NOTE: Labor costs are almost always the highest cost. Because the reagents for the benzoylecgonine test shown here are expensive, materials costs are higher than labor.

†Excludes all other indirect costs other than instrument-related indirect costs, e.g., rent, insurance, power, heat, lights, taxes, etc.: 60% is only an example since indirect costs are different for each hospital or corporate laboratory; private sector indirect costs may be as high as 148%.

Adapted with permission from Travers EM. *Workbook for Managing Costs in Clinical Laboratories*. New York: The McGraw-Hill Companies; 1989:57.

Appendix B. Spreadsheet for Estimating Test Margin & Profitability

Table B1. Procedure-Analysis Cost Report (PACR)

Laboratory Medicine
Department: Microbiology
Section: Parasitology

Column #		1	2	3	4	5	6	7	8	9	10	11	12	13
		-------Test-Specific Costs-------- (Direct Costs)						-----Laboratory-Specific Costs--- (Indirect Costs)						
Test Code	Procedure Name	Price*	Labor	RGTS/DISP	Other	Total Test-Specific Costs	Contribution Margin	Section	Dept.	Division	Total Lab.-Spec. Costs	Allocated Institution/ Corp. Indirect Costs	Total Cost	Net Margin
001	CHLAMYDIA DFA	$25.00	$3.90	$5.92	$1.25	$11.07	$13.93	$0.75	$1.25	$1.50	$3.50	$3.25	$17.82	$7.18
002	O/P CHLAMYDIA DFA	20.00	3.90	5.92	1.25	11.07	8.93	0.75	1.25	1.50	3.50	3.25	17.82	2.18
003	CRYPTOSPORIDIA EXAMS	25.00	11.07	5.03	1.25	17.35	7.65	0.75	1.25	1.50	3.50	3.25	24.10	0.90
004	O/P CRYPTOSPORIDIA EXAMS	15.00	11.07	5.03	1.25	17.35	(2.35)	0.75	1.25	1.50	3.50	3.25	24.10	(9.10)
005	CHLAMYDIA CULTURES	50.00	5.27	4.89	1.25	11.40	38.60	0.75	1.25	1.50	3.50	3.25	18.15	31.85
006	O/P CHLAMYDIA CULTURE	46.00	5.27	4.89	1.25	11.40	34.60	0.75	1.25	1.50	3.50	3.25	18.15	27.85
007	LEPTOSPIRA CULTURES	38.00	43.37	0.78	1.25	45.40	(7.40)	0.75	1.25	1.50	3.50	3.25	52.15	(14.15)
008	O/P LEPIOSPIRA CULTURES	38.00	43.37	0.78	1.25	45.40	(7.40)	0.75	1.25	1.50	3.50	3.25	52.15	(14.15)
009	MYCOPLASMA CULTURES	36.50	8.48	8.54	1.25	18.27	18.23	0.75	1.25	1.50	3.50	3.25	25.02	11.48
010	O/P MYCOPLASMA CULTURES	33.50	8.48	8.54	1.25	18.27	15.23	0.75	1.25	1.50	3.50	3.25	25.02	8.48
011	PARA AMOEBA	36.50	10.63	0.10	1.25	11.98	24.52	0.75	1.25	1.50	3.50	3.25	18.73	17.77
012	O/P CULT PARA AMOEBA	33.50	10.63	0.10	1.25	11.98	21.52	0.75	1.25	1.50	3.50	3.25	18.73	14.77
013	DARKFIELD EXAMS	33.00	4.08	0.78	1.25	6.11	26.89	0.75	1.25	1.50	3.50	3.25	12.86	20.14
014	FECAL FATS	11.00	3.69	0.25	1.25	5.19	5.81	0.75	1.25	1.50	3.50	3.25	11.94	(0.94)
015	FREE PHENOLPHTHALEIN	11.00	1.70	0.78	1.25	3.72	7.28	0.75	1.25	1.50	3.50	3.25	10.47	0.53
016	O/P FREE PHENOLPHTHALEIN	10.00	1.70	0.78	1.25	3.72	6.28	0.75	1.25	1.50	3.50	3.25	10.47	(0.47)
017	MEAT FIBERS	11.00	3.19	0.25	1.25	4.68	6.32	0.75	1.25	1.50	3.50	3.25	11.43	(0.43)
018	O/P MEAT FIBERS	10.00	3.19	0.25	1.25	4.68	5.32	0.75	1.25	1.50	3.50	3.25	11.43	(1.43)
019	OCCULT BLOOD (HEMOCCULT)	8.00	2.53	0.32	1.25	4.10	3.90	0.75	1.25	1.50	3.50	3.25	10.85	(2.85)
020	O/P ANTIGEN DETECTION ROTAVIRUS	27.00	17.86	8.54	1.25	27.65	(0.65)	0.75	1.25	1.50	3.50	3.25	34.40	(7.40)
021	ANTIGEN DETECTION ROTAVIRUS	41.00	17.86	8.54	1.25	27.65	13.35	0.75	1.25	1.50	3.50	3.25	34.40	6.60
022	OVA & PARASITE	25.00	4.82	4.88	1.25	10.95	14.05	0.75	1.25	1.50	3.50	3.25	17.70	7.30
023	O/P OVA & PARASITE	22.00	4.82	4.88	1.25	10.95	11.05	0.75	1.25	1.50	3.50	3.25	17.70	4.30
024	BLOOD PARASITES	24.00	7.65	0.29	1.25	9.19	14.81	0.75	1.25	1.50	3.50	3.25	15.94	8.06
025	PH FECAL	11.00	3.19	0.78	1.25	5.21	5.79	0.75	1.25	1.50	3.50	3.25	11.96	(0.96)
026	PINWORM PREPARATIONS	14.50	1.76	0.52	1.25	3.53	10.97	0.75	1.25	1.50	3.50	3.25	10.28	4.22
027	QUALITATIVE BILE	11.00	2.59	0.10	1.25	3.94	7.06	0.75	1.25	1.50	3.50	3.25	10.69	0.31
028	O/P QUALITATIVE BILE	10.00	2.59	0.10	1.25	3.94	6.06	0.75	1.25	1.50	3.50	3.25	10.69	(0.69)
029	QUALITATIVE PARASITOLOGY	11.00	2.98	0.32	1.25	4.55	6.45	0.75	1.25	1.50	3.50	3.25	11.30	(0.30)
030	TOXIN CL DIFF	38.50	4.67	2.44	1.25	8.36	30.14	0.75	1.25	1.50	3.50	3.25	15.11	23.39
031	O/P TOXIN CL DIFF	35.00	4.67	2.44	1.25	8.36	26.64	0.75	1.25	1.50	3.50	3.25	15.11	19.89
032	TRICHOMONAS PREPARATIONS	14.50	1.61	0.10	1.25	2.96	11.54	0.75	1.25	1.50	3.50	3.25	9.71	4.79
033	SPECIAL STAIN GMS PARA	9.50	7.06	0.48	1.25	8.78	0.72	0.75	1.25	1.50	3.50	3.25	15.53	(6.03)
034	O/P FECAL FAT	10.00	3.69	0.25	1.25	5.19	4.81	0.75	1.25	1.50	3.50	3.25	11.94	(1.94)
035	CS OVA & PARASITE	10.00	4.82	4.88	1.25	10.95	(0.95)	0.75	1.25	1.50	3.50	3.25	17.70	(7.70)

NOTE: O/P = OUTPATIENT

The table provides an overview of a parasitology laboratory's costs, separated by category. Columns 2 through 5 provide the test-specific (direct) costs incurred for each test, while columns 7 through 10 list the non test-specific (indirect) costs. Columns 6 and 13 list the contribution margin and net margin, respectively. *The price, i.e., the list price, standard price, or "in house" price in most laboratories is different than reimbursed charges and/or discounted charges.

*Price may also be charged or amount reimbursed, (e.g., medicare fee schedule).

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Table B1. Procedure-Analysis Cost Report (PACR) (Continued)

Key to Table B1 (PACR):

Column 1 = Price billed for individual test.
Column 2 = Labor to perform the test (Section 4.1)
Column 3 = (Consumables/Reagents/Disposables) used to perform the test (Section 4.2).
Column 4 = Other direct expenses that may be appropriate to the section being costed (i.e., equipment). (Use of this column allows the spreadsheet to be flexible to different sectional needs. Use is optional.)
Column 5 = Total Test-Specific Costs = (Column 2 Labor + Column 3 Reagents/Disposables + Column 4 Other).
Column 6 = Contribution Margin = (Column 1 (Price) Column 5 Total Test-Specific Costs).
Column 7 = Section indirect costs = [Annual Total Section Costs* Annual Test Volume for the section x Column 5 Total Test-Specific Costs)]
Note:* From Financial Operating Statement.
Column 8 = Department costs that are allocated to the laboratory section ÷ the total annual test volume.
Column 9 = Division costs that are allocated to the laboratory section ÷ the total annual test volume.
Column 10 = Total Laboratory-Specific Costs = (Column 7 Section + Column 8 Department + Column 9 Division)
Column 11 = Institution/Corporate indirect costs that are allocated to the laboratory section ÷ the total annual test volume.
Column 12 = Total Cost = (Column 5 Total Test-Specific Costs + Column 10 Total Laboratory Specific Costs + Column 11 Allocated Institution/Corporate Indirect Costs).
Column 13 = Net Margin = [Column 1 (Price) - Column 12 Total Cost].

Note: With multiple payors and changes in reimbursement patterns due to healthcare reforms, the user may wish to generate a separate spreadsheet for each payor source, depending on how much detail is needed for management purposes.

Table B2. Volume-Analysis Cost Report (VACR)

LABORATORY MEDICINE
DEPARTMENT: MICROBIOLOGY
SECTION: PARASITOLOGY
VOLUME-ANALYSIS COST REPORT

Column #		1	2	3	4	5	6	7	8	9	10	11	12
								Laboratory-Specific (Indirect) Costs:				Net Profit Margin	
Test Code	Procedure Name	Test Volume	% of Total Revenues	Total Revenues*	Direct Total Test-Specific Cost	Test-Specific Contrib. Margin	% of Total Test-Specific Contrib. Margin	Section	Dept.	Div.	Institution Corporate Indirect Allocation	Amount	Percent
001	CHLAMYDIA DFA	954	9.9	$23,850	$10,563	$13,287	8.9						
002	O/P CHLAMYDIA DFA	336	2.8	6,720	3,720	3,000	2.0						
003	CRYPTOSPORIDIA EXAMS	203	2.1	5,075	3,523	1,552	1.0						
04	O/P CRYPTOSPORIDIA EXAMS	0	0.0	0	0	0	0.0						
005	CHLAMYDIA CULTURES	580	12.0	29,000	6,615	22,385	14.9						
006	O/P CHLAMYDIA CULTURE	79	1.5	3,634	901	2,733	1.8						
007	LEPTOSPIRA CULTURES	6	0.1	228	272	(44)	0.0						
008	O/P LEPIOSPIRA CULTURES	3	0.0	114	136	(22)	0.0						
009	MYCOPLASMA CULTURES	209	3.2	7,629	3,819	3,810	2.5						
010	O/P MYCOPLASMA CULTURES	9	0.1	302	164	137	0.1						
011	CULT PARA AMOEBA	14	0.2	511	168	343	0.2						
012	O/P CULT PARA AMOEBA	0	0.0	0	0	0	0.0						
013	DARKFIELD EXAMS	12	0.2	396	73	323	0.2						
014	FECAL FATS	87	0.4	957	452	505	0.3						
015	FREE PHENOLPHTHALEIN	21	0.1	231	78	153	0.1						
016	O/P FREE PHENOLPHTHALEIN	8	0.0	80	30	50	0.0						
017	MEAT FIBERS	2	0.0	22	9	13	0.0						
018	O/P MEAT FIBERS	5	0.0	50	23	27	0.0						
019	OCCULT BLOODS (HEMOCCULT)	953	3.2	7,624	3,909	3,715	2.5						
020	O/P ANTIGEN DETECTION ROTAVIRUS	14	0.2	378	387	(9)	0.0						
021	ANTIGEN DETECTION ROTAVIRUS	39	0.7	1,599	1,078	521	0.3						
022	OVA and PARASITE	2,353	24.4	58,825	25,760	33,065	22.1						
023	O/P OVA and PARASITE	0	0.0	0	0	0	0.0						
024	BLOOD PARASITES	2	0.2	528	202	326	0.2						
025	PH FECAL	10	0.0	110	52	58	0.0						
026	PINWORM PREPARATIONS	38	0.1	551	134	417	0.3						
027	QUALITATIVE BILE	4	8.0	44	16	28	0.0						
028	O/P QUALITATIVE BILE	36	23.0	360	142	218	0.1						
029	QUALITATIVE PARASITOLOGY	1,765	8.0	19,415	8,028	11,387	7.6						
030	TOXIN CL DIFF	1,444	23.0	55,594	12,074	43,520	29.0						
031	O/P TOXIN CL DIFF	296	4.3	10,360	2,475	7,885	5.3						
032	TRICHOMONAS PREPARATIONS		62	0.4	899	184	715 0.5						
033	SPECIAL STAIN GMS PARA	162	0.6	1,539	1,423	116	0.1						
034	O/P FECAL FAT	14	0.1	140	73	67	0.0						
035	CS OVA & PARASITE	481	2.0	4,810	5,266	(456)	-0.3						
	NOTE: O/P = OUTPATIENT												
	TOTAL	10,221	100.0	$241,574	$91,749	$149,825	100.0	$7,666	$12,776	$15,332	$33,218	$80,833	33.5
	% OF TOTAL REVENUE			100.0	38.0	62.0	100.0						

This table utilizes the same information for test-specific processes and costs as in Table B1, but it also incorporates test volumes to determine the magnitude of individual test profitability and its relationship to the entire section's profitability.

*Revenue may include any source, (e.g., medicare, third-party payor, self-pay).

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Table B2. Volume-Analysis Cost Report (VACR) (Continued)

Key To Table B2 (VACR):

Column 1 = Annual volume of tests performed (i.e., billed).

Column 2 = Percentage of Total Revenues = (Column 3 Total Revenue ÷ the sum of the total revenues of all tests; in this example $241,574.00).

Column 3 = Total Revenues = (Column 1 Volume x Price; from previous schedule Table B1).

Column 4 = Total Test-Specific Costs = (Column 1 Volume x Test-Specific Cost; from previous schedule Table B1).

Column 5 = Test-Specific Contribution Margin = (Column 3 Total Revenues Column 4 Total Test-Specific Costs).

Column 6 = Percentage of Total Test-Specific Contibution Margin = Column 5 Test-Specific Margin ÷ the sum of the contribution margin of all tests (in this example $149,825.00).

Columns 7 to 10 = Explained in the key to Table B1. On this schedule, these dollars are not allocated by test. They are displayed in total because they would be allocated back to the laboratory section.

Column 11 = Net Profit Margin: Amount = (Column 3 Total Revenues (Column 4 + Column 7 + Column 8 + Column 9 + Column 10).

Column 12 = Net Profit Margin: Percent = (Column 11 ÷ Column 3).

Table B3. Contribution Margin Benchmarks (CMB)

Column #
LABORATORY MEDICINE
DEPARTMENT: MICROBIOLOGY
SECTION: PARASITOLOGY

PROCEDURE-ANALYSIS COST REPORT

Column #		1	2	3	4	5	6	7	8	9	10	11	12	13
			---------TEST-SPECIFIC COSTS----------- (Direct Costs)											
Test Code	RGTS/ Procedure Name	Price*	Labor	DISP	Other	Total Test-Specific Costs	Contribution Margin	Section	Depts.	Divison	Total Lab-Specific Costs	Allocated Inst./Corp. Indirect Costs	Total Cost	Net Margin
001	CHLAMYDIA DFA	$25.00	$3.90	$5.92	$1.25	$11.07	$13.93							
002	O/P CHLAMYDIA DFA	20.00	3.90	5.92	1.25	11.07	8.93							
003	CRYPTOSPORIDIA EXAMS	25.00	11.07	5.03	1.25	17.35	7.65							
004	O/P CRYPTOSPORIDIA EXAMS	15.00	11.07	5.03	1.25	17.35	(2.35)							
005	CHLAMYDIA CULTURES	50.00	5.27	4.89	1.25	11.40	38.60							
006	O/P CHLAMYDIA CULTURE	46.00	5.27	4.89	1.25	11.40	34.60							
007	LEPTOSPIRA CULTURES	38.00	43.37	0.78	1.25	45.40	(7.40)							
008	O/P LEPIOSPIRA CULTURES	38.00	43.37	0.78	1.25	45.40	(7.40)							
009	MYCOPLASMA CULTURES	36.50	8.48	8.54	1.25	18.27	18.23							
010	O/P MYCOPLASMA CULTURES	33.50	8.48	8.54	1.25	18.27	15.23							
011	CULT PARA AMOEBA	36.50	10.63	0.10	1.25	11.98	24.52							
012	O/P CULT PARA AMOEBA	33.50	10.63	0.10	1.25	11.98	21.52							
013	DARKFIELD EXAMS	33.00	4.08	0.78	1.25	6.11	26.89							
014	FECAL FATS	11.00	3.69	0.25	1.25	5.19	5.81							
015	FREE PHENOLPHTHALEIN	11.00	1.70	0.78	1.25	3.72	7.28							
O/P	FREE PHENOLPHTHALEIN	10.00	1.70	0.78	1.25	3.72	6.28							
017	MEAT FIBERS	11.00	3.19	0.25	1.25	4.68	6.32							
018	O/P MEAT FIBERS	10.00	3.19	0.25	1.25	4.68	5.32							
019	OCCULT BLOOD (HEMOCCULT)	8.00	2.53	0.32	1.25	4.10	3.90							
020	O/P ANTIGEN DETECTION ROTAVIRUS	27.00	17.86	8.54	1.25	27.65	(0.65)							
021	ANTIGEN DETECTION ROTAVIRUS	41.00	17.86	8.54	1.25	27.65	13.35							
022	OVA and PARASITE	25.00	4.82	4.88	1.25	10.95	14.05							
023	O/P OVA and PARASITE	22.00	4.82	4.88	1.25	10.95	11.05							
024	BLOOD PARASITES	24.00	7.65	0.29	1.25	9.19	14.81							
025	PH FECAL	11.00	3.19	0.78	1.25	5.21	5.79							
026	PINWORM PREPARATIONS	14.50	1.76	0.52	1.25	3.53	10.97							
027	QUALITATIVE BILE	11.00	2.59	0.10	1.25	3.94	7.06							
028	O/P QUALITATIVE BILE	10.00	2.59	0.10	1.25	3.94	6.06							
029	QUALITATIVE PARASITOLOGY	11.00	2.98	0.32	1.25	4.55	6.45							
030	TOXIN CL DIFF	38.50	4.67	2.44	1.25	8.36	30.14							
031	O/P TOXIN CL DIFF	35.00	4.67	2.44	1.25	8.36	26.64							
032	TRICHOMONAS PREPARATIONS	14.50	1.61	0.10	1.25	2.96	11.54							
033	SPECIAL STAIN GMS PARA	9.50	7.06	0.48	1.25	8.78	0.72							
034	O/P FECAL FAT	10.00	3.69	0.25	1.25	5.19	4.81							
035	CS OVA & PARASITE	10.00	4.82	4.88	1.25	10.95	(0.95)							
	NOTE: O/P = OUTPATIENT													
						ALTERNATIVE "BENCHMARK" ALLOCATIONS: (SEE ABOVE FOR EXPLANATION)								
						AVERAGE PER TEST COST		0.75	1.25	1.50	3.50	3.25	6.75	
						% OF TEST -SPECIFIC COST		8.4	13.9	16.7	39.0	39.0	78.0	

NOTE: Benchmarks (below) are used here to illustrate potential allocations of indirect costs to the individual test level. Recognizing the arbitrary nature of this type of allocation, the first is a flat dollar amount spread evenly to all tests. The second represents a percent multiplied by the (direct) test-specific cost to develop an allocation based on the proportionate direct cost (resources directly consumed) for each test.

This spreadsheet attempts to highlight the contribution margin concept while still recognizing that the margin must also cover indirect costs. If the user feels a need to make allocations to the test level, one or the other of the two methods may be used. If a combination of the two is used, indirect costs may or may not be recognized.

Note: The purpose of this table is to focus on the contribution margins generated by direct costing.
*Price may also be charged or amount reimbursed (e.g., medicare fee schedule).
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Table B3. Procedure-Analysis Cost Report (PACR) (Continued)

Key to Table B3:

Column 1 =	Price billed for individual test.
Column 2 =	Labor to perform the test (Section 4.1).
Column 3 =	(Consumables/Reagents/Disposables) used to perform the test (Section 4.2).
Column 4 =	Other direct expenses that may be appropriate to the section being costed (i.e., equipment). (Use of this column allows the spreadsheet to be flexible to different sectional needs. Use is optional.)
Column 5 =	Total Test-Specific Costs = (Column 2 Labor + Column 3 Reagents/Disposables + Column 4 Other).
Column 6 =	Contribution Margin = (Column 1 (Price) Column 5 Total Test Specific Costs).
Column 7 =	Section indirect costs = [Annual Total Section Costs* Annual Test Volume for the section x Column 5 Total Test-Specific Costs)] Note:* From Financial Operating Statement.
Column 8 =	Department costs that are allocated to the laboratory section ÷ the total annual test volume.
Column 9 =	Division costs that are allocated to the laboratory section ÷ the total annual test volume.
Column 10 =	Total Laboratory Specific Costs = (Column 7 Section + Column 8 Department + Column 9 Division)
Column 11 =	Institution/Corporate indirect costs that are allocated to the laboratory section ÷ the total annual test volume.
Column 12 =	Total Cost = (Column 5 Total Test-Specific Costs + Column 10 Total Laboratory Specific Costs + Column 11 Allocated Institution/Corporate Indirect Costs).

Appendix C. Historical Costing Method for Materials

Historical (retrospective) costing is a simple means of determining the cost of materials based on previously generated data (Table C1). It is used when monitoring the cost of existing equipment and/or methods.

The essential components include:

- Costing period
- Billable test volume
- Actual (traceable) cost of reagents, supplies, parts, fluids, etc.

Costing Period

A six-month costing period is adequate under most circumstances. The costing period should encompass a period of time in which:

(1) Testing is performed under routine circumstances.

(2) Experienced technologists are operating the analyzer or performing the manual procedure.

(3) Scheduled maintenance is being performed at designated intervals.

(4) Calibration and control frequencies have been established and are being followed.

(5) Reagents are permitted to reach expiration dates, if limited (i.e., 30, 60, or 90 days).

(6) Ordering practices have been established and the inventory has turned.

Table C1. General Guidelines for Retrospective Costing Methods (Method A)

(1) Determine the time interval to be studied. Establish the quantity of items consumed from either inventory records or vendor invoices.

(2) Perform a beginning inventory if feasible. If a beginning inventory is not feasible, establish appropriate assumptions regarding inventory status. Record an ending inventory if appropriate. If inventory records are not available, order quantities from vendor invoices for the appropriate time interval may be substituted.

Beginning Inventory (January 1) $40,000.00	+	Purchases $55,000.00	−	Ending Inventory (December 31) $35,000.00	=	Inventory Consumed $60,000.00

(3) Determine the billable test volume (see definition, Section 2.4).

(4) Determine the actual cost of all materials on a per-unit basis (see Section 2.1).

(5) Complete the summary table in Appendix C, Table C3.

Because the actual use of consumables may vary from expected or assumed usage, monitoring the inventory becomes the only practical way of determining the actual consumption of the items needed to perform testing. Therefore, a comprehensive initial inventory should be recorded at the beginning of the costing period. The inventory must include all items that are used or consumed by the analyzer or procedure. At the conclusion of the costing period, an ending inventory must be recorded in order to determine the quantity of reagents and supplies consumed. For items shared between workstations or analyzers, an estimation of usage at a particular station may be necessary (i.e., control fluids, 75% station 1, 20% station 2, 5% station 3).

If an analyzer has been in use continually over a period of at least one year, assumptions about the inventory may be made in order to avoid physical counting, i.e., the beginning inventory is equal to the ending inventory. Of course, these assumptions should be adopted only if they reflect the actual situation.

The actual cost of reagents, supplies, parts, and fluids must be obtained from vendor invoices to ensure that the correct costs are being applied. Prices may vary per order due to volume discounts or inflationary increases. The overall cost must be reflected in the cost assessment. Shipping charges, if incurred, must also be applied to the overall cost.

A detailed list of the majority of items considered within each of these major categories can be found in Table C3.

Examples of historical materials costing for multiple tests: Table C2 illustrates a simple use of retrospective materials costing for multiple tests. The billable test volume for seven tests was derived from laboratory workload recording records. Consumables costs and shipping charges were determined from actual vendor invoices after it was determined that the inventory on January 1, 1986, was equal to the ending inventory on December 31, 1986. The end result of the analysis is an overall average cost of materials per billable result. If desired, each chemistry test could be costed individually by assigning designated costs to each method and apportioning supplies on a percentage-of-billable-tests basis.

Table C3 can be used to summarize the data and compare the materials cost differences between alternative methods.

Table C2. Example of Historical Costing for Multiple Tests System A

Costing Period: January 1, 19__ ,through December 31, 19__.

Billable Test Volume:			
	Based on your internal records		
	Glucose		10,000
	BUN		8,000
	Creatinine		8,000
	AST		6,000
	ALT		6,000
	CK		6,000
	LDH		6,000
		Total	50,000
Consumables:	Actual Expenditures from 1986 Invoices		
Reagents:	Glucose reagent		$2,500
	BUN reagent		3,000
	Creatinine reagent		2,800
	AST		4,000
	ALT		5,600
	CK		6,000
	LDH		6,000
		Subtotal	$29,900
Supplies:			
	Glucose membranes		16
	Pump tubing		428
	Fittings		35
	Cuvettes		135
	Lamps		400
		Subtotal	$1,014
Fluids:			
	Calibrator		$1,600
	Control		2,600
	Linearity standards		500
	Wash solution		100
	Cleaning solution		100
		Subtotal	$4,900
Disposables:			
	Sample cups		265
	Tips		1,635
	Cups		200
	Dispo-pipettes		250
		Subtotal	$2,350
Shipping charges:			$725
Total annual cost			$38,889
Average cost per billable test (38,889/50,000):			$ 0.778

BUN, blood urea nitrogen.
AST, aspartate aminotransferase.
ALT, alanine aminotransferase.
CK, creatine kinase.
LDH, lactate dehydrogenase.

Table C3. Laboratory Material Cost Worksheet Summary

Billable Tests___________ Consumables	Alternative A Quantity per____	Alternative A Annual Cost	Alternative B Quantity per____	Alternative B Annual Cost	Alternative C Quantity per____	Alternative C Annual Cost	Alternative D Quantity per____	Alternative D Annual Cost
Fluids								
Reagents	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Diluents	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Calibration material	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Reference fluids	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Linearity standards	______	$______	______	$______	______	$ _ _ _ _ _ _	______	$______
Control fluids	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Rinse/wash solutions	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Cleaning solutions	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Deionized water	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Analyzer-specific Solutions	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Other	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Subtotal	______	$______	______	$______	_____	$______	_ _ _ _ _ _	$______
Supplies								
Chemicals	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Gases	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Paper	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Labels	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Ribbons	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Water	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Cartridges, filters, etc.	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Other	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Subtotal	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Parts								
Syringes	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Tubing	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Membranes	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Valves	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Reagent caps	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Seals	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Reagent vessels	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Cuvettes	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______

Vials	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Lamps	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Needles	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Probes	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Electrodes	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Filters	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Detectors	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Reaction chambers	______	$______	______	$______	______	$ _ _ _ _ _	______	$______
Other	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Subtotal	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Disposables								
Sample cups	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Sample caps	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Pipette tips	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Glass tubes	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Bar Code labels	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Micro inserts/cups	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Cuvettes	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Other	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Subtotal	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Total	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______
Material cost per Billable test	______	$______	______	$______	______	$______	_ _ _ _ _ _	$______

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Appendix D. Prospective Costing Method for Materials

Introduction

Prospective costing methods are used to evaluate the potential cost of equipment and/or methods before making acquisition decisions or changes to existing protocols. A prospective costing method is more abstract than retrospective costing and requires considerably more thought and effort. Obtaining access to operator's manuals, various vendor documents, and current users may all be key elements in assessing the projected costs. A practical approach to prospective costing is presented. The essential ingredients include:

- projected total testing;
- projected consumable usage;
- projected disposable usage; and
- projected cost of consumables and disposables.

Projected Total Testing

To project reagent and supply consumption, actual testing volumes must be determined. Because testing volumes and reagent usage can be interdependent, it is best to establish an initial testing volume chart (Table D1) then revise the chart after all the dependencies have been determined and projected (Table D2). The initial chart should be limited to those components that are readily assessable. Dependencies for reagent wastage should be included in the revised chart.

The total number of tests must reflect the actual number of tests being processed. For example, if calibrations are run in triplicate using three levels of calibration fluid, the total number of tests per calibration would be nine. A single prime frequently consumes more reagent than a "test." To avoid underestimating reagent costs, primes must be converted into "test equivalents." For example, if an analyzer primes five times using 1 mL of reagent per prime, 5 mL of reagent would be consumed. Assuming that 100 μL of reagent are used for each "test," the number of "test equivalents" consumed during priming would be 50.

General Guidelines for Prospective Materials Costing Methods

(1) Determine the projected total testing by completing both an initial Table D1 and revised Table D2 testing table (on the following pages) or similar substitutes. (The revised testing table may be dependent on calculations made in step 2 below.)

(2) Determine the projected consumables usage and pay particular attention to all sources of wastage. Calculations here may require an additional iteration to the testing tables previously completed.

(3) Project the cost of materials based on previously established usage.

The subject of prospective costing for materials is considered in more detail in laboratory cost-management reference books [3,5]

Table D1. Projected Total Testing

Initial Table

	Billable Tests	Blanks	Quality Control	Calibrators	Replicates	Repeats	Waste & Primes as Test Equivalents	Total Tests	Average # of Tests per Day
Albumin	13,456	0	1,460	360	0	764	300	16,340	45
ALP	12,345	0	1,460	360	0	708	300	15,173	42
ALT	11,234	0	1,460	360	0	653	300	14,007	38
Ammonia	12,345	0	1,460	360	0	708	300	15,173	42
AST	12,334	0	1,460	360	0	708	300	15,162	46
Calcium	13,456	0	1,460	360	0	764	300	16,340	45
Carbon dioxide	12,345	0	8,760	1,440	12,345	1,745	300	36,935	101
Chloride	11,234	0	1,460	360	0	653	300	14,007	38
Cholesterol	12,345	0	1,460	360	0	708	300	15,173	42
CK	12,334	0	1,460	360	0	708	300	15,162	42
Creatinine	13,456	0	1,460	360	0	764	300	16,340	45
Glucose	12,345	0	1,460	360	0	708	300	15,173	42
LDH	11,234	0	1,460	360	0	653	300	14,007	38
Phosphorus	12,345	0	1,460	360	0	708	300	15,173	42
Potassium	12,334	0	1,460	360	0	708	300	15,162	42
Sodium	13,456	0	1,460	360	0	764	300	16,340	45
Total protein	12,345	0	1,460	360	0	708	300	15,173	42
Triglyceride	11,234	0	1,460	360	0	653	300	14,007	38
Total bilirubin	12,345	14,165	1,460	360	0	1,417	300	30,047	82
Urea nitrogen	12,334	0	1,460	360	0	708	300	15,162	42
Uric acid	13,456	0	1,460	360	0	764	300	16,340	45
TOTAL	260,312	14,165	37,960	8,640	12,345	16,674	6,300	356,396	

ALP, alkaline phosphatase.
ALT, alanine aminotransferase.
AST, aspartate aminotransferase.

Table D2. Projected Total Testing

Revised Table

	Billable Tests	Blanks	Quality Controls	Calibrations	Replicates	Waste & Repeats	Primes As Test Equivalents	Total Tests
Albumin	13,465	0	1,464	360	0	765	300	16,365
ALP	12,345	0	1,484	360	0	709	300	15,198
ALT	11,234	0	1,484	360	0	654	300	14,032
Ammonia	12,345	0	1,484	360	0	709	300	15,198
AST	12,334	0	1,484	360	0	709	300	15,187
Carbon dioxide	12,345	0	8,784	1,440	12,345	1,746	300	36,960
Chloride	11,234	0	1,484	360	0	654	300	14,032
Cholesterol	12,345	0	1,484	360	0	709	300	15,198C
KC	12,334	0	1,484	360	0	709	21,470	36,357
Creatinine	13,456	0	1,484	360	0	765	300	16,365
Glucose	12,345	0	1,484	360	0	709	300	15,198
LDH	11,234	0	1,484	360	0	654	300	14,032
Phosphorus	12,345	0	1,484	360	0	709	300	15,198
Potassium	12,334	0	1,484	360	0	709	300	15,187
Sodium	13,456	0	1,484	360	0	765	300	16,365
Total protein	12,345	0	1,484	360	0	709	300	15,198
Triglyceride	11,234	0	1,484	360	0	654	300	14,032
Total bilirubin	12,345	14,189	1,484	360	0	1,419	300	30,097
Urea nitrogen	12,334	0	1,484	360	0	709	300	15,187
Uric acid	13,456	0	1,484	360	0	765	300	16,365
TOTAL	260,312	14,189	38,464	8,640	12,345	16,696	27,470	378,116

ALP, alkaline phosphatase.
ALT, alanine aminotransferase.
AST, aspartate aminotransferase.
CK, creatine kinase.
LDH, lactate dehydrogenase.

Summary of Comments and Subcommittee Responses

GP11-T: *Cost Accounting in the Clinical Laboratory; Tentative Guideline*

General

1. We agree that the clinical laboratory community will benefit from your subcommittee's efforts in this area. We would suggest that, once finalized, the option to purchase software that had all the calculations and tables in a spreadsheet format would help laboratorians more easily utilize this financial tool. Programming and formatting one's own computer might be problematic for some users.

- **NCCLS, as it expands its offerings of computer applications based on its standards and guidelines, will consider GP11-A as a viable option.**

2. The next edition should include a table by instrument type with an associated labor factor. The labor associated with calibration, QC and daily maintenance by test and instrument would be included. It could be based on the worksheet on page 30, with number of hours per test per year for each instrument. Or, perhaps an average based on the labor formula on page 11 would provide a reasonable estimate.

- **The subcommittee does not believe this to be a practical consideration, due to the continuous introduction of new analyzers and models from a wide host of manufacturers. However, the Labor Cost Accumulation Worksheet, on page 59, was exclusively designed for each laboratory manager to develop their own labor factor which is unique for each site.**

3. Having to refer back and forth from the body of the text to the tables and appendices is somewhat cumbersome. Put tables and figures in with text whenever reference is made, even if this means duplication of tables and figures throughout. Or, put tables and figures in a supplemental binder.

- **GP11-A has been reformatted so that the text is in two columns and tables and figures are located near the text where they have been referenced.**

4. Worksheets available on disks would be useful (for purchase of course).

- **Refer to Comment 1 response.**

5. A guideline addressing cost accounting issues for managed care operations is needed. Points to include are:

   (a) Utilization review by service (cost center), by physicians, etc., and the pathologist's role in presenting the data effectively.

   (b) Competitive reviews with peers, etc., and LMIP by the College of American Pathologists.

   (c) Examples for laboratories using billable testing and ordered testing.

- **Although the subcommittee is not certain as to what the commentor is asking for in item (a), it considers utilization review to be beyond the scope of GP11-A. And although it is wise for a laboratory manager and/or director to verify a manufacturer s performance with several peers, specific recommendations are also considered to be outside the scope of the subcommittee s charge. The principles presented in GP11-A regarding true costing in the clinical laboratory apply whether the laboratory is in a fee for service mode (tests are billable) or considered a cost center.**

The methods and the reasons for cost accounting are thus independent of the business environment.

6. I have found GP11-T to be a generally useful, well organized and comprehensive manual. I have considered this document from the perspective of both a laboratory director and as a resident in training.

   This document covered the generalities of laboratory cost accounting, providing well defined terms, an overview of general principles and relative examples. The length was surprisingly tolerable, requiring 3-1/2 hours to review. I have little formal background in accounting or the related areas of management engineering or marketing. However, I quickly grasped the terms, comprehended the concepts and was able to comfortably follow the examples provided.

   The organization followed a logical pattern and flowed well. The document is designed to be flexible in nature and as a consequence of such did possess an underlying level of vagueness. However, I agree with this format given the broad nature of the audience.

   The document will likely be overly general and elementary for a more knowledgeable reader and does not lend itself to immediate application. This fact may hinder this project from realizing its initial goal.

   As a laboratory director, I was pleased with the document's ability to present the principles and terms of accounting in clear and relevant terms. The knowledge gained will serve to facilitate communication amongst myself, laboratory managers, section heads as well as institutional administrators.

   As a resident in training, I was gratified to have a concise general primer for laboratory cost accounting and would recommend this text to others.

   The figures, tables and appendices were useful and coherent. I would suggest indexing the appropriate heading of text with each figure or table, to facilitate cross-referencing.

   One question I did not see addressed was "insensible" or "immeasurable" costs. Are there such elements, what are examples of such, and is there a marginal factor computed to account for such costs?

- **The subcommittee appreciates the reviewer s comments and the document now includes an index. Relative to the commentor s last question, there are intangible expenses which can be measured with great difficulty and the subcommittee does not consider the terms insensible and immeasurable as applicable to cost accounting in this context. Examples of intangible costs which are actually indirect costs are given in Table 2 and Figure 5.**

7. Would not a continuous method of accounting be available via computers, instrument interfacing and correlation with marketing and personnel databases? This would seem more accurate and less labor intensive once appropriate software, relays, and links were in place.

- **The subcommittee believes that a computerized approach would be ideal but does not believe that such options are available to the full spectrum of GP11 users. Thus, a local software application that conforms to the unique characteristics of each laboratory, as described in Comment 1, would be a better alternative.**

8. We are currently reviewing the costs of a laboratory that has equipment which is fully depreciated (i.e., 20 or more years old). How do we account for costs associated with those pieces of equipment when calculating costs per test?

Should we factor in replacement costs (it is not known when the laboratory intends to replace these pieces of equipment), or do we just include maintenance costs for these pieces of equipment?

- **If laboratory equipment is fully depreciated, it is owned and therefore the depreciation for a cost per test calculation should be zero. Maintenance costs, which could be considerable depending on the age of the equipment, should be included in cost per test calculations. If a replacement instrument has been acquired, moving, renovation and installation expenses can be factored into the cost per test, depending on the institution s preference. Although replacement cost may affect your cost per test, you should go to the financial manager of your institution to determine how your institution accounts for replacement cost.**

Section 5.1

9. It is not clear what the third spreadsheet is after Table 8 and Table 9. Is it separate for each person or the same schedules for each section (section-by-section)?

- **The subcommittee refers the reader to the footnote for Table B3 and the detailed explanation of the table s purpose located on Table B3 between columns 7 and 10. This table does not separate costs for each technologist s performance. It is a composite of all costs for all tests performed by all staff in the parasitology section.**

10. In the response to #4, is the price $6.00 or $6.50, or did you round off to $6.00?

- **The subcommitee recognized the typo and $6.50 in issue #4 of Section 5.1 has been changed to $6.00.**

Section 5.3

11. Add more information or an example of costs for Disease Specific Tests - updated for Managed Care.

- **Although the question is very important in today s managed care environment, the subcommittee feels that the scope and complexity of this issue should be considered in a future NCCLS publication. However, there are a number of new textbooks and journal articles on utilization management and clinical decision analysis.**

Figure 11

12. The output statement is misleading. Quality control, standards, repeats, and duplicates are generally not billable tests, and quality control and standards are not patient results. These do not directly contribute to revenue generation.

- **The subcommittee recognized the formatting error of Figure 11 and has corrected the figure.**

Table 5

13. Please explain the source of 15% for PFD. References would be helpful.

- **Additional references have been added to Table 5.**

Figure I-E

14. This figure reads right to left and therefore is initially confusing.

- **This figure has been revised to read left to right.**

Table 1B

15. Does the maintenance cost address the warranty period?

- **Manufacturers would customarily provide a warranty period for purchased or leased analyzers. During such warranty periods, there would be no additional maintenance cost. How this is treated over the life cycle of a piece of equipment would be determined by local policies and practices. For example, if a piece of equipment with a five-year expected life includes a one-year warranty period, you may only budget a maintenance expense for years two through five of the expected life cycle.**

INDEX

Related NCCLS Publications*

GP6-A Inventory Control Systems for Laboratory Supplies; Approved Guideline (1993). Gives basic recommendations for laboratorians and suppliers to develop and maintain efficient, cost-effective inventory control systems. Emphasizes the development of strong working relationship with the manufacturer and supplier. Details how to establish an internal inventory control system that is based on documented procedures, appropriate ordering decisions, and control of expenses. To facilitate record keeping, sample forms are included as well as a flow analysis chart depicting the four phases of inventory control: planning, systems development, procurement, and management.

GP9-A Selecting and Evaluating a Referral Laboratory; Approved Guideline (1998). This guideline provides an outline of reasons and criteria for choosing a referral laboratory. A checklist for evaluating potential referral laboratories is included to assist in the decision process.

*Proposed- and tentative-level documents are being advanced through the NCCLS consensus process. Therefore, readers should refer to the most recent editions.

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