CHAPTER 20

Quantifying pharmaceutical requirements

ILLUSTRATIONS

COUNTRY STUDIES

BOXES

SUMMARY

Quantification is the first step in the procurement process (see Chapter 18). In general terms, quantification is the process used to determine how much of a product is required for the purpose of procurement. But more specifically, quantification involves estimating not only the quantities needed of a specific item, but also the financial means required for purchasing the item. Needs are estimated for a given context, and the analysis must include contextual factors, such as available funds, human resources capacity, storage space capacity, and capacity to deliver services.

The methods and strategies described in this chapter can be used as tools to—

- Prepare and justify a pharmaceutical budget
- Plan for new and expanding programs
- Optimize pharmaceutical budgets based on priority health problems to be treated and the most cost-effective treatment approaches
- Calculate emergency needs for disaster relief and epidemics
- Resupply an existing supply network that has become depleted of products
- Compare current medicine consumption/demand with public health priorities and usage in other health systems

The quantification method must be chosen in light of the resources and information available.

The consumption method, which uses data on medicine consumption, gives in many instances the most accurate prediction of future needs. Large, well-established pharmaceutical supply systems rely primarily on the consumption method. To be reliable, the consumption data must come from a stable supply system with a relatively uninterrupted supply and a full supply pipeline. Consumption data may or may not reflect rational prescribing and use of medicines or actual demand for medicines.

The morbidity method quantifies the theoretical quantity needed for the treatment of specific diseases. This method requires reliable data on morbidity and patient attendances (visits to health facilities) and uses standard treatment guidelines to project medicine needs. This method is the most complex and time-consuming, and it can produce major discrepancies between projections and subsequent use. Nevertheless, this method is often useful for new and expanding programs and may be the most convincing approach for justifying a budget request.

If no reliable information is available on past consumption or morbidity, use can be extrapolated from data for other facilities, regions, or countries. The proxy consumption method is flexible enough to apply to various situations and can be either population or service based. Service-level quantification of budget requirements can be applied when only budget requirements, and not specific medicine quantities, are needed. It provides a clear, logical, one-page justification of pharmaceutical financing requirements.

Several critical issues are common to all methods. The medicines list is the central component and must be produced in a format suitable to the type of quantification. In a new supply system, or one in which shortages have been widespread, quantification estimates must be adjusted because the supply pipeline must be filled. The lead time has a major effect on quantities required for safety stocks. In virtually all supply systems, adjustment is necessary for losses caused by wastage and theft.

Quantification estimates can be cross-checked by combining different methods. No matter which method is used, a gap may exist between the initial estimates of medicine needs and the allocated budget. The quantification process itself may help justify an increase in the budget, but often the quantification estimates must be adjusted and reconciled to match available funds. The choice between manual and computerized quantification may be dictated by circumstances, but the process is much easier with computer assistance. Quantification can be centralized, or it can be decentralized to staff of peripheral warehouses and health facilities. The personnel and time requirements depend on the quality and accessibility of source data and on the type and scope of quantification.

20.1 Methods of quantification

Quantification is the first step in the procurement process (see Chapter 18). In general terms, quantification is the process used to determine how much of a product is required for the purpose of procurement. But more specifically, quantification involves estimating not only the quantities needed of a specific item but also the financial means required for purchasing the item. Needs are estimated for a given context, so the analysis must include contextual factors, such as available funds, human resources capacity, storage space capacity, and capacity to deliver services. Often, the terms *quantification* and *forecasting* are used interchangeably. For purposes of this chapter, forecasting refers to the projection of future needs beyond the next purchase order.

Medicine needs can be quantified by using one or a combination of four standard methods. Quantification involves estimating the quantities of specific medicines or supply items needed for a procurement. Most quantification exercises also estimate the financial requirements to purchase the medicines. The quantification methods described in this chapter are normally used to quantify needs for an annual or semiannual procurement. They are not usually used to calculate routine order quantities in an established supply system that uses scheduled purchasing (periodic orders) or perpetual purchasing (orders placed whenever need arises). In such situations, one of the reorder formulas presented in Chapter 23 is used to calculate the optimal order quantity and order interval for each item. The goal is to maintain the most cost-effective balance between service levels and inventory costs.

Major options for quantification

The four general methods discussed in this chapter are—

1. Consumption method
2. Morbidity method
3. Proxy consumption method
4. Service-level projection of budget requirements

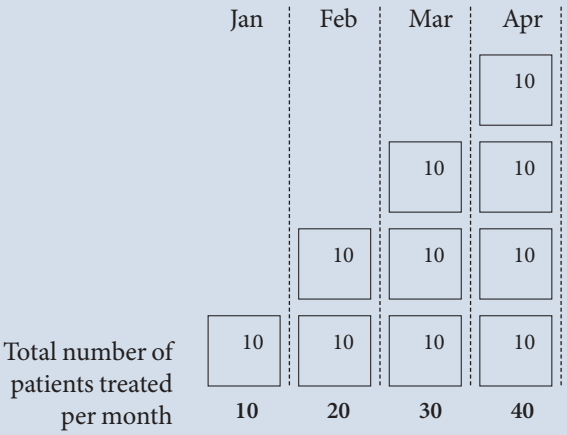
The *consumption method* uses records of past consumption of individual medicines (adjusted for stockouts and projected changes in medicine use) to project future need (see Section 20.4).

The *morbidity method* estimates the need for specific medicines based on the expected number of attendances, the incidence of common diseases, and standard treatment patterns for the diseases considered (see Section 20.5). Box 20-1 describes the morbidity method used when a program is scaling up.

The *proxy consumption method* uses data on disease incidence, medicine consumption, demand, or use, and/or pharmaceutical expenditures from a "standard" supply system and extrapolates the consumption or use rates to the target supply system, based on population coverage or service level to be provided (see Section 20.6).

Box 20-1
Estimating for programs that are scaling up care for patients requiring continuous treatment

In the following example, the program is scaling up with ten new patients per month requiring continuous treatment. The number of patient-months of medicines that can be expected to be consumed from January to April is 10 + 20 + 30 + 40 = 100 patient-months.



A formula used to determine number of patient-months is—

$$P\left(\frac{n(n+1)}{2}\right)$$

P = average number of patients added each month
n = number of months covered

For the preceding example the calculation would be—

$$10\left(\frac{4(5)}{2}\right) = 100 \text{ patient-months for the period of January to April}$$

Service-level projection of budget requirements uses the average medicine cost per attendance or bed-day in different types of health facilities in a standard system to project medicine costs in similar types of facilities in the target system (see Section 20.7). This method does not estimate quantities of individual medicines.

Relative predictive accuracy of quantification methods

Quantification of pharmaceutical requirements is inherently imprecise because of the many variables involved. Useful results depend as much on "art," or human judgment, as on science.

In many instances, the most precise method for quantifying pharmaceutical usage is the consumption-based approach, provided the source data are complete, accurate, and properly adjusted for stockout periods and anticipated changes in demand and use. This method does not normally address the appropriateness of past consumption patterns, which may or may not correspond with public health priorities and needs. Thus, irrational medicine use may be perpetuated by total reliance on the consumption method. If stockouts have been widespread for long periods, applying this method accurately may be impossible, which is why capturing actual demand is the most accurate approach.

Morbidity-based quantification is the most complex and time-consuming method. In many countries, assembling valid morbidity data on more than a defined set of diseases is very difficult; therefore, some needs will be overlooked in the quantification. Data on patient attendance are often incomplete and inaccurate, and predicting what percentage of prescribers will actually follow the standard treatment regimens used for quantification is difficult. Despite these constraints, this method may remain the best alternative for planning for procurement or for estimating budget needs in a supply system or facility in which a limited range of health problems accounts for virtually all medicine consumption, such as a small primary care system; a special-purpose hospital; a new program with no previous consumption history, such as HIV/AIDS programs rolling out antiretroviral therapy (ART); or changes in standard treatment guidelines.

Proxy consumption is the method generally used if neither the consumption-based nor the morbidity-based method is feasible. This method is most likely to yield accurate projections when used to extrapolate from one set of facilities to another set that serves the same type of population in the same type of geographic and climatic environment. If the method is applied by drawing standard data from another country, the results will be only a rough estimate of need. Even when target and standard facilities are closely matched, quantification estimates are suspect, because it is a big leap to assume that disease incidence, utilization patterns, and prescribing habits will be essentially the same in both settings. Still, this method may be the best alternative in the absence of suitable data required for the consumption- or morbidity-based method. The proxy consumption method is also useful for cross-checking projections made with other methods.

Service-level projection of budget requirements produces a rough estimate of financial needs for pharmaceutical procurement and not the quantity of products. The method relies on two assumptions: (1) that the "standard" system (used for comparison) and the target system are comparable in terms of patient attendance and bed-days per type of facility, and (2) that the patterns of medicine use are roughly the same in both systems. Despite its limitations, this method can be useful in predicting medicine costs in a new system or in a system in which no data are readily available. Table 20-1 summarizes the applications and limitations of the four major quantification methods.

20.2 Applications of quantification

Quantification is normally applied for—

Calculating order quantities for procurement: Formal quantification may be necessary before each scheduled procurement. These estimates need to be accurate to avoid stockouts, emergency purchases, and overstocks and to maximize the effect of procurement funds. The consumption method is the first choice, cross-checked to assess the appropriateness of usage and demand patterns. When consumption data are unreliable or unavailable, such as in new programs, the morbidity method, the proxy consumption method, or both, may need to be applied for an initial quantification, switching to the consumption method when reliable data can be compiled or the program has stabilized.

Estimating budget requirements: In many countries, the annual pharmaceutical procurement budget is determined by adding a fixed percentage to the previous year's request or allocation to allow room for contingencies, such as expected cuts by the ministry of finance, population growth, or expansion of services. Both budget requests and cuts are frequently prepared without reliable estimates of actual needs. This cycle can be broken with rational, well-documented quantification. Although consumption-based quantification is the best guide to probable expenditures, the morbidity-based method may be the most convincing documentation for a budget request. Proxy consumption is useful for checking and justifying either consumption or morbidity methods. When budget requirements do not need to be justified by specifying order quantities, the service-level method can be used as an alternative.

Table 20-1 Comparison of quantification methods

Method	Uses	Essential data	Limitations
Consumption	• First choice for procurement quantifications, given reliable data • Most reliable predictor of future consumption	• Reliable inventory records • Records of supplier lead time • Projected pharmaceutical costs	• Must have accurate consumption data • Can perpetuate irrational use
Morbidity	• Estimating need in new and scaling-up programs or disaster assistance • Comparing use with theoretical needs • Developing and justifying budgets	• Population and patient attendances • Actual or projected incidence of health problems • Standard treatments (ideal, actual) • Records of supplier lead time • Projected pharmaceutical costs	• Morbidity data not available for all diseases • Standard treatments may not really be used • Accurate attendance difficult to predict
Proxy consumption	• Procurement quantification when other methods are unreliable • Comparing use with other supply systems	• Comparison area or system with good per capita data on consumption, patient attendance, service levels, and morbidity • Number of local health facilities by category • Estimates of local user population broken down by age	• Questionable comparability of patient populations, morbidity, and treatment practices
Service-level projection of budget requirements	• Estimating budget needs	• Use by service levels and facility type • Average medicine cost per attendance	• Variable facility use, attendance, treatment patterns, supply system efficiency

Developing procurement quantities for new programs: When medicines are needed for launching a new full-service health system or vertical program (such as HIV/AIDS programs or DOTS), quantification serves two purposes: to establish funding requirements for procurement and to develop the initial procurement list. In most situations, the consumption-based method is not feasible, and some combination of morbidity-based and proxy consumption methods must be used for the initial quantification.

Developing procurement quantities for scaling-up programs: *Scaling up* is the term used to describe an incremental increase or growth in the number of patients being treated over a period of time. Patient-months can be used to estimate needs for scaling up, where one "patient-month" is the quantity of a product needed to treat one patient for one month. The total number of patients treated over an incremental period of time in patient-months is often used in this situation for estimating needs for chronic conditions. For example, programs may not be able to serve all the patients needing ART at the start of an HIV/AIDS program but are able to scale up slowly as they receive additional donor funds, human resources, and training and address other access barriers (see Box 20-1 for an example of a scaling-up calculation).

Quantifying for assistance projects: A donor organization may undertake ad hoc quantification studies to plan procurement needs in the context of a development project. When local consumption data are not sufficiently reliable for quantification, the morbidity or proxy consumption method should be used, either singly or in combination.

Estimating pharmaceutical requirements for emergency relief situations: In emergencies such as floods or earthquakes, the first step is to provide emergency kits quickly (Chapter 26). As local health problems become clear, a morbidity-based method can be used to project requirements in the short and medium term, until the regular supply system can resume services. Country Study 20-1 describes quantification for a cholera epidemic.

Comparing actual medicine consumption with theoretical need: In most functional supply systems, the regular procurement quantification is based on past consumption. However, periodic comparison of consumption with theoretical demand based on public health priorities is a useful practice. The morbidity-based method provides the most informative comparison, but simply comparing consumption data from different systems is worthwhile because significant differences in medicine use can help identify irrational prescribing patterns or persistent inventory problems.

20.3 Issues to consider in quantification

Several issues must be addressed in any quantification process—

- Preparing an action plan for quantification
- Using centralized or decentralized quantification
- Using manual or computerized methods for quantification

- Estimating the time required
- Developing and organizing the medicines list
- Filling the supply pipeline
- Estimating the procurement period
- Considering the effect of lead time
- Estimating safety stock
- Adjusting for losses and other changes
- Cross-checking the results of quantification
- Estimating total procurement costs
- Adjusting and reconciling final quantities
- Preparing for possible program expansion (scaling up)

Preparing an action plan for quantification

Perhaps the most critical step in any large-scale quantification is preparing and then following a sound action plan through each step of the quantification. Country Study 20-2 shows the Dominican Republic's quantification experience when scaling up its national TB program. Essential points in planning for quantification include—

- Naming the official or office that will manage the process and define roles and responsibilities

Country Study 20-1
The morbidity method and a cholera epidemic in a Latin American country

A cholera epidemic in Latin America spread rapidly to most regions of one country within six months. A quantification was carried out to determine pharmaceutical supply needs to treat cholera patients.

Target coverage. All cholera patients requiring treatment through hospitals, clinics, and community health workers were to be covered.

Medicines list. The medicines to be included were not clear, because average treatment practices were not known and standard treatment guidelines had not yet been developed. A team collected data from sample patient charts and focused surveys to determine current treatment practices.

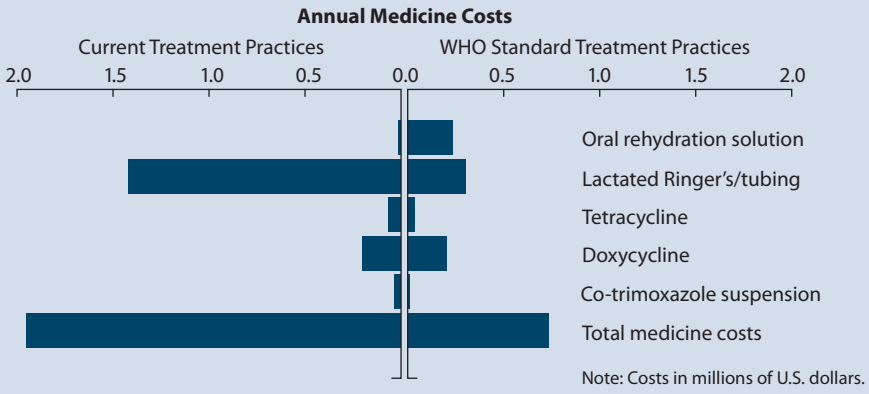
Source of supply. Products were to be purchased from both local and international suppliers. All cost estimates were converted to U.S. dollars for purposes of consistency.

Data. Because demand had increased dramatically for medicines used to treat cholera, stockouts were common and consumption data were not reliable. Fairly accurate morbidity data were readily available, reported weekly by fax to the central level.

Resources for quantification. A team of local and international specialists collected and analyzed data on disease incidence and current treatments and developed a computer spreadsheet for quantification.

Quantification. The morbidity method was used to calculate supply needs based on current epidemiological data, with two alternatives for treatment: current average treatment practices, and WHO treatment guidelines. The accompanying graph illustrates the projected annual supply costs for both calculations. Note the huge difference in total costs of the alternative treatment regimens. Total medicine costs were more than two times higher with current treatment practices, with the excess almost exclusively caused by overuse of lactated Ringer's IV solution when oral rehydration solution (ORS) could be safely substituted.

Results and follow-up. The results of calculations were presented to the national cholera committee, which agreed to a switch to WHO guidelines. Policy makers used the comparative cost information in educational activities to improve prescribing practices.



- Forming a working group to coordinate activities of the offices, departments, and facilities involved
- Defining the objectives and coverage of the quantification
- Examining the availability of data and choosing the best quantification method according to objectives and available data and resources (personnel, funding, computer capacity)
- Developing medicines lists and data collection forms
- Determining standard treatments used in quantification
- Training staff members in the applicable quantification method and in data collection and analysis
- Developing a workplan and timeline for quantification, with realistic deadlines for each phase
- Managing quantification according to plan (adjusting for inevitable delays and unexpected constraints)
- Communicating results to relevant committees or

Country Study 20-2
Using consumption data to quantify medicines for the national TB program in the Dominican Republic

The morbidity method is usually recommended for quantifying tuberculosis (TB) medicines and supplies. The advantage of this method is that the necessary information, either the number of cases in previous years or the expected number of respiratory symptomatic cases (expected RS), is usually available in most TB programs. Since implementing the DOTS strategy in 2002, the Dominican Republic has used the expected RS–morbidity method to estimate the needs of TB medicines and commodities. However, as in most countries in the initial phases of implementing DOTS, the Dominican Republic National TB Program (DR-NTP) identified many fewer cases than expected. So in the program's initial years, the quantifications were overestimated, and deficiencies in the inventory reporting systems prevented corrections, leading to large surplus stocks. When a national financial crisis in 2004–05 slowed the public procurement process, the surplus TB medicine was used as safety stock.

In 2004, the DR-NTP pilot-tested a pharmaceutical information system based on consumption. The data showed a progressive depletion of the safety stocks in the health facilities in the pilot areas and overstocks of some medicines in certain other health facilities. Based on this information, the DR-NTP redistributed medicines from health facilities with overstocks to those with limited safety stocks to reduce the risk of interrupting or delaying the start of DOTS treatment. Furthermore, because of devaluation of the local currency, resources to procure TB medicines were insufficient to meet demand. Using data generated by the system, RPM Plus showed that the cost of a course of treatment for a new patient had increased from USD 32 in 2004 to USD 155 in 2005. RPM Plus presented the price analysis to Ministry of Health and TB program authorities and recommended they procure lower-priced, quality medicines through international agencies. As a result, a ministerial decree was promulgated that required TB medicines to be procured through the Global Drug Facility (GDF). The annual savings were estimated at about USD 775,000.

Although the information system was running in just two pilot areas, the data proved valuable for decision making. The staff endorsed the new system because the time it took to fill out the forms was less than the time it took to take physical counts of the medicines. Staff members also appreciated having an updated register of the availability of medicines in health facilities and warehouses at any given time. In addition, the daily consumption form provides an overview of medicine use in the health facilities, showing data on the start of new treatments, the completion of treatments, and treatment defaulters.

The consumption-based information system relies on four basic forms—

- A daily consumption form filled out in health facilities
- A quarterly report on consumption and availability (which is a requisition form, as well) filled out in health facilities and sent to the provincial authorities
- A quarterly report on distribution and availability (which is a requisition form, as well) filled out by the provinces and sent to the national authorities
- A quarterly national summary that is prepared at the national level

By 2010, the scaled-up information system was generating data routinely on stock levels at facilities. In addition to allowing program managers to respond promptly to the stock crisis, the information on prices paid allowed the national TB program to make important decisions about procurement methods to maximize the efficient and effective use of public resources.

Source: Management Sciences for Health/Rational Pharmaceutical Management Plus Program and Strengthening Pharmaceutical Systems Program.

managers to determine final assumptions and quantities
- Adjusting estimated quantities as needed
- Evaluating the quantification process and planning improvements to resolve problems encountered

The WHO manual *Estimating Drug Requirements* (WHO/DAP 1988) discusses how to develop a good action plan and manage the quantification process.

Countries that are faced with the major challenge of rapidly scaling up ART programs have special quantification issues to address. Country Study 20-3 describes how some African countries have worked to improve the quantification process for their ART programs.

Using centralized or decentralized quantification

Most supply systems have traditionally managed quantification at the central level. The increasing trend toward decentralizing this responsibility adds significantly to ownership of the results at health facilities and, if managed properly, can improve the accuracy of the results. However, a centralized approach is generally more efficient when the supply system is in equilibrium, with adequate supply to all levels.

Country Study 20-3
Quantification challenges in sub-Saharan countries scaling up antiretroviral therapy

An increase in funding from global initiatives such as the Global Fund to Fight AIDS, Tuberculosis and Malaria and the U.S. President's Emergency Plan for AIDS Relief has resulted not only in greater access to antiretrovirals (ARVs) in developing countries, but also in political pressures to increase the number of patients receiving ART. Previous methods used for quantifying pharmaceuticals clearly were not effective in the context of the unprecedented level of scale-up of HIV/AIDS programs, and new methods and tools were required to help countries and facilities determine their ARV needs.

Besides the scope and speed of the scale-up efforts, a key difference to address was the chronic nature of ART—lasting for the lifetime of a patient. A concern that continues to vex HIV/AIDS programs is quantification for pediatric ART. Issues include inappropriate pack sizes, the lack of fixed-dose combination products that are suitable for children, and the need to accommodate a child's growth patterns when calculating dose and consumption. (See Chapter 2 discussion of HIV/AIDS, tuberculosis, and malaria.)

Management Sciences for Health's Rational Pharmaceutical Management (RPM) Plus Program worked with a number of countries in sub-Saharan Africa in developing effective ways to quantify their needs for scaling up ART programs—

Data collection. Often, data collected at the clinics do not meet the needs of pharmacy staff for quantification; for example, data may not represent patients who actually collect their medicines from the dispensary. Mechanisms and tools, such as the Electronic Dispensing Tool (MSH/SPS n.d.), were put into place to collect data at the dispensary. The tool has been used in Côte d'Ivoire, Kenya, Namibia, Rwanda, Tanzania, and Zambia. The data collection activities were developed in collaboration with the facility staff members who collect and use the data themselves, resulting in more consistent collection and better quality data. Good quality data at the facility level is forwarded to the national program to use for national quantification purposes and results in more accurate forecasts and assumptions.

Quantification tools and related training. Facility-level tools were developed to determine quantification needs for ARVs. A manual and electronic version of the tool is used by facility staff to determine order quantities from the central medical stores. Quantimed, a quantification tool for larger programs, includes the capability to perform quantification for programs that are scaling up. Training for staff at central medical stores and ministries of health focuses on how to use Quantimed to estimate the amount of pharmaceuticals needed for procurement purposes and also to plan budgets and reports to donors. More information on Quantimed can be found in Box 20-2.

Coordination mechanisms. Kenya, Namibia, and Rwanda established committees under their national AIDS control programs to regularly discuss procurement and quantification activities for HIV/AIDS programs. The committees include representatives from donors, central medical stores, and ministries of health as well as ART providers. The committees track growth trends, monitor data collection, and evaluate the assumptions used in national quantifications on a quarterly basis. The committees' key role is to identify problems in the quantification process and make recommendations to remedy them.

A common approach in decentralizing quantification is to have each responsible office or facility compile its own estimates, based on a common list of approved medicines. The list can be sent directly to the procurement office, which compares the list with past consumption, clarifies any questions directly with the client, and compiles the master list for procurement. Reviews at the district and provincial levels before submission to the procurement office may increase the validity and ownership of estimates, at the cost of adding time to the process.

It is important to make sure that consumption is not double counted: that is, if all medicines come to facilities through a central warehouse, and a needs estimate is submitted by both the central warehouse and the client facilities that order from the warehouse, the total estimate for each medicine should be either the total of all facility estimates (plus central warehouse safety stock) or the central warehouse estimate, whichever is deemed more accurate.

Using manual or computerized methods for quantification

Conducting an accurate pharmaceutical quantification without computerization is possible; however, computers

Box 20-2
Quantimed: Pharmaceutical quantification and cost estimation tool

Quantimed is a Microsoft Access–based tool, developed by Management Sciences for Health, that facilitates the calculation of pharmaceutical needs using one of three primary quantification methods—past consumption, morbidity (including scaling-up patterns), and proxy consumption—or any combination of these. With appropriate data, Quantimed determines needs for a single health facility, a national public health program, or a group of geographic or administrative areas.

Quantifying needs for HIV/AIDS-related medicines and other commodities is particularly challenging in rapidly expanding prevention of mother-to-child transmission (PMTCT) and antiretroviral therapy (ART) programs that do not have data history to drive conventional model estimates. Quantimed's scaling-up function facilitates calculations of pharmaceutical requirements and costs for programs that are expanding, and allows comparisons of different scaling-up scenarios.

The primary users of the Quantimed tool are program managers of public or private programs and government planners, all of whom can gain information useful for strategic and program planning, pharmaceutical rationalization, and financial planning.

Quantimed is designed to—

- Quantify requirements and calculate estimated cost of pharmaceuticals needed for a short course of treatment or long-term treatment for chronic conditions, such as HIV/AIDS
- Develop caseload estimates for each type of health service or intervention for a given target population, using morbidity-based, consumption-based, and/or proxy consumption–based methods
- Determine pharmaceutical requirements for a new or expanding public health program
- Compare the costs of alternative treatment regimens and pharmaceutical products
- Compare alternative expansion models to enable the user to determine the possible extent and speed for scaling up a program with given resources
- Calculate percentages of the patient population receiving various therapies for a program with limited treatment data
- Calculate the estimated total cost of medicines, medical supplies, laboratory supplies, and reagents needed to provide services for a given target population, or for an estimated number of patients
- Calculate order quantity, based on the best estimate of requirements for each pharmaceutical, according to user-defined procurement and inventory factors
- Assist program managers in comparing medicine and other health commodity prices from local and international suppliers
- Provide cost estimates in local currency and international currencies, as well as conversions between currencies

Users should be aware that Quantimed is only a tool; it cannot reason for itself. All results must be analyzed and interpreted using human judgment. Quantimed cannot be used to distinguish between accurate and erroneous data, or for distinguishing between rational and irrational therapy, determining which pharmaceuticals should be ordered, or making management decisions. A user's guide is available (MSH/RPM Plus 2006).

For more information on Quantimed, see http://www.msh.org/projects/sps/Resources/Software-Tools/Quantimed.cfm.

using spreadsheet or database software make the process much easier. The examples of quantification tables in this chapter were constructed with a standard spreadsheet. One database software tool developed to ease the process of quantification is called Quantimed. For more information on Quantimed, see Box 20-2.

Computerized quantification has three major advantages: speed, accuracy, and flexibility. The process is much faster because the formulas can be programmed into the software, and after the data for basic assumptions are entered, the calculations are done automatically. The computer itself will not make errors in computation; if the data are entered correctly and the formulas are correct, the calculated answer will be correct. Speed and accuracy are especially useful for very complicated calculations such as those used to determine the number of patient-months of treatment for programs that are scaling up.

Finally, it is much easier to do "what if" analysis, where the user makes changes in quantities of various items to see what happens to the total procurement costs. Tables constructed manually need to be retyped or rewritten, and all sums need to be recalculated each time a change is made. With a computer, the recalculation and reprinting are done at the touch of a key. When a computerized medicines list and quantification model have been developed, they can be reused repeatedly.

Estimating the time required

Quantification is time-consuming, and a realistic time frame must be established for all the steps in the quantification plan. The time frame depends largely on how many levels of the supply system are involved and on the quality and type of data available. In multilevel systems in which data are incomplete, several months will almost certainly be required to produce a useful quantification.

Developing and organizing the medicines list

The medicines list is the central component of any quantification process. The quantities needed cannot be calculated until it is known which products are needed. Specifications for each medicine on the list should include the following elements—

- Medicine description, generic name, or International Nonproprietary Name (INN)
- Dosage form, such as tablet, suppository, ampoule for injection
- Strength/concentration—for example, 250 mg, 95 percent, 10 mg/mL
- Basic unit, such as tablet, tube, milliliter, bottle
- Package size in basic units
- Projected purchase price per basic unit or per package

In computerized quantification, data management is easiest when a separate field is provided for each of these specifications (see Chapter 50).

The medicines on the list need to be sorted according to the type of quantification and the type of facilities and personnel that will be recording data. The list must be provided in a form useful for retrieving information quickly and correctly. For example, if medicines are stored and records are arranged by dosage form (all tablets and capsules together, all injections together), the list should be organized by dosage form. If items are stored by therapeutic class, the list should be organized by therapeutic class, and so on. If the process involves decentralized data collection, the list should be distributed on data collection forms to each level and facility responsible for quantification at least three months before the estimates are needed for procurement.

For decentralized quantification, all facilities should submit estimates directly on the list (by hard copy or electronically). This procedure allows the compilation of one master list in a reasonable time, comparison of estimated quantities among facilities, and verification of estimates and adjustment if necessary. Dosage forms and strengths should match those included in the appropriate standard treatment guidelines and those available from likely sources of supply. For example, if 500 mg tablets are quantified but suppliers offer only 300 mg tablets, making a conversion will be difficult.

Medicines lists for quantification are often derived from past procurement or formulary or essential medicines lists. Procurement lists from previous purchases may contain specifications and the last prices paid, but they may not represent rational medicine selection or comply with the formulary or essential medicines list. Essential medicines lists or medicine formulary lists that have been regularly updated should be the basis for the quantification list, because they reflect medicines needed for current morbidity patterns (see Chapters 16 and 17).

Filling the supply pipeline

The supply pipeline refers to stock levels within the supply system and the number of supply points at each level, as discussed in Chapter 23. The number of levels, the frequency of requisition and delivery, and the amount of safety stock at each level all influence the amount of pharmaceuticals needed to fill the pipeline and, hence, the amount that must be procured when a program is started or expanded. Underestimation of stock in the pipeline is a common cause of program failure, particularly when a revolving drug fund has been planned. Quantification for a depleted pipeline should include the safety stock levels required at each level of distribution, not just the central level.

Estimating the procurement period

The procurement period covers the time from one order until the next regular order will be placed. In a scheduled system, this period might be multiples of one month; in a perpetual system, it could be counted in days or weeks for the purposes of quantifying. Note that the quantity ordered plus the safety stock must cover the time until the next order is received, which is the procurement period plus the lead time (see below). Procurement periods are influenced by funding and storage space availability as well as by expiry and stability of the stock being ordered.

Considering the effect of lead time

The procurement order quantity should be sufficient to last until the next procurement cycle is completed. The steps of the procurement process needed to place an order may take several months. In addition, after an order is placed, several more months are often required for the pharmaceuticals to arrive in the country, clear customs, and reach the central warehouse. The waiting period from the time an order is prepared until it arrives in the country is the lead time (Chapter 23). The lead time can vary for each product and/or supplier. When lead times are underestimated, the likely results are shortages and more expensive emergency purchases.

When quantifying for a program that is scaling up, the quantity required to cover the lead time will also need to be scaled up.

Estimating safety stock

Safety stock is the amount of stock that is kept in reserve in case an item is unavailable from the supplier or for a sudden increase in demand.

$$\text{Safety stock} = C_A \times LT$$

C_A = Average monthly consumption, adjusted for stockouts (see Section 20.4)

LT = Average lead time (for projected supplier or worst case), in months

Any length of time can be used for the lead time in the preceding equation, but the period should be at least as long as the lead time period, while taking financial resources and storage space into consideration.

When a lead time is unreliable, safety stock should be increased. With a variable lead time, use the following formula—

$$DD_E = DD_P + (OD \times OD\%)$$

DD_E = expected delivery date
DD_P = promised delivery date
OD = average overdue period in days
OD% = percentage of orders overdue

When quantifying for a program that is scaling up, the quantity required for safety stock will also need to be scaled up.

Adjusting for losses and other changes

Inevitably, some medicines will be lost because of damage, spoilage, expiration, and theft. If such losses are not considered in quantification and procurement, stockouts are likely to result. To prevent shortages, a percentage can be added to allow for losses when quantifying requirements. Many systems need to allow at least 10 percent for losses.

Not all medicines are equally at risk for loss—for example, some are more attractive to thieves than others, such as valuable antiretrovirals and artemisinin-based antimalarials. The medicines that are most at risk may vary from country to country. If they can be identified, adjusting the quantities for those items by a higher percentage may be feasible, rather than applying the same adjustment to all items. One strategy is to allow a loss percentage only for vital items, accepting the risk of stockouts for other items. If losses have already been accounted for as part of a consumption-method quantification, there is no need to make a loss adjustment.

Clearly, the best interests of the health system are served by making every effort to control loss and wastage. Options for controlling theft are discussed in Chapter 43; Chapter 40 offers tips for analyzing expiry dates in a large pharmaceutical inventory; and Chapters 45 and 46 provide suggestions for managing stock to avoid wastage.

In a supply system in which patient use or the number of facilities is growing, assuming that medicine consumption will increase is reasonable. In such situations, estimated quantities can be increased by a percentage corresponding to the rate of growth.

Cross-checking the results of quantification

Because there will be some imprecision in the estimates no matter how rigorously the appropriate quantification methods are followed, checking the estimates with a different quantification method is always useful. Ideally, the estimates would produce very similar results, but in practice this rarely happens. The two sets of data can then be evaluated to see which appears to be more realistic, considering the reliability of source data used for the two estimates. Box 20-3 provides guidelines for how to evaluate and compare consumption-based versus morbidity-based estimates. These quantities will likely need to be adjusted to fit

Box 20-3
Comparing morbidity- and consumption-based estimate results

The following scenarios include suggested actions to take based on the results of each method and depending on confidence in the data used. For the consumption method, the pharmaceutical management information system should accurately and reliably maintain data on *consumption* (not on stock movement, which may include losses and expired stock). A crucial factor to consider in any analysis of results is the possible irrational use of medicines in the system.

Consumption-based estimate greater than morbidity-based estimate

If the consumption-based estimate is 50 percent greater than the morbidity-based estimate, conduct a more detailed investigation of the data before proceeding with the quantification. Were the data entry and transcription done correctly? Was the correct population and morbidity information obtained? Is there a possibility of large-scale leakage and/or diversion of supplies? When the data have been verified, or for discrepancies less than 50 percent, proceed as follows—

If **not confident in the quality of either** the consumption or morbidity data—

- Consider an overall system assessment, then strengthening of the health management information system and pharmaceutical management information system.
- Seek comparative facilities, regions, or countries with reliable information systems and use their data as proxy data.
- Try to estimate the percentage of confidence in the accuracy, completeness, or reliability of the data and adjust the results accordingly.

If **more confident in the consumption data** than the morbidity data—

- Examine the morbidity data for underestimation of disease incidence.
- Make sure the population data are current. Ask whether any large movement of population into the area has occurred, such as refugees, seasonal workers, or employees of new industries.
- Determine whether standard treatment guidelines are followed.
- Investigate whether pharmaceuticals are used in other programs or for other purposes.

If **more confident in the morbidity data** than the consumption data—

- Consider whether pilferage, expiration, or stock leakage is high.
- Investigate whether pharmaceuticals are used in other programs or for other purposes.
- Ask whether stockouts of related pharmaceuticals caused higher consumption of this item.

If **confident in the quality of both** the consumption and morbidity data—

- Use the consumption-based estimate to avoid the problem of ordering too few pharmaceuticals and supplies.

Morbidity-based estimate greater than consumption-based estimate

If **not confident in the quality of either** the consumption or morbidity data—

- Consider an overall system assessment, then strengthening of health management information system and pharmaceutical management information system.
- Seek comparative facilities, regions, or countries with reliable information systems and use their data as proxy data.
- Try to estimate the percentage of confidence in the accuracy, completeness, or reliability of the data and adjust the results accordingly.

If **more confident in the consumption** data than the morbidity data—

- Examine the morbidity data for overestimation of disease incidence.
- Ask whether a change in population has occurred as a result of exodus caused by war, unrest, drought, famine, migration of seasonal workers, or departure of refugees.
- Determine whether standard treatment guidelines are followed.
- Investigate whether pharmaceuticals are used for other programs or for other purposes.
- Consider whether program coverage is low and/or support services or diagnostics for health conditions are inadequate.

If **more confident in the morbidity** data than the consumption data—

- Consider whether the management information system is poor.
- Ask whether the budget has been sufficient to meet the full needs of the population or if a proportion has gone untreated.
- Consider whether program coverage is low and/or support services or diagnostics for health conditions are inadequate, and whether access to these services has been limited by unrest, strikes, or transport problems.
- Determine whether medicines are being supplied from multiple sources not included in the quantification.

If **confident in the quality of both** consumption and morbidity data—

- Use the morbidity-based estimate to avoid ordering too few pharmaceuticals and supplies.

the budget as well. Table 20-2 illustrates how three different quantification methods produced different estimates for the same supply system in a Latin American country.

Cross-checking is a fundamental step in reconciling procurement quantities with available funds. It is also useful to cross-check consumption with theoretical demand to get an idea of the rationality of pharmaceutical therapy in the system. If the supply system usually bases purchases on past consumption, cross-checking for high-volume, high-cost medicines using another method may reveal targets for interventions to promote more rational medicine use. For example, in one quantification conducted for intrauterine devices (IUDs), the quality of the issues data (quantities distributed from a storage point) were considered good, and indeed they were an accurate record of the stocks given out. However, enough IUDs had been issued for every man, woman, and child in the province. A comparison of the population and morbidity data highlighted the problem of leakage and/or resale of the IUDs outside the country. This comparison produced a more accurate quantification for next year's supply.

Table 20-2 Comparison of quantification results in a Latin American country

Medicine	Consumption estimate	Morbidity estimate	Proxy consumption estimate
ORS 1 L package	11,290,000	18,650,000	14,850,000
Chloroquine 300 mg tablet	1,230,000	2,233,000	2,005,000
Paracetamol 500 mg tablet	20,960,000	14,010,000	22,320,000

Estimating total procurement costs

When estimating the cost of medicines on a quantified list, the critical issue is determining the next purchase prices. Using the last purchase prices is not adequate, because in most cases, doing so results in an underestimate of the actual next purchase prices, leading to insufficient funds when the time comes to place orders.

Two basic ways exist to estimate the next purchase price of a medicine; both are usually needed to estimate the cost for the full list of medicines.

The first option is obtaining data on current medicine prices in the market where the medicines will be purchased. As discussed in Chapter 21, sources for price data include local suppliers, international procurement agencies, and references such as Management Sciences for Health's *International Drug Price Indicator Guide,* which is updated annually.

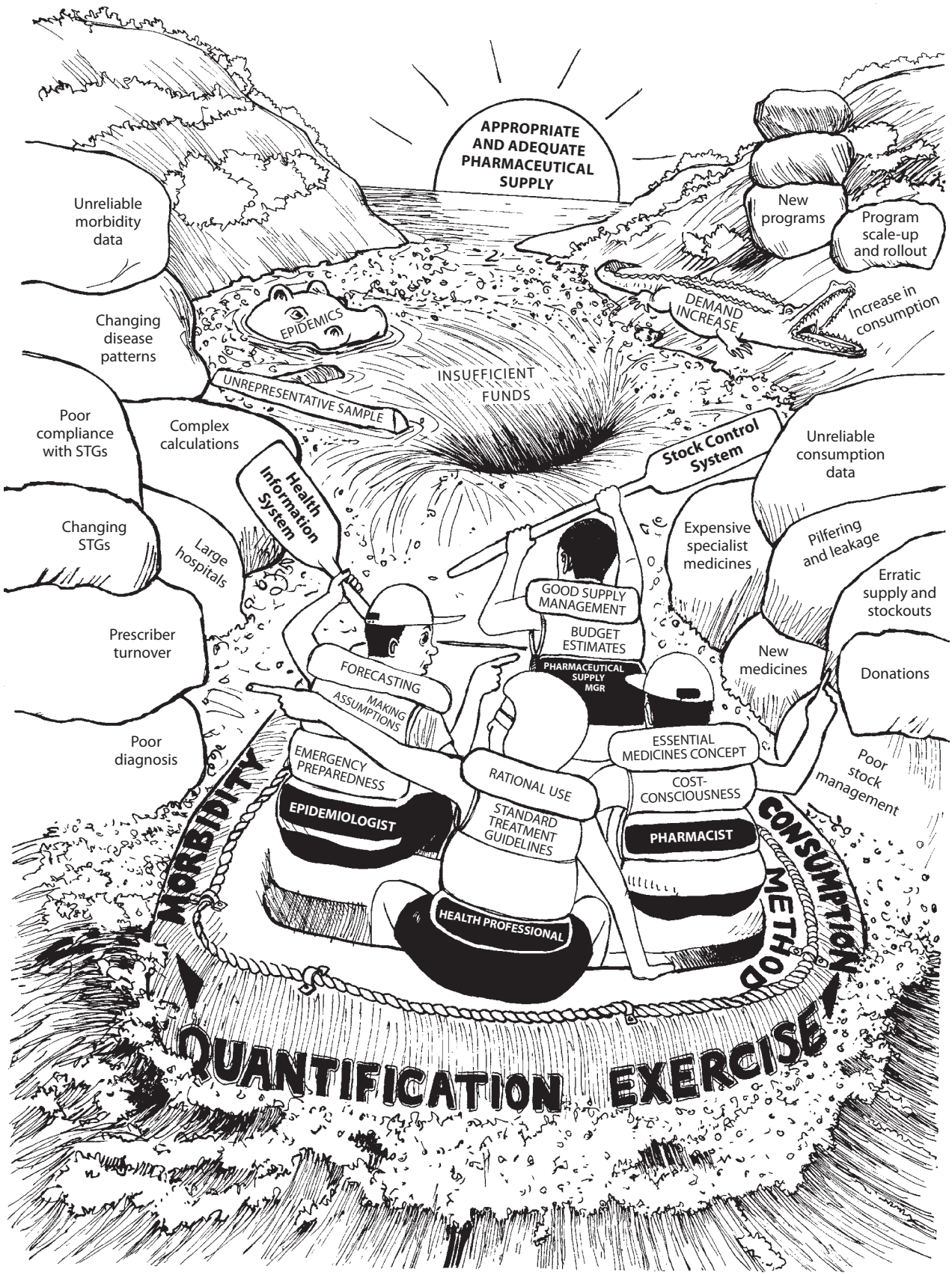
The other option for estimating next purchase price is to adjust the last purchase price for factors such as—

- International inflation for products bought internationally
- Devaluation of local currency for products purchased internationally (if relevant)—this percentage is added to the price for medicines purchased on the international market
- Local inflation for products purchased on the local market, adding the appropriate percentage based on the current local situation

After price estimates are obtained, percentages for shipping and insurance of pharmaceuticals obtained from international sources (usually 15 to 20 percent) and any known fees, such as those paid to a tender board or for local customs duties, must be added.

Adjusting and reconciling final quantities

Difficult decisions must often be made to reduce the number of medicines or the quantities of medicines or both until the estimated quantities and costs correspond with the available budget. These reductions may require policy decisions regarding priority diseases, priority age groups, priority facilities to be supplied, selection of less expensive



SUCCESSFUL PHARMACEUTICAL QUANTIFICATION REQUIRES A TEAM EFFORT AND A MIX OF METHODS

therapeutic alternatives, and changes to standard treatment guidelines. Chapter 40 discusses several approaches for making reductions rationally, using specific tools such as VEN (vital, essential, nonessential) categories, ABC analysis, and therapeutic category analysis. Another way of providing a foundation for reduction is to cross-check the quantification with another method to find out where the quantified estimate is much higher than necessary based on known morbidity and attendance data or much higher than that in a comparable health system.

Eliminating adjustments for expected losses may be a tempting first step in reducing quantities, but it is a false economy unless losses will in fact be eliminated. If the losses are likely to occur, they must be incorporated into the final quantification, or stockouts will almost certainly result. Cutting the overall percentage allowed for losses may be possible by targeting the allowance to those items most at risk and/or eliminating the adjustment for nonvital medicines, with the expectation that some stockouts will result for medicines that are not covered.

20.4 Consumption method

In the consumption method, a list is prepared of all medicines eligible for procurement, and the most accurate inventory records of past consumption are used to calculate the quantities needed for each medicine.

Consumption during a recent period of six to twelve months is adjusted for stockouts to obtain the average monthly consumption. A percentage for increase in projected use is added to the projected monthly consumption. Then the average monthly consumption is multiplied by the number of months to be covered by the procurement. Safety stock and lead time levels (in months) are also multiplied by the projected monthly consumption. These three figures are added to obtain the gross needs during the period, subtracting the usable stock on hand and any stock on order from the gross estimate, to derive the quantity to purchase. This quantification formula is the same as the consumption-based reorder formula described in Chapter 23. An adjustment is then made for losses.

The anticipated unit cost for each medicine (not the last unit cost) is multiplied by the number of units to be purchased to obtain the expected purchase value for the entire quantity. All purchase values for individual medicines are added to obtain the total expected procurement cost. If this cost is greater than the budget, adjustments are made, as described in the previous section.

Example

Table 20-3 shows a sample consumption-based quantification from an eastern Caribbean country. This sample is not the complete quantification list, but it illustrates the estimates for nineteen medicines. Box 20-4 provides a summary of calculations used in consumption-based quantification.

Steps in the quantification

Step 1. Prepare a list of medicines to be quantified. The medicines list should be prepared as described in Section 20.3, sorted into the order that will best facilitate data collection, and distributed to those officials and facilities that will enter consumption data.

Step 2. Determine the period of time to be reviewed for consumption. If the procurement is to cover a twelve-month period, the consumption data for the past twelve months should be reviewed (if a full year's useful data are available). A twelve-month review may also be used for a procurement covering six months, but if seasonal variations are significant, such as with malaria, using the same six-month period from the preceding year may be preferable. A short review period, such as three months, is inadequate to plan a procurement to cover twelve months, unless the three months reviewed reflect a steady state of consumption for the entire year.

Step 3. Enter consumption data for each medicine. For each medicine on the list, enter—

- The total quantity used during the review period, in basic units
- The number of days in the review period that the medicine was out of stock (if the number of days out of stock cannot be determined with accuracy, the estimated number of months out of stock during the period can be entered)
- The lead time for the last procurement (or the average from the last several procurements)

Using the most accurate and current records available is important. The likely sources for data on consumption and lead time are—

- Stock records and distribution reports from a central distribution point
- Stock records and reports from regional or district warehouses
- Invoices from suppliers
- Dispensing records from health facilities

If projected pricing data are available at this stage, entering prices while entering consumption data (see step 10) may save time.

Step 4. Calculate the average monthly consumption. The average monthly consumption is a key variable in the quantification formula and should be as accurate as

Table 20-3 Consumption-based quantification for an eastern Caribbean country

Medicine	Strength	BU	Pack size	C_T Total consumption in period (BU)	D_{OS} Days out of stock	C_A Adjusted average monthly consumption (BU)	C_P Projected average monthly consumption (BU)	S_I Stock on hand (BU)	S_O Stock on order (BU)	SS Safety stock level (BU)	Q_O Suggested quantity to order (BU)	Q_A Adjusted order quantity	Order quantity (packs)	Probable pack price (USD)	Value of proposed order (USD)
Ampicillin	500 mg	Capsule	1,000	59,500	0	9,917	10,413	32,000	42,000	31,239	50,956	56,052	57	46.50	2,650.50
Ampicillin	250 mg	Capsule	1,000	89,000	34	18,218	19,129	81,000	58,000	57,387	90,548	99,603	100	24.70	2,470.00
Ampicillin sodium injection	500 mg	Ampoule	100	3,879	0	647	679	111	7,600	2,037	437	481	5	17.03	85.15
Ampicillin suspension 100 mL	125 mg/ 5 mL	Bottle	1	4,128	0	688	722	1,513	3,000	2,166	4,151	4,566	4,567	0.57	2,603.19
Antihistamine decongestant elixir	250 mL	Bottle	1	853	29	169	177	351	929	531	844	928	929	1.57	1,458.53
Antihistamine decongestant	(Any)	Tablet	500	50,000	0	8,333	8,750	0	62,500	26,250	42,500	46,750	94	12.00	1,128.00
Bacitracin antibiotic ointment	—	Tube	1	2,414	31	484	508	3,400	100	1,524	2,596	2,856	2,856	0.54	1,542.24
Bendrofluazide	5 mg	Tablet	500	141,500	30	28,208	29,618	142,000	50,000	88,854	163,416	179,758	360	4.60	1,656.00
Benzathine benzyl-penicillin injection	2.4 MU	Ampoule	50	1,318	0	220	231	1,486	0	693	1,286	1,415	29	12.10	350.90
Cephradine injection	500 mg	Ampoule	100	2,695	0	449	471	2,300	1,100	1,413	2,252	2,477	25	75.00	1,875.00
Chlorhexidine gluconate solution (Hibitane)	5%	Liter	5	302	0	50	53	433	0	159	203	223	45	3.90	175.50
Chlorhexidine/cetrimide (Savlon)	5 liter	Liter	5	438	0	73	77	418	250	231	256	282	57	14.70	837.90
Chlorpropamide	250 mg	Tablet	1,000	162,000	0	27,000	28,350	169,000	0	85,050	171,200	188,320	189	27.90	5,273.10
Cimetidine (Tagamet) inj.	200 mg	Ampoule	10	1,090	0	182	191	2,580	0	573	0	0	0	2.49	0.00
Cimetidine	400 mg	Tablet	1,000	24,000	0	4,000	4,200	23,500	25,000	12,600	1,900	2,090	3	17.90	53.70
Cloxacillin suspension 100 mL	125 mg/ 5 mL	Bottle	1	882	0	147	154	1,446	0	462	402	442	443	1.00	443.00
Co-trimoxazole suspension 100 mL	200/ 40 mg/ 5 mL	Bottle	1	1,152	0	192	202	374	1,930	606	120	132	132	0.75	99.00
Co-trimoxazole	400/80 mg	Tablet	1,000	81,000	0	13,500	14,175	82,000	0	42,525	88,100	96,910	97	21.00	2,037.00
Dextrose in saline (IV) 1,000 mL	5%/0.9%	Bottle	1	1,525	32	308	323	0	2,288	969	1,588	1,747	1,747	1.35	2,358.45
														Total order cost:	**27,097.16**

Note: BU = basic unit; USD = U.S. dollars; MU = mega-unit; consumption period = 6 months; lead time = 3 months; procurement period = 6 months; use adjustment for 6 months = 5%; loss adjustment = 10%.

Box 20-4
Consumption-based calculations

Formula number	Objective of formula	Calculations
1	Adjusted average monthly consumption (preferred)	$C_A = C_T \div [R_M - (D_{OS} \div 30.5)]$
2	Adjusted average monthly consumption (alternative)	$C_A = C_T \div (R_M - M_{OS})$
3	Projected average monthly consumption	$C_P = C_A + (C_A \times A_U)$
4	Basic safety stock requirements	$C_A \times LT$
5	Quantity to order	$Q_O = C_A \times (LT + PP) + SS - (S_I + S_O)$
6	Quantity to order adjusted for losses	$Q_A = Q_O + (Q_O \times A_L)$

C_A = Average monthly consumption, adjusted for stockouts
C_T = Total consumption during review period, in basic units
R_M = Total consumption review period, in months
D_{OS} = Number of days an item was out of stock during the review period
M_{OS} = Estimated number of months an item was out of stock during the review period
C_P = Projected average monthly consumption
A_U = Use adjustment
SS = Quantity needed for safety stock
LT = Average lead time (for projected supplier or worst case), in months
Q_O = Quantity to order in basic units, before adjustment for losses or program change
PP = Procurement period (number of months to be covered by order)
S_I = Stock now in inventory, in basic units
S_O = Stock now on order, in basic units
Q_A = Quantity to order adjusted for losses or program change
A_L = Loss adjustment

possible. The simple approach is to divide total consumption by the number of months reviewed. If stockouts occurred during that period, the average must be adjusted to include the consumption that would have occurred if stock had been available.

Two ways exist of accounting for stockouts when computing average monthly consumption. The recommended method is illustrated in Box 20-4 as formula number 1. Enter the total consumption and divide this number by the number of months in the review period minus (the total number of days out of stock in the same period divided by 30.5 to convert to months). For example, see the entry for ampicillin 250 mg capsules in Table 20-3, which shows consumption-based quantification for a Caribbean country. Total consumption for a six-month review period was 89,000 capsules. The medicine was out of stock for thirty-four days in the six-month period. Therefore, the average monthly consumption is—

$$C_A = 89{,}000 \div [6 - (34 \div 30.5)],$$
$$\text{or } 89{,}000 \div 4.8852 = 18{,}218$$

An alternative method, which is simpler but less precise, is shown as formula number 2 in Box 20-4. It uses the estimated number of months out of stock for adjusting consumption, omitting the step of converting days to months. Using the same medicine from Table 20-3, the medicine was in stock for about five of the six months, leaving about one month out of stock. Therefore, the average monthly consumption is—

$$C_A = 89{,}000 \div (6 - 1) = 89{,}000 \div 5 = 17{,}800$$

Step 5. Calculate projected average monthly consumption for expected changes in consumption pattern. When using the example of ampicillin 250 mg capsules in Table 20-3, if use is expected to increase by 5 percent in the coming year, adjusting the average monthly consumption by 5 percent would be reasonable, which would raise the expected monthly need by 911 capsules, bringing the total to 19,129 capsules.

Some changes in consumption may be independent of trends in overall patient use. One example is predictable seasonal variation in the consumption of cough and cold remedies. A potential spike in an unpredictable epidemic disease such as cholera is another example. If such variation is anticipated or is part of the consumption data, increasing or decreasing estimates for medicines such as oral rehydration solution, parenteral solutions, and some antibiotics would be sensible; however, this variation does not mean that the need for all medicines will increase or decrease by the same factor.

If a new formulary medicine is known to be replacing an older medicine in the formulary, the estimate for the older medicine should be reduced. If an initiative is being launched to alter prescribing patterns, anticipating at least some success by reducing the expected need for targeted medicines by a small percentage would be reasonable. When a turnover occurs in prescribing staff members, the new prescribers may have different ways of treating common conditions that could substantially affect medicine needs in some therapeutic categories. If such changes can be anticipated, adjusting the forecasts would be wise to avoid spending resources on medicines that will not be as popular as in the past.

Step 6. Calculate the safety stock needed for each medicine. Safety (buffer) stock is needed to prevent stockouts, although high levels of safety stock increase inventory holding costs and should be avoided (see Chapter 23). In some supply systems, the safety stock is set for each item at a fixed quantity or a fixed number of months' worth of consumption. However, the preferred method is to calculate the safety stock based on the projected average consumption and the expected lead time (see formula number 3 in Box 20-4). The projected average consumption from step 5 is multiplied by the average lead time. This safety stock level should avoid stockouts, assuming that the item is reordered when only the safety stock remains, the supplier delivers within the projected lead time, and consumption is no greater than average. Using formula number 3 in Box 20-4, the safety stock for ampicillin 250 mg capsules in the example is 19,129 × 3 months = 57,387.

For vital items identified from a VEN analysis (see Chapter 40), adjusting the safety stock may be necessary to cover variations in consumption or lead time. Several options can be used for adjusting safety stock levels (see Chapter 23). The simplest method multiplies the basic safety stock by an adjustment factor. For example, an adjustment factor of 1.5, or 50 percent, would increase the safety stock of ampicillin 250 mg capsules in Table 20-3 to 86,081 capsules. If this sort of adjustment is done for all items, the cost of safety stock will increase substantially; therefore, adjustments should be made only when true uncertainty exists about the lead time or consumption.

Step 7. Calculate the quantity of each medicine required in the next procurement period. The suggested formula for calculating the quantity to order is shown as formula number 5 in Box 20-4. The calculation is done in three main steps. First, the projected average consumption is multiplied by the sum of the lead time and the procurement period, yielding the total needs before considering safety stock, stock on hand, or stock on order. The second step is to add the quantity needed for safety stock. Finally, the quantity of usable stock on hand and the stock on order are added together, and then subtracted from the previous total. Using the example of ampicillin 250 mg capsules from Table 20-3, the quantity to order is—

$$Q_O = 19{,}129 \times (3 + 6) + 57{,}387 - (81{,}000 + 58{,}000) = 90{,}548$$

Because the ampicillin capsules are purchased in bottles of 1,000, ninety-one bottles should be ordered.

Step 8. Adjust for losses. To avoid stockouts, one should adjust quantification estimates to allow for losses, as discussed in Section 20.3. If the supply system from Table 20-3 averaged 10 percent per year in losses, and this percentage was applied to ampicillin 250 mg capsules, the allowance would add 9,055 capsules to the estimate from step 7, bringing the total purchase quantity to 99,603, or 100 bottles of 1,000 capsules.

Step 9. Compile decentralized quantifications (if applicable). In a decentralized quantification, staff members at each facility or storage point enter their own consumption quantities and stockout information following the preceding steps, and the estimates of the individual facilities are totaled and compiled on the master quantification list.

Step 10. Estimate costs for each medicine and total costs. In order to estimate procurement costs, multiply the quantities estimated for each medicine by the most accurate prediction of the expected next purchase price (not the last one), as discussed in Section 20.3.

After the expected price has been entered for each medicine, multiply the price by the estimated quantity needed to obtain the total procurement value for each medicine. Table 20-3 uses the package price as the basis for making these projections, but in many cases using the unit price is preferable, because combining information from different sources to arrive at an average allows more flexibility. The basic unit price is also preferable if the package sizes that will be ordered are not known or if projections are based on average international prices from a source such as the annual *International Drug Price Indicator Guide*.

After the estimated procurement value has been calculated for each medicine, the final step in the basic quantification process is to add the estimated procurement values for all medicines to obtain the total expected cost for the procurement.

Step 11. Compare total costs with budget and make adjustments. If the total expected procurement cost exceeds the available budget, only two choices exist: either obtain more funds or reduce the number of medicines and/or the quantities ordered. Section 20.3 discusses rational ways to adjust the estimates.

20.5 Morbidity method

The morbidity method uses data on patient use (attendances at health facilities) and morbidity (the frequency of common health problems) to project the need for medicines based on assumptions about how the problems will be treated. Readers who plan to undertake a morbidity-based quantification can refer to the WHO manual *Estimating Drug Requirements* (WHO/DAP 1988), which provides a more detailed discussion of the steps in this type of quantification.

The morbidity method requires a list of common health problems, an essential medicines list that includes therapy for the problems, and a set of standard treatments for quantification purposes (based on either average current practices or "ideal" treatment guidelines). For most health problems, at least two alternative treatments exist, and a percentage must be assigned based on how frequently each regimen is

used. Then, the expected incidence (number of treatment episodes) of each health problem must be estimated. The incidence of a health problem can be estimated from total patient contacts or from a subgroup, for example, "number of HIV-infected patients" or "number of women attending antenatal clinic services."

The quantification formula involves multiplying the quantity of each medicine included in standard treatments for each health problem by the number of treatment episodes expected for the health problem. The expected total need for each medicine is the sum of the estimates from all treatment regimens in which the medicine is included. Then the estimates are adjusted to fill the supply pipeline, allowing for losses caused by theft and wastage. Finally, the expected cost is calculated on the basis of the expected purchase price of each medicine, and estimates are reconciled with available funds.

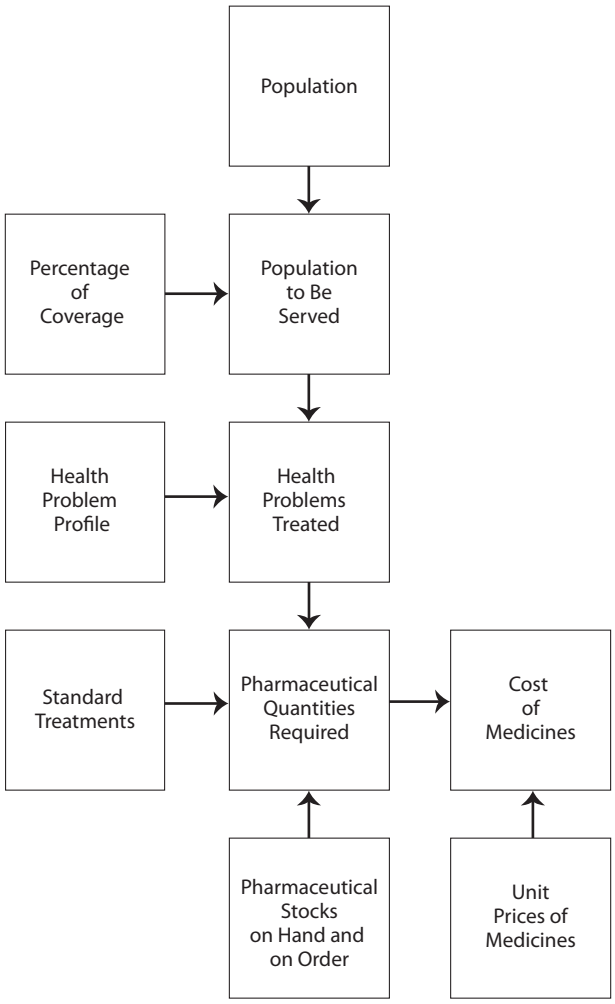
Because of the limited data likely to be available on morbidity patterns and the difficulty in defining standard treatments that are meaningful for quantification, applying this method to every health problem is difficult. This difficulty limits the method's utility for a complex health system with many types of health problems and several levels of health facilities. In general, the morbidity method is most useful in estimating for a relatively small number of different health problems, for example, in primary care and special-purpose facilities and programs.

Because a limited number of health problems are likely to be addressed in most morbidity-based quantification procedures, the resulting estimates for each medicine must be adjusted to cover health problems not considered in the quantification, usually using some variant of proxy consumption (see Section 20.6). Adjustments may also be required to fill the supply pipeline, to account for losses, and, in most cases, to reconcile the quantities needed with the funds available.

In a simple quantification exercise for one health problem, such as cholera (see Country Study 20-1), or for a small group of health problems and medicines, the process can be done manually (although it is easier with a computer). A spreadsheet program or specialized quantification software, such as Quantimed, is virtually required to conduct a complicated morbidity-based quantification covering a large number of health problems and medicines (see Box 20-2).

Figure 20-1 is a flow diagram that illustrates how the data inputs on population, percentage of coverage, health problems, standard treatments, and unit costs are used to calculate the quantities needed and projected procurement costs.

Figure 20-1 Morbidity method



Example

Table 20-4 is an example of morbidity-based quantification. The table shows a number of health problems for which medicines are to be procured, morbidity estimates for a one-year period, and sample standard treatment regimens expected to be prescribed for the health problems. The medicine needs for the health problems are calculated in basic units. All this information, together with projections for losses, adjustments made to reflect available funds, and quantities required to fill the supply pipeline, is used to produce a procurement list. Table 20-4 follows steps 1–6 in the next section. Box 20-5 provides a summary of calculations used in morbidity-based quantification.

Steps in the quantification

Step 1. Specify the list of problems. List the major specific health problems encountered (see Table 20-4). If an existing information system reports on diseases, those disease codes should be used; if no coding system exists, the International Classification of Diseases (ICD) system can be used. (See http://www.who.int/classifications/icd/en for more information.)

Table 20-4 Pharmaceutical needs based on morbidity

Problem	Severity	Age group	F: Episodes per 1,000 contacts	C_E: Expected number of contacts	E_T: Projected number of episodes	Number of regimen	P_T: % Cases treated with regimen	Pharmaceutical product	Basic unit	D_{CU}: Basic units per dose	N_D: Doses per day	L_D: Number of days	Q_E: Basic units per episode	Q_T: Total basic units needed
Malaria	1	<5	364	3,279,578	1,193,767	1	100	Artesunate 50 mg	Tablet	1	1	3	3	3,581,301
						1	100	Amodiaquine 150 mg	Tablet	1	1	3	3	3,581,301
						2	80	Paracetamol solution 120 mg/5 mL	mL	1.50	4	10	60	57,300,816
		>5	278	3,279,578	911,723	1	100	Artesunate 50 mg	Tablet	4	1	3	12	10,940,676
						1	100	Amodiaquine 150 mg	Tablet	4	1	3	12	10,940,676
						2	80	Paracetamol 500 mg	Tablet	2	4	5	40	29,175,129
	2	<5	65	3,279,578	213,173	1	100	Quinine injection 300 mg/mL	mL	0.50	3	1	1.5	319,759
						1	100	Quinine 300 mg	Tablet	0.50	3	6	9	1,918,553
						2	100	Paracetamol solution 120 mg/5 mL	mL	1.50	4	10	60	12,790,356
		>5	61	3,279,578	200,054	1	100	Quinine injection 300 mg/mL	mL	2	3	1	6	1,200,326
						1	100	Quinine 300 mg	Tablet	2	3	6	36	7,201,954
						2	100	Paracetamol 500 mg	Tablet	2	4	10	80	16,004,343
Conjunctivitis	—	<5	53	3,279,578	173,818	1	100	Tetracycline 1% eye ointment	5 g tube	1	3	7	1	173,818
		>5	38	3,279,578	124,624	1	100	Tetracycline 1% eye ointment	5 g tube	1	3	7	1	124,624
Otitis media	—	<5	106	3,279,578	347,635	1	100	Co-trimoxazole suspension	mL	5	2	10	100	34,763,531
						2	100	Paracetamol solution 120 mg/5 mL	mL	1.50	4	10	60	20,858,119
						3	80	Pseudoephedrine syrup	mL	2.50	4	5	50	13,905,412
		>5	29	3,279,578	95,108	1	100	Co-trimoxazole 800/160 mg	Tablet	1	2	10	20	1,902,155
						2	100	Paracetamol 500 mg	Tablet	2	4	5	40	3,804,311
						3	80	Pseudoephedrine 60 mg	Tablet	1	4	5	20	1,521,724
Acute tonsillitis	—	<5	72	3,279,578	236,130	1	100	Penicillin VK 125 mg/5 mL liquid	mL	5	4	5	100	23,612,964
						2	100	Paracetamol solution 120 mg/5 mL	mL	1.50	4	10	60	4,167,779
		>5	33	3,279,578	108,226	1	100	Procaine penicillin 3 MU injection	Vial	1	1	1	1	108,226
						2	100	Penicillin VK 250 mg	Tablet	1	4	5	20	2,164,522
						3	100	Paracetamol 500 mg	Tablet	2	4	5	40	4,329,043
Gastritis, heartburn	—	<5	11	3,279,578	36,075	1	100	Antacid suspension	mL	5	4	5	100	3,607,536
		>5	77	3,279,578	252,528	1	70	Antacid suspension	mL	10	4	5	200	35,353,855
						2	30	Cimetidine 300 mg	Tablet	1	4	5	20	1,515,165

Note: Based on 3,123,408 contacts in the past year; 5 percent expected rate of increase; MU = mega-unit.

The health problem list should not be broken down into too much detail but should be defined according to the diagnostic capacity and health problems treated at each type of health facility. At the lowest level of the system, only a limited number of problems are recognized and treated; the range of problems diagnosed and treated normally increases at the health center, district hospital, and referral hospital levels.

Because treatments differ markedly for adult and pediatric patients, at least two categories (under five years and over five years) need to be included for most problems. Although it may be tempting to establish several categories (under five, five to twelve, thirteen to sixty-five, and over sixty-five), it is best to avoid overcomplicating the development of treatment guidelines (see below) and the process of compiling data on treatment episodes.

Step 2. Establish the list of medicines to be quantified. The objective here is a list of essential medicines that covers the major health problems and forms the basis for standard treatment schedules (see Table 20-4). A current and appropriate national or health system formulary or essential medicines list should be used when available. If no official list exists, one needs to be developed (see Chapter 17); it may grow out of the process of developing standard treatments.

The medicines list must be available in two formats—one organized in alphabetical order by generic name (INN) and one by therapeutic categories. The therapeutic category list is most useful in developing standard treatment schedules, and the list organized by generic name is used for the procurement list.

Step 3. Establish standard or average treatments. Standard or average treatment regimens are required for each health problem to forecast medicine needs, as in Table 20-4. Developing this information is the most complicated part of using the morbidity method. Two basic options exist for developing standard treatments: average actual treatments or ideal standard treatments. The components are the same, but an important difference exists between the approaches: average regimens are based on observed or reported practices and are more likely to predict what will actually happen, whereas ideal regimens define what should happen if prescribers follow the ideal guidelines. Country Study 20-1 illustrates how different the results can be between average current treatments and standard treatments.

Which should be used? Perhaps both, in a combination approach. For example, if one treatment regimen is viewed as ideal but another is commonly used, include both regimens in the guidelines for quantification and estimate the percentage of treatment episodes that will receive each of the two regimens.

For some health problems, particularly with severely ill patients, the duration of treatment varies significantly between individual patients, depending on their treatment response. Expert advice should be used to help estimate average treatment duration. The same applies for preventive treatment, where adherence to treatment can significantly influence treatment duration.

In most quantification exercises, developing (or modifying) the treatment guidelines is necessary (see Chapter 17). Ideally, standard treatment guidelines should be developed by expert committees (with additional expert assistance, if needed). Unless reliable information is available on medicine use and prescribing patterns, a special study may be needed to determine average actual treatment patterns; this study can be combined with a study to determine morbidity patterns and incidence of health problems (see step 4).

Whichever option is used, the same information must be compiled (see Section 20.3)—

- The percentage of treatment episodes in which the medicine will be prescribed
- The name of each medicine and strength/concentration with separate treatments listed for age (or weight) level, as appropriate

Box 20-5
Morbidity-based calculations

Formula number	Objective of formula	Calculations
1	Quantity of medicines needed per treatment episode	$Q_E = D_{CU} \times N_D \times L_D$
2	Expected total number of contacts (in thousands)	$C_E = C + (C \times A_U)$
3	Expected treatment episodes	$E_T = C_E \times F$
4	Total quantity of medicines needed	$Q_T = E_T \times Q_E \times P_T$

Q_E = Quantity of each medicine needed for each treatment episode
D_{CU} = Basic units per dose
N_D = Number of doses per day
L_D = Length of treatment in days
C = Past total number of contacts
A_U = Utilization adjustment
C_E = Expected total number of contacts
F = Frequency of health problem (per thousand)
E_T = Expected treatment episodes
Q_T = Total quantity required
P_T = Percentage of cases expected to be treated

- The basic unit
- The number of basic units in each average dose for the health problem in question
- The average number of doses of each medicine per day for the problem
- The average number of days of treatment for each medicine per episode

These components are combined to project the quantity of each medicine needed for each treatment episode (Q_E) in each standard treatment regimen. This projection is made by multiplying the basic units per dose (D_{CU}) by the number of doses per day (N_D). This result is multiplied by the length of treatment per episode, in days (L_D). The entire formula is—

$$Q_E = D_{CU} \times N_D \times L_D$$

In the example from Table 20-4, three different medicine products are prescribed for otitis media for both age groups; the medicines are the same, but the dose and dosage form differ. The quantity of co-trimoxazole suspension needed to treat otitis media in patients under five years old is calculated as—

$$Q_E = 5 \text{ mL} \times 2 \text{ doses/day} \times 10 \text{ days} = 100 \text{ mL}$$

Generally, this calculation is done for all medicines in all the standard treatment regimens; however, the formula may not be appropriate for all formulations, such as in pediatric solutions, because patients may receive an entire bottle rather than the exact volume needed for a treatment course. Using the average consumption over the course of treatment (or monthly, for chronic conditions) may be more accurate. Similarly, for conjunctivitis in Table 20-4, the basic unit used in the treatment is one tube of eye ointment, but one dose would not comprise one tube—a tube should last throughout the course of treatment.

If different treatment regimens (perhaps with multiple medicines) are used for the same disease according to its severity, separate standard regimens must be considered and assigned for each. This situation is illustrated by the malaria treatment guidelines in Table 20-4, which include two levels of severity. Patients who are categorized as severity 2 could have started on this regimen directly or have been put on this regimen after first-line treatment failed.

For each regimen, the proportion of patients with each disease who will be treated with each different therapy is estimated. From Table 20-4, in patients over five years old with gastritis, 70 percent are expected to be treated with antacid and 30 percent with cimetidine. In some situations, depending on treatment practices, allocating 70 percent for antacid and 50 for cimetidine (because some patients will receive both medicines) might be appropriate. Thus, the cumulative percentage may exceed 100 percent for a particular health problem.

If major differences exist in the way that health conditions are treated by different level and/or prescribers, estimating how many (or what percentage of) treatment episodes of each disease will be managed by each category of prescriber may be useful; then specify separate treatment regimens common for each prescriber category.

Practitioners involved in developing standard treatment guidelines for quantification should understand that the guidelines are for quantification only and that a prescriber's freedom will not necessarily be curtailed as a result. In one West African country, a committee was formed to develop standard treatment guidelines for quantification, with the assistance of an outside expert. The committee met but decided that standard treatment guidelines would restrict doctors' freedom to choose a therapy and instead produced a simple therapeutics manual. When the external quantification team arrived in the country, no lists had been produced of common diseases with guidelines for quantification, and the process ultimately failed to produce a useful list for procurement.

Step 4. Collect morbidity data for each health problem treated. This step estimates the expected number of treatment episodes for each health problem from step 1. A treatment episode is "a patient contact for which a standard course of drug treatment is required" (WHO/DAP 1988, Module 6, Section 1). Table 20-4 shows one way of organizing morbidity data for the health problems from step 1 and estimating the number of treatment episodes.

Information from the regular health information system on morbidity patterns and treatment episodes can be used for quantification. In many cases, however, this information is not available, and a special study is needed in sentinel facilities, from which data can then (with caution) be extrapolated. The study can take two forms: a retrospective review of records in selected facilities (if those records are relatively accessible, complete, and accurate), or a prospective study in a sample of health facilities. The study must be completed before actually starting the quantification. Some key issues in conducting these studies include—

- Both the number of contacts and the number of treatment episodes must be obtained in the study of sample facilities. In new programs or during scale-up, treatment episodes could take the form of target treatment figures, rather than historical figures from actual patients.
- Only patient contacts that normally result in pharmaceutical treatment should be counted, separate from those that do not (such as well-child programs).
- The sample data should specify the frequency of each health problem in terms of a common denominator, such as 1,000 inpatients or 1,000 outpatient visits (for

example, number of acute diarrhea cases per 1,000 outpatient contacts). The health problem data can also be presented as a percentage of the population (cases out of 100); for example, 20 percent of child visits are for diarrhea.

- Separate frequencies must be developed for all age groups specified in the standard treatment guidelines. Table 20-4 shows one format for doing so.
- Separating curative from noncurative contacts may not be possible in a retrospective review of records. Even for curative contacts, not all patients who come to facilities with health problems receive pharmaceutical therapy (although the vast majority does if medicines are in stock). If this factor is thought to be important, the proportion of cases that will be treated with pharmaceuticals can be estimated.
- Also, some health problems will require short-term treatment, while others, such as HIV/AIDS, will require lifelong ART, which makes distinguishing between acute and chronic treatments important.
- If discrete types of prescribers (such as doctors compared with paramedical staff) use different treatment regimens, the number of treatment episodes must be compiled separately for each prescriber type.
- The sample data should also specify the number of patient contacts per total population in the area served by the sample facilities. For example, if the total population in the sample area was 3.9 million, and 3,123,408 patient contacts took place per year (as in Table 20-4), on average 0.8 patient contacts occurred per inhabitant. This average could be used to project the number of contacts in another area, as described in Section 20.6 on the proxy consumption method.

Estimating Drug Requirements (WHO/DAP 1988) provides guidelines for surveying health facility records, doing a prospective study of morbidity, and constructing morbidity projections. Chapter 28 of this manual provides guidance for studying medicine use in health facilities.

Step 5. Calculate the number of treatment episodes for each health problem. Two options exist for calculating the number of treatment episodes. If the number of expected patient contacts (outpatient contacts, inpatient admissions, or both) can be estimated directly in the target facilities, the calculations are done in one step based on the number of contacts. If the information on contacts is not reliable, it must be estimated from the population in the area served and the frequency of contacts per inhabitant in the target population.

First, the number of treatment episodes must be adjusted for expected changes in patient use. In Table 20-4, the 3,123,408 contacts from the previous year are separated into two categories: under five years of age and over five years of age. A 5 percent increase is expected (A_U). Therefore, the estimated number of treatment episodes for each age group and each health problem is multiplied by 1.05.

$$C_E = C + (C \times A_U)$$
$$C_E = 3{,}123{,}408 \times 1.05$$

Next, multiply the expected total number of contacts (C_E) by the expected frequency of the problem (F) to obtain the number of treatment episodes (E_T) based on the previous year's data. The estimated total number of patient contacts for the past year is divided by 1,000, so that the denominators of contacts and treatment frequency are the same. (The frequency of treatment episodes is usually expressed in treatment episodes per 1,000 contacts.) This calculation must be done separately for each discrete age range used in the process. If multiple levels of treatment are used, the number of treatment episodes at each level must also be estimated—

$$E_T = C_E \times F$$

In the Table 20-4 example, there were 3,279,578 expected contacts, and in the past year there were 364 episodes of malaria per 1,000 patients under five years old. Therefore, the calculation is—

$$E_T = 3{,}279{,}578 \times 364 \div 1{,}000$$

Step 6. Calculate the quantity of medicines needed for each health problem. For each health problem, the projected number of treatment episodes from step 5 (E_T) is multiplied by the quantity of basic units (Q_E) specified in the guidelines for each age group (and each level of disease severity from step 3). This result is then multiplied by the percentage of cases that are expected to be treated (P_T). The full formula is—

$$Q_T = E_T \times Q_E \times P_T$$

In Table 20-4, 80 percent of patients under age five with malaria, severity level 1, are expected to be treated with paracetamol solution. Therefore, the calculation is—

$$Q_T = 1{,}193{,}767 \times 60 \text{ mL} \times 0.8$$

This calculation yields a total of 57,300,816 mL needed for this treatment regimen.

Step 7. Combine the estimates for each medicine from the various health problems into a master procurement list. This step combines the estimated quantities from different treatment regimens into one master list for procurement. For example, in Table 20-4, paracetamol solution is included in four different treatment guidelines (malaria severity 1 and severity 2, otitis media, and tonsillitis). For the master procurement list, the four separate

estimated quantities must be added to yield the total number of milliliters of paracetamol needed. Master list quantities usually then need to be adjusted to cover factors such as health problems not considered in the basic estimates, shortages in the supply pipeline, and losses caused by theft and wastage.

Step 8. Adjust quantities to cover other health problems. The reliability of morbidity-based quantification increases as the number of health problems addressed increases, but getting reliable data or estimates for all major health problems is rarely feasible. In this situation, the morbidity-based quantification cannot predict total pharmaceutical needs, and medicine needs must be adjusted to cover health problems not addressed in the quantification. Otherwise, stockouts will occur.

Because reliable consumption data from the target system are not available for comparison (or that method would probably have been used for the quantification), the proxy consumption method described in Section 20.6, or "expert opinion," may be used to estimate what percentage adjustment should be made to the morbidity-based estimates.

If data on medicine use are available from another similar health system, extrapolating requirements for twenty or thirty commonly used medicines might be possible, and then determining the average percentage difference between the estimates produced by each method. For example, if the extrapolated method produces estimates that average 10 percent higher than those produced by the morbidity method, the quantities of all medicines could be increased by 10 percent.

An alternative is surveying local experts to determine what percentage of overall patient contacts have been captured in the list of health problems used for morbidity quantification. For example, if local experts agree that about 90 percent of the medicine needs are covered in the standard treatments, estimated quantities could again be increased by 10 percent.

Step 9. Adjust for filling the pipeline and current stock position. So far, the calculations assume that the supply pipeline (see Section 20.3) is relatively intact and that the procurement is only replacing medicines that are being consumed. If major stockouts have occurred that need to be corrected, additional stock will be necessary to fill the pipeline.

If applicable, make adjustments for stock on hand, stock on order, lead time, and safety stock as described in the consumption method (see Section 20.4, step 6) to finalize the preliminary estimates. Because no average monthly consumption data are available to calculate lead time and safety stock, estimate the projected monthly consumption by dividing the total quantity required by the number of months it is to be used. This estimate could be plugged into the formula used to determine safety stock and lead time in the consumption method.

Step 10. Adjust quantities for expected losses. This procedure is discussed in Section 20.3. In most supply systems, losses are a reality, and unless they are considered in the quantification process, stockouts will be unavoidable.

Step 11. Estimate costs for each medicine and total costs. With adjustments made to cover needs for additional health problems, losses, and filling the pipeline (if necessary), the total estimated quantity can be divided by the purchase pack size to determine the number of packs to be ordered. For example, in Table 20-4, 23,612,964 mL of penicillin VK solution are the estimated need. If this medicine is produced in 100 mL bottles, 236,130 bottles should be ordered.

If the basic unit price is used as the basic estimate of cost, multiply it by the expected package size to determine the expected package price. If the available prices are based on package price, enter it directly.

To calculate the estimated procurement value, multiply the expected pack price by the estimated number of packages to be purchased. The prices used in the estimate should be the expected next purchase price, not the last purchase price (see Section 20.3).

Step 12. Compare total costs with budget and make adjustments. Reduce the estimated quantities or the number of medicines or both to conform to budget realities, if necessary. The morbidity-based method lends itself to considering the relative therapeutic value of pharmaceuticals on the list. In the example illustrated by Table 20-4, one might determine that because pseudoephedrine has not proved to be useful in otitis media, the percentages allotted for this medicine could be reduced. The important point is that when reductions are required, they should be made rationally, with the goal of maximizing the therapeutic benefit of expenditures.

20.6 Proxy consumption method

Many supply systems face a severe information deficit, which limits accurate quantification. When neither consumption nor morbidity methods are feasible, the best option is extrapolating from consumption data from another region or health system. The proxy consumption method uses known consumption data from one system, called the standard, to estimate the medicine needs in a similar or expanded system, known as the target.

This method can be population based, defining medicine use per 1,000 population, or service based, defining medicine use per specified patient case, inpatient admission, or rural health center. A complete quantification may use a combination of the two methods, with different denominators for different products.

Table 20-5 Proxy consumption

Pharmaceutical product	Strength	Basic unit	Standard system consumption: 50,000 inhabitants, 32,500 outpatient contacts						Target system extrapolation: 80,000 inhabitants, unknown outpatient contacts				
			Total usage in 6-month period (BU)	Days out of stock	Adjusted average monthly usage (BU)	Adjusted annual usage (BU)	Usage per 1,000 inhabitants	Usage per 1,000 outpatient contacts	Projected requirements in BUs based on 80,000 inhabitants	Pack size	Order quantity (packs)	Probable pack price (USD)	Value of proposed order (USD)
Ampicillin	500 mg	Capsule	59,500	0	9,917	119,000	2,380	3,662	190,400	1,000	191	46.50	8,881.50
Ampicillin	250 mg	Capsule	89,000	34	18,218	218,617	4,372	6,727	349,788	1,000	350	24.70	8,645.00
Ampicillin suspension 100 mL	125 mg/ 5 mL	Bottle	4,128	0	688	8,256	165	254	13,210	1	13,210	0.57	7,529.70
Antihistamine decongestant elixir 250 mL	—	Bottle	853	29	169	2,027	41	62	3,244	1	3,244	1.57	5,093.08
Bacitracin antibiotic ointment	—	Tube	2,414	31	484	5,813	116	179	9,300	1	9,301	0.54	5,022.54
Bendrofluazide	5 mg	Tablet	141,500	30	28,208	338,490	6,770	10,415	541,584	500	1,084	4.60	4,986.40
Benzathine benzyl-penicillin injection	2.4 MU	Ampoule	1,318	0	220	2,636	53	81	4,218	50	85	25.00	2,125.00
Chlorpropamide	250 mg	Tablet	162,000	0	27,000	324,000	6,480	9,969	518,400	1,000	519	27.90	14,480.10
Cimetidine	400 mg	Tablet	24,000	0	4,000	48,000	960	1,477	76,800	1,000	77	17.90	1,378.30
Co-trimoxazole	400/80 mg	Tablet	81,000	0	13,500	162,000	3,240	4,985	259,200	1,000	260	21.00	5,460.00
Erythromycin	250 mg	Tablet	80,500	0	13,417	161,000	3,220	4,954	257,600	500	516	14.50	7,482.00
Ferrous salt/folic acid	200/.04 mg	Tablet	353,000	0	58,833	706,000	14,120	21,723	1,129,600	1,000	1,130	2.30	2,599.00
Fluphenazine decanoate injection 10 mL	25 mg/mL	Vial	324	0	54	648	13	20	1,037	1	1,037	8.63	8,949.31
Indomethacin	25 mg	Capsule	167,000	0	27,833	334,000	6,680	10,277	534,400	1,000	535	3.30	1,765.50
Insulin lente	100 IU/mL	Vial	4,504	0	751	9,008	180	277	14,413	1	14,413	3.91	56,354.83
Methyldopa	500 mg	Tablet	191,000	32	38,579	462,954	9,259	14,245	740,726	500	1,482	30.00	44,460.00
Nystatin skin cream 30 g	100,000 IU	Tube	1,815	0	303	3,630	73	112	5,808	1	5,808	0.67	3,891.36
Oral rehydration salts	—	Sachet	6,820	0	1,137	13,640	273	420	21,824	1	21,824	0.06	1,309.44
Paracetamol elixir 150 mL	120 mg/ 5 mL	Bottle	2,934	0	489	5,868	117	181	9,389	1	9,389	0.65	6,102.85
Paracetamol	500 mg	Tablet	319,000	0	53,167	638,000	12,760	19,631	1,020,800	1,000	1,021	3.90	3,981.90
Penicillin VK suspension 100 mL	125 mg/ 5 mL	Bottle	1,447	0	241	2,894	58	89	4,630	1	4,631	0.71	3,288.01
Salbutamol liquid 150 mL	2 mg/5 mL	Bottle	1,063	0	177	2,126	43	65	3,402	1	3,402	0.83	2,823.66
Tetracycline HCl	250 mg	Capsule	62,000	0	10,333	124,000	2,480	3,815	198,400	1,000	199	12.00	2,388.00
Vitamins, multiple	—	Tablet	259,000	0	43,167	518,000	10,360	15,938	828,800	1,000	829	3.80	3,150.20
												Total order cost:	212,147.68

Note: BU = basic unit; USD = U.S. dollars; MU = mega-unit; IU = international unit.

Example

Table 20-5 illustrates the proxy consumption method of extrapolating consumption of outpatient pharmaceuticals from a standard health system to the target health system. The data in Table 20-5 do not represent any particular country.

Steps in the quantification

Step 1. Select the standard system for comparison and extrapolation. The standard facilities should, if feasible, closely resemble the region or country for which the estimate is made in terms of geography and climate, patient population served, morbidity patterns, prescribing practices, standard treatment guidelines, essential medicines lists, and pharmaceutical supply status. Representative standard facilities should be selected at each level of health care that has a different medicines list, morbidity patterns, or prescribing practices. They should have an adequate and uninterrupted pharmaceutical supply (but not greatly overstocked), fairly rational prescribing practices, and complete and accurate records of patient contacts and pharmaceutical inventory movement. Of course, finding an ideal standard may not be possible, but an effort should be made to select the best standard data available.

Step 2. Develop the medicines list. See Section 20.3 for a discussion of issues.

Step 3. Establish the period to be covered in review. Determine the number of months' worth of data to be reviewed in the standard system. See Section 20.4 for a discussion of these issues.

Step 4. Review records from the standard system to compile contact or population data. Use available reports on patient contacts in the standard system; if reports with suitable data are not already compiled, a survey of standard facilities can be done to determine the number of patient contacts during the period established. A similar survey might be carried out in the target system, but if the target system has had a severe problem with stockouts, the attendance data may not reflect the number of contacts that can be expected when medicines are available.

Step 5. Establish the denominator for extrapolation. The denominator used to extrapolate consumption can be either population in the area served or number of patient contacts, depending on the data obtainable through step 4. Whichever one is used, the denominator is usually thousands of patient contacts or thousands of inhabitants in the region (as in Table 20-5). In very large systems, using tens of thousands or even millions of contacts or inhabitants might be preferable.

Step 6. Determine the consumption rate in the standard system. For each medicine, produce an adjusted average monthly consumption (see Section 20.4). The average monthly consumption is multiplied by twelve to obtain the adjusted annual consumption (or by the applicable number of months for any other period that was determined in step 3). Then divide the adjusted annual consumption by the number of thousands of contacts or inhabitants to establish the consumption rate.

Step 7. Extrapolate the standard system's consumption rate to the target system. Multiply the standard consumption rate for each medicine by the estimated number of thousands of contacts or inhabitants in the target system to yield the projected requirements in the target system.

Step 8. Adjust for expected losses. Because these estimates are very rough and the percentages of losses that were experienced in the standard system may be unclear, adjusting for losses may not be realistic. However, if known losses exist, add a percentage allowance, at least for vital medicines (see Section 20.3).

Step 9. Estimate costs for each medicine and total costs and make adjustments. Multiply the projected quantities for each medicine by the most accurate prediction of the next procurement cost and reconcile that product with available funds, as discussed in Section 20.3.

20.7 Service-level projection of budget requirements

This method is used to estimate financial requirements, not specific medicine quantities, for pharmaceutical procurement on the basis of costs per patient treated at various levels of the same health system or, with great caution, data from other health systems. It does not forecast needs for specific medicines but provides a clear, logical, one-page justification of pharmaceutical financing requirements. Generalizing from one region in a country to another region in the same country is more reliable than extrapolating data to a different country.

Like the proxy consumption method, this extrapolation method produces rough estimates because significant, but not always apparent, variations may exist between the target health system and the system used as a source of standard data. Possible sources of error include prescribers in the target system using a different mix of medicines from those in the source system, variability in disease frequency and the number of patient attendances per facility, and differences in the effectiveness of procurement and financial management systems in the two settings.

The main requirement for this method is a fairly reliable estimate of average medicine cost per patient attendance and average numbers of patient attendances at various levels of the standard health system. This information may not be readily available, but it can be compiled through a special study in one part of a health system where pharmaceutical

Table 20-6 Service-based budgeting of essential medicines requirements

Type of facility and patient (1)	Number of facilities (2)	Average annual workload per facility (3)	Average cost per attendance or bed-day from sample facilities (USD) (4)	Annual pharmaceutical needs (USD) (5)
Provincial general hospitals	13			
Inpatients		176,000 bed-days	0.55	1,258,400
General outpatients[a]		195,000 attendances	0.55	1,394,250
Prenatal patients		19,500 attendances	0.15	38,025
District hospitals	42			
Inpatients		57,000 bed-days	0.50	1,197,000
General outpatients		85,000 attendances	0.50	1,785,000
Prenatal patients		11,000 attendances	0.15	69,300
Subdistrict hospitals	35			
Inpatients		21,500 bed-days	0.45	338,625
General outpatients		60,000 attendances	0.50	1,050,000
Prenatal patients		7,500 attendances	0.15	39,375
Rural health training centers	38			
Inpatients		20,000 bed-days	0.40	304,000
General outpatients		40,000 attendances	0.45	684,000
Prenatal patients		5,000 attendances	0.15	28,500
Health centers	315			
Inpatients		1,500 bed-days	0.20	94,500
General outpatients		32,000 attendances	0.40	4,032,000
Prenatal patients		4,000 attendances	0.15	189,000
Dispensaries	1,114			
General outpatients		18,000 attendances	0.30	6,015,600
Subtotals				
Provincial general hospitals				2,690,675
District and subdistrict hospitals				4,479,300
Rural health training centers				1,016,500
Health centers and dispensaries				10,331,100
Total				18,517,575
Per capita requirement				0.686

Source: Adapted from Ministry of Health, Government of Kenya. 1992. Workload-Based Annual Budget for Pharmaceuticals and Non-Pharmaceuticals.
Note: USD = U.S. dollars. The exchange rate used is Kenya shillings 60 to USD 1. Population equals 27 million (estimate for 1993).
[a] This category includes (for all levels) adult and pediatric general outpatients, casualty, and specialty clinics.

supplies are consistent and where treatment practices are considered to be representative. The following data must be compiled—

- The average number of curative and noncurative outpatient attendances and inpatient bed-days and/or other type of patient contact for each type of facility in the source health system
- The average cost per outpatient curative and noncurative attendance and per bed-day and/or other type of patient contact in each type of facility in the source health system

Example

Table 20-6 shows the method applied to estimate financial requirements for pharmaceutical procurement in Kenya.

Steps in the quantification

Step 1. Establish the categories of facilities and determine the number in each category. List each type of facility to be quantified for in the first column. The number of facility categories used depends on the size and scope of the target health system. Table 20-6 shows six significant levels,

ranging from provincial general hospitals to dispensaries (see column 1). The number of facilities in each category is entered in the second column.

Step 2. Determine the patient contact denominators for each type of facility, and compile or estimate the average number of patient contacts of each type at each category of facility. These data can be obtained from centrally available information or from a special-purpose survey to determine the average number of patient contacts for each category of facility. For each category, several different types of patient contact may result in pharmaceutical costs. Minimally, inpatient and outpatient costs and contacts should be separated.

In the example in Table 20-6 (column 3), in all but the lowest-level facility (dispensaries) contacts were separated into three types: inpatient, with bed-days as the common denominator; and general outpatient and prenatal visits, each with attendances as the denominator.

Step 3. Calculate the average cost per contact. The average cost per attendance and/or bed-day is derived by dividing the total pharmaceutical purchases for the sample facility or facilities that are providing the source of data for extrapolation in the class by the total attendances or bed-days. In facilities with both inpatients and outpatients, the fraction of total procurement costs attributable to inpatients, outpatients, and noncurative visits must be estimated. Column 4 in Table 20-6 shows the average cost data based on the source data from the sample facilities.

Step 4. Calculate the total projected pharmaceutical costs. Multiply the average number of patient contacts for each facility (column 3 in Table 20-6) by the number of facilities (column 2). This result is then multiplied by the average pharmaceutical cost for that type of patient in that type of facility (column 4), which estimates total financial requirements for each type of attendance in each type of facility (column 5). These totals are then summed to produce the total financial requirements. The result is an estimate of the probable pharmaceutical costs, on average, for each type of facility and for the system as a whole. The results are not necessarily applicable to any specific facility. ■

References and further readings

★ = Key readings.

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ASSESSMENT GUIDE

Availability of data

- Do the medical stores and health facilities have current and accurate records of medicine usage?
- What data and reports are maintained centrally (or at other levels of the health system) on outpatient attendances, inpatient bed-days, or other counts of patient contacts?
- For how many diseases does reliable information exist on numbers of cases reported or treated annually?
- Are there official standard treatment guidelines for certain diseases? If so, how many diseases are covered, and how is compliance monitored?

Management of quantification

- Do a formal workplan and schedule for quantification exist?
- Does a quantification committee exist with representatives from health facilities (prescribers and pharmacy staff), government (heads of special disease programs and health information systems staff), central medical store (or other group handling pharmaceutical distribution), and donors?
- Is quantification done manually or by computer? If computers are used, which offices have computers, and what software program is used for quantification? Which levels of warehouses and facilities have computerized procurement and inventory records?
- Is quantification decentralized or managed centrally? Which offices and levels of the system are responsible for quantification?
- If quantification is decentralized, what training is or has been provided to responsible staff members at peripheral facilities?
- Are preprinted quantification and/or data-collection forms distributed to the facilities?

Quantification methods

- What quantification methods are used to forecast pharmaceutical and budget needs?
- Are actual procurement quantities and costs compared at the end of each year against the initial quantification estimates?
- Is the supply system pipeline functioning well, or have pharmaceutical shortages been frequent or widespread? If shortages have occurred, do only certain medicines present problems, or do shortages exist for many different medicines?
- What information is used to predict procurement costs? If last year's prices are used, how are they adjusted?
- What standard formulas are used to calculate order quantities?
- Is there an essential medicines list or health system medicine formulary that is used for quantification? Is procurement limited to medicines on the list?
- What techniques are used to adjust initial estimates to conform to budget realities?