CHAPTER SEVEN

STAFFING

The efficient and effective allocation of resources is perhaps the greatest challenge facing the health care manager today. Human capital resources represent the largest portion of the budget for most health care organizations, and therefore are of particular concern. In manufacturing, deciding on the proper staffing levels and skill mix is relatively simple. Demand for the manufactured product is predictable within certain limits, and unanticipated demand can be met with inventory surplus. Health care managers, however, face considerable uncertainty—that is, patient census and acuity levels can vary dramatically daily or even hourly. Health care managers struggle with chronic staffing shortages or surpluses, over-budget labor costs and dissatisfied patients and staff. Balancing the quality of care with patient, physician, and nurse satisfaction is another significant challenge.

So how is the health care manager to cope with such problems created by uncertainty? One solution is to staff for peak levels at all times; however, common sense tells us that would soon become prohibitively expensive. Yet, staffing only for the minimal census and acuity levels would lead to overworked staff, patient dissatisfaction at best, and at worst, poor outcomes of care. Minimal staffing levels could be increased with part-time labor in times of high demand; but paying part-time or temporary staff at a premium rapidly raises costs. A solution is using flexible staffing methodologies. In flexible staffing, a core level of staff is established based on a long-term assessment of staff needs; that is augmented by

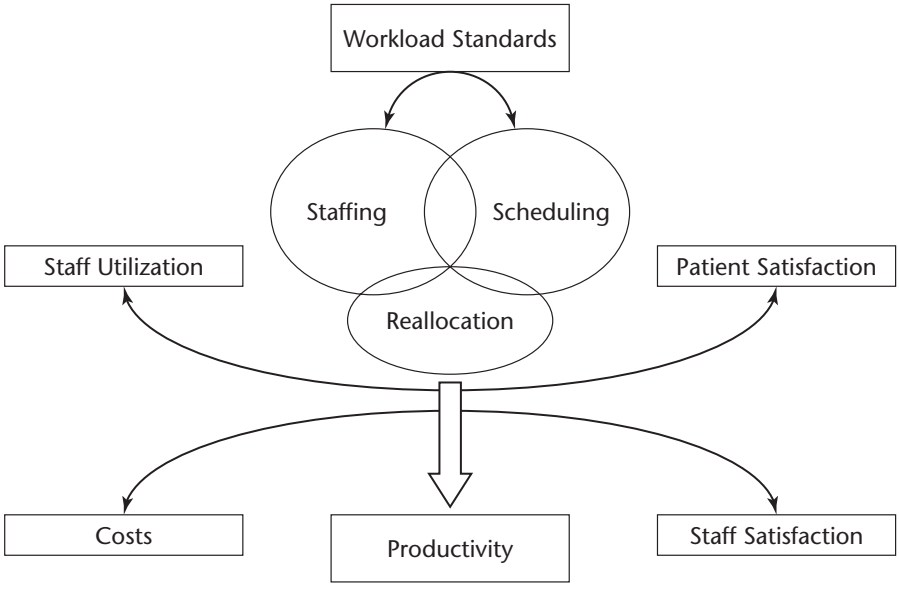
short-term (daily) adjustments using various methods to match staffing levels to patient needs.

This chapter examines vital staffing and scheduling issues that the health care manager must handle. How many nurses are needed, and how many lab technicians? What if patient demand suddenly rises, or several nurses are sick? Is turnover high because the demand on the nurses' workload is too high? After deciding on staffing levels, the manager must develop a successful work schedule. Should we use a 4-day, 10-hour shift, or a 5-day, 8-hour shift? Or is a 12-hour shift preferable? How satisfied are the nurses with the scheduling process, and how is their level of satisfaction affecting patient care? These questions, among others are addressed here and in Chapter Eight.

Workload Management Overview

Workload management is a general term that refers to staffing and scheduling operations by an organization's manager. The three duties of workload management: staffing, scheduling, and reallocation, are not mutually exclusive, as illustrated in Figure 7.1. Figure 7.1 also shows the direct link among staffing, scheduling, and productivity variables.

FIGURE 7.1. WORKLOAD MANAGEMENT.



First of all, let us define those three components of workload management. Staffing procedures decide on the appropriate number of full-time employees (FTEs) to be hired in each skill class (RN, LPN, aides). Staffing decisions are generally made annually, although taking seasonal variations into account; thus staffing decisions are tactical.

Scheduling establishes when each staff (nurse) will be on or off duty, and on which shifts they will work. Weekends, work stretches, vacation requests, and potential sick days are all important considerations in scheduling decisions, which are generally considered to be operational.

The third component is the reallocation of human resources, which fine-tunes the previous two decisions. Reallocation is a daily, if not a shift-by-shift decision. The number of float nurses needed on each unit is determined daily according to unforeseen changes in need as classified by a patient acuity system. We will discuss reallocation later in section "Daily Adjustments."

Although staffing, scheduling, and reallocation are the core responsibilities of workload management, other tasks, other dimensions too, are important. The development of workload standards, for instance, is a prerequisite for effective workload management. Both workload management and workload standards development significantly affect productivity and productivity-related variables: staffing costs, job-satisfaction levels, and staff utilization. The following sections examine each of these aspects of workload management more closely.

Establishment of Workload Standards and Their Influence on Staffing Levels

Recall that staffing refers to deciding on the number of full-time equivalents to be hired for a particular unit. Because labor costs can represent 40 percent or more of a hospital or other health care organization's budget, it is vital to hire only the necessary staff. Equally important, however, is to maintain high quality patient care. Patient and staff satisfaction are also considerations, as is the premium paid to temporary staff needed on short notice.

To assist in staffing decisions, the health care manager must develop standards. A work standard is defined as the predetermined allocation of time available for a unit of service, to maintain an appropriate level of quality (Kirk, 1986.). The unit of service varies with the department. Nursing units, for instance, use the patient day as the unit of service. Because patient days are usually adjusted for acuity, the work standard is referred to as an acuity-adjusted standard. When the unit of service is a procedure, such as a laboratory test or x-ray, the standard is a procedural one. Examples of work standards often used today are found in Table 7.1.

TABLE 7.1. EXAMPLES OF WORK STANDARDS.

Description of Work	Standard
Nursing care hours per patient day (Medical-Surgical Unit)	4.5
Nursing care hours per patient day (Coronary ICU)	12.0
Physical therapist hours per patient treatment	0.5
Indirect nursing hours per ER visit	0.7
Technician hours per CT scan	0.4

Historically, standards were based mainly on the average census levels of the entire organization. Queuing analysis or other forecasting techniques were applied to the patient census data to base staffing levels on previous admissions and expected lengths of stay. Although these methods did estimate overall hospital census variation with relative accuracy, their application to individual hospital units was limited. Hospital occupancy could be predicted with relative accuracy in the aggregate; however, census variations at the departmental level fluctuated widely, limiting the effectiveness of forecasting techniques. The success of the various forecasting methods also depended on the accuracy of the length-of-stay estimate. In the past such estimates often came from the physicians and could be inaccurate (Walker, 1990). Today, however, precise estimates of length of stay can be obtained from hospital information systems.

We will focus on three major areas to assist in staffing decisions: 1) patient acuity and classification systems and their usefulness for creating work standards; 2) the methods for developing work standards internally, with examples of how the standards can be translated into FTEs; 3) some of the controversies about the development of professional and industry work standards.

Patient Acuity Systems

According to Warner (1976), there are three important components of any staffing decision. 1) A reliable patient classification and acuity system must be used to determine the need for services based upon such patient specific characteristics as age, diagnosis, acuity, and so on. 2) Time standards should be established that reflect the time necessary to care for each patient within each unit, using the patient classification system. 3) A method must be adopted to convert the total number of minutes of coverage needed into the appropriate number of full-time equivalents and FTE skill mix. The conversion method must adjust for factors such as expected sick days, vacations, and substitution among nursing skill levels. This sub section discusses focus on Warner's first requirement—development of

a patient classification system. The second and third requirements will be discussed in detail.

The modern hospital relies greatly on the departmental acuity-adjusted census, rather than on an aggregate census estimate, to establish work standards. Shukla (1991) notes that fewer subsequent adjustments to staffing levels are needed when an admissions monitoring system is based on the unit's patient care requirements rather than on unit census. Indeed, the use of an acuity standard is intuitively appealing. For example, the time and supervision per day required to care for an elderly gentleman in the intensive care unit is surely more than that required for a patient recovering from a minor surgical procedure. When such differences are not reflected in the nursing workload standards, the number of FTEs would be based solely on the fact that two patients were in the hospital at a particular time (patient census), regardless of the time needed to treat each. The result would be an inappropriate staffing pattern.

There is another reason for adopting acuity-adjusted standards. Today the population entering the hospital is sicker than it was a decade ago, and that trend is likely to continue. Coupled with this greater acuity is a decline in reimbursement and growing emphasis on cost control. The use of acuity-adjusted work standards can help to ensure that staffing is adjusted to meet the needs of a sicker population, thus maintaining a high quality of care.

In order to adopt acuity-adjusted standards, the health care organization must first implement a patient acuity system, which is a workload measurement system that measures the amount of care required by any given patient (Piper, 1989). Patient acuity systems, often called patient classification systems, are used routinely in nursing, since a Joint Commission standard requires nursing departments to "define, implement, and maintain a system for determining patient requirements for nursing care on the basis of demonstrated patient needs, appropriate nursing intervention, and priority for care" (Piper, 1989; p. 43). However, it is important to understand that acuity level is not synonymous with severity of illness. An extremely ill individual, for example someone with chronic obstructive pulmonary disease (COPD), may require only basic, palliative care. On the other hand, a less severe condition can nevertheless require large time commitments from the staff.

According to Piper (1989; p. 46), acuity systems fall into two categories—prototype and factor-analysis systems. Prototype systems classify patients according to the type of care needed. Patients are usually grouped into one of three to ten levels based upon expected nursing time commitments, diagnosis, mobility, medications, and education needed for either the patient or the family. Prototype systems are relatively simple to set up and use, but they are highly subjective.

A factor analysis system establishes classifications by summing the relative values assigned to individual tasks or indicators of patient need. For instance, on

a scale of activities of daily living (ADL), a patient needing no assistance may receive a 10, a patient needing minimal assistance in one or two ADLs may receive a score of 20, and a patient needing total care in five or six areas will receive a 50. Factor analysis techniques provide a highly developed set of workload data. The health care manager can identify the reasons for fluctuations in patient acuity, which can assist in deciding on the staff skill mix needed for the unit. However, developing a factor analysis method is both time consuming and difficult.

An example of a factor-analysis system is the GRASP system. This workload management system was designed to help resolve inefficiencies that arose from fluctuating workloads. The program's goal was to replace state and national average standards with internally developed standards, to prevent over- and understaffing. The approach of the system was simply to match patient care needs with the available nursing care.

GRASP System. The GRASP system was developed as a management information tool that could help reduce errors and inefficiencies arising from uncontrolled and fluctuating nursing work loads. The goal, as stated before, was to provide local-level data, rather than national averages, for use in staffing budget determination. The system essentially matches nursing care available to patient care needs.

The amount of nursing care available is easy to measure. GRASP defines one hour of nursing care as a single nursing care unit (NCU). Thus, one nurse who works 10 hours equals 10 NCUs. On the contrary, patient care needs are much more difficult. Strict reliance on census figures, or simply the number of beds available, is inadequate. Instead, the care needs of each individual patient must be collected—GRASP is designed to accomplish this task. GRASP considers all patient-related variables in its determination of the amount of care each patient should receive daily. One hour of required patient care is defined as one patient care unit (PCU); the care needs of each patient in terms of PCUs are assessed upon admission and reassessed daily for the patient's length of stay.

The total amount of care needed for each patient is determined by giving a point value to each of the following areas: direct physical care, indirect care, and teaching time. Delay and fatigue factors are also added. Physical care activities include diet, toilet, cleanliness, vital signs, turning and assisted activities, medications, suctioning, and respiratory aids. Time standards for each were developed (which must be modified for each hospital using the system).

Within each nursing unit, a wall chart lists these activities and assigns a point value to each (each point is equal to 6.5 minutes). Daily assessment of needs is made by circling the number of points that corresponds to the level of care required of the patient based on physician orders. The points are then totaled for each patient. The total points represent 85 percent of total physical care. The

remaining 15 percent includes unmeasured care activities, and is assigned on a predetermined basis.

Indirect care is relatively constant for all patients, and therefore is not assessed on an individual basis. A standard time for teaching and emotional support is also added. Finally, all time standards are increased by 12 percent, an industrial engineering standard to account for interruptions, delays, and fatigue. The number of points is then converted to the number of PCUs required (Meyer, 1978).

Another similar system was developed by the Medicus Sytems Corporation and is called the Nursing Productivity and Quality System (NPAQ).

NPAQ System. This system was designed to assist in the area of nursing resource management. The development of the system's methodology by Medicus Systems Corporation cost several million dollars of research and development spread over more than ten years.

The Medicus patient classification system uses factor evaluation techniques that objectively categorize patients based on 37 key indicators (40 for psychiatry). Five categories are created based on the number of care hours the staff should provide over a given 24 hour period. The classification process is usually done using a preprinted classification tool. Each day, nurses on each unit mark the indicators appropriate for each patient, a process which generally takes less than 10 minutes per unit (15–30 patients). The scoring of the forms is automated and each indicator is weighted during the scoring process.

The classification process produces two parameters which describe the nursing workload requirements for the unit—a workload index and average acuity index. Together, these indices provide a basis for the objective determination of nursing workload per unit. This workload value can be converted into staffing and skill mix requirements using a separate module of the Medicus system—the Staff Planning and Allocation Module (Medicus Systems Corporation, 1989).

Patient acuity systems are necessary to accurately calculate the core staffing level necessary to meet patient requirements. Tables 7.2 and 7.3 illustrate how patient acuity systems operate. Table 7.2 lists the number of patients in a medical/surgical unit on each day of January 2005. The census hours have been collected retrospectively from a hospital information system. Also recorded are the numbers of patients in each of the acuity levels, with level one patient requiring the least amount of care, and level four the most.

Remember that historically, staffing levels were based mostly on total census, which as we noted could lead to staffing inefficiencies. Compare, for instance, January 5 (census = 9) and January 7(census = 12). If the staffing requirements were based solely on census, a greater number of FTEs would be used on January 7. However, when we look at the acuity levels of the patients, we observe that nearly 80 percent of the patients on January 5 are in categories three and four, compared

TABLE 7.2. DAILY CENSUS, REQUIRED LABOR HOURS, AND ACUITY LEVEL STATISTICS FOR A MEDICAL/SURGICAL FLOOR.

		Census				Based on Patient Classification—Required Hours per Patient Day				Number of Patients in Acuity Level			
Date	*Day of Week*	A.M.	P.M.	Night	Total	A.M.	P.M.	Night	Total	1	2	3	4
01/02/05	SUN	12	13	12	12.3	2.3	1.4	0.8	4.5		6	7	
01/03/05	MON	13	12	12	12.3	1.9	1.6	0.9	4.4		6	7	
01/04/05	TUE	22	22	10	18.0	2.1	1.7	1.0	4.7	1	5	16	
01/05/05	WED	9	9	9	9.0	2.1	1.7	1.0	4.8		2	7	
01/06/05	THU	11	11	9	10.3	1.8	1.4	0.9	4.1	3	3	5	
01/07/05	FRI	12	12	12	12.0	1.6	1.3	0.7	3.6	6	4	2	
01/08/05	SAT	12	12	11	11.7	2.0	1.6	0.9	4.6	3	3	4	2
01/09/05	SUN	14	14	14	14.0	1.7	1.4	0.8	3.9	4	3	5	
01/10/05	MON	14	13	13	13.3	2.0	1.6	1.0	4.6	2	4	7	
01/11/05	TUE	12	12	10	11.3	1.3	1.1	0.6	3.0	7	5		
01/12/05	WED	18	20	13	17.0	2.1	1.7	1.0	4.8		4	14	
01/13/05	THU	13	13	13	13.0	1.9	1.5	0.9	4.3	2	4	6	
01/14/05	FRI	13	13	13	13.0	2.0	1.5	0.9	4.4	2	2	9	
01/15/05	SAT	13	12	10	11.7	1.9	1.5	0.9	4.2	2	4	7	
01/16/05	SUN	11	12	11	11.3	1.7	1.3	0.8	3.7	3	4	3	
01/17/05	MON	11	10	10	10.3	1.9	1.5	0.9	4.2		6	5	
01/18/05	TUE	9	10	8	9.0	2.0	1.5	0.9	4.5		3	6	
01/19/05	WED	9	9	9	9.0	1.9	1.4	0.9	4.2	1	3	4	
01/20/05	THU	10	11	10	10.3	1.6	1.3	0.8	3.7	1	7	1	
01/21/05	FRI	13	13	13	13.0	1.8	1.5	0.9	4.1	2	4	5	
01/22/05	SAT	12	12	12	12.0	1.8	1.5	0.9	4.2	2	6	3	1
01/23/05	SUN	13	13	13	13.0	2.5	2.0	1.2	5.7		1	4	2
01/24/05	MON	12	10	6	9.3	1.9	1.6	1.0	4.5	1	7	2	2
01/25/05	TUE	8	8	8	8.0	1.3	1.1	0.6	2.9	4	2		
01/26/05	WED	6	5	5	5.3	1.9	1.6	0.9	4.4	1	2	3	
01/27/05	THU	7	5	5	5.7	1.4	1.1	0.6	3.1	3	4		
01/28/05	FRI	6	6	6	6.0	2.0	1.4	0.8	4.2	1	1	4	
01/29/05	SAT	7	7	7	7.0	1.8	1.3	0.8	3.9	2	1	3	
01/30/05	SUN	9	9	9	9.0	1.8	1.3	0.7	3.8	2	2	3	
01/31/05	MON	9	9	9	9.0	1.9	1.6	0.9	4.4	1	3	5	
Statistics													
Mean		*11.3*	*11.2*	*10.1*	*10.9*	*1.9*	*1.5*	*0.9*	*4.2*	*18.9*	*32.7*	*45.9*	*2.5*
Minimum		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum		22.0	22.0	14.0	18.0	2.5	2.0	1.2	5.7	7.0	7.0	16.0	2.0
St. Deviation		3.8	4.4	3.1	3.5	0.5	0.3	0.2	0.9	1.5	1.9	3.5	0.7

TABLE 7.3. AVERAGE CENSUS, REQUIRED LABOR HOURS, AND ACUITY LEVEL STATISTICS FOR A MEDICAL/SURGICAL FLOOR.

		Census				Based on Patient Classification—Avg. Required Hours per Patient Day				Number of Patients in Acuity Level			
Year	Month	A.M.	P.M.	Night	Total	A.M.	P.M.	Night	Total	1	2	3	4
2003	January	14.1	13.8	13.8	13.9	1.8	1.5	0.9	4.1	26.3	26.9	45.0	1.7
	February	14.9	14.3	14.1	14.4	1.8	1.5	0.9	4.1	26.2	31.8	38.6	3.3
	March	15.3	14.9	14.6	14.9	1.9	1.5	0.9	4.3	19.7	27.5	48.8	3.5
	April	18.7	18.4	18.2	18.4	1.8	1.4	0.8	4.1	27.3	26.4	44.3	2.0
	May	19.8	19.5	19.3	19.5	2.0	1.6	0.9	4.4	21.7	21.0	52.7	4.3
	June	19.2	18.5	18.3	18.7	1.8	1.5	0.9	4.2	23.8	24.9	50.2	1.1
	July	18.4	17.5	17.0	17.6	2.0	1.6	0.9	4.5	15.9	24.8	53.7	4.9
	August	22.8	22.2	21.9	22.3	1.8	1.5	0.9	4.2	26.5	29.2	38.6	5.2
	September	19.9	19.4	18.7	19.3	1.7	1.4	0.8	3.9	35.3	28.4	33.4	2.9
	October	22.1	20.9	20.6	21.2	1.6	1.3	0.8	3.7	38.0	29.2	31.4	1.4
	November	17.1	16.5	15.7	16.4	1.8	1.5	0.8	4.1	29.2	26.3	40.0	4.2
	December	10.2	9.6	9.2	9.7	1.7	1.4	0.8	4.0	28.1	26.8	43.8	1.3
2004	January	20.9	19.8	19.3	20.0	1.8	1.4	0.8	4.1	27.7	27.7	42.3	2.3
	February	19.1	18.7	18.1	18.6	1.9	1.5	0.9	4.2	22.4	31.6	42.2	3.7
	March	16.6	16.0	15.6	16.1	1.8	1.4	0.8	4.1	25.1	30.2	41.6	3.1
	April	4.5	4.4	4.1	4.3	1.9	1.5	0.9	4.3	12.2	39.1	43.7	5.0
	May	9.7	9.5	8.9	9.4	1.9	1.5	0.9	4.2	14.1	36.8	47.1	2.0
	June	8.3	8.5	7.8	8.2	1.9	1.5	0.9	4.2	15.0	33.3	50.4	1.2
	July	8.7	8.2	7.5	8.1	1.7	1.4	0.8	4.0	18.0	43.4	38.1	0.6
	August	8.0	7.5	6.7	7.4	1.6	1.4	0.8	3.7	23.1	44.8	32.1	
	September	7.4	6.9	6.5	6.9	1.8	1.4	0.8	4.0	15.4	44.6	38.2	1.7
	October	6.4	6.1	5.3	5.9	1.8	1.5	0.9	4.1	13.0	39.7	47.3	
	November	13.5	13.2	12.7	13.1	1.8	1.4	0.8	4.1	28.7	30.4	38.3	2.6
	December	13.3	12.6	11.2	12.4	1.6	1.3	0.7	3.7	30.3	43.6	25.7	0.4
2005	*January*	*11.3*	*11.2*	*10.1*	*10.9*	*1.9*	*1.5*	*0.9*	*4.2*	*18.9*	*32.7*	*45.9*	*2.5*
Statistics													
Mean		14.4	13.9	13.4	**14.0**	1.8	1.5	0.8	**4.1**	23.3	32.0	42.1	2.4
Minimum		4.5	4.4	4.1	4.3	1.6	1.3	0.7	3.7	12.2	21.0	25.7	0.0
Maximum		22.8	22.2	21.9	22.3	2.0	1.6	0.9	4.5	38.0	44.8	53.7	5.2
St. Deviation		5.3	5.1	5.2	5.2	0.1	0.1	0.0	0.2	6.7	6.7	6.8	1.5

to only 17 percent of the patients in these categories on January 7. The greater acuity is reflected in the required hours per patient day (HPPD). Notice that the HPPD for January 5 are 4.8, and for January 7, 3.6 hours. Multiplying the census times the required HPPD, we see that the acuity-adjusted census is the same for both days: 43.2 hours of care are required. Viewed in this way, the staffing requirements for both days are the same, although the skill mix may differ.

Similarly, even when census levels are the same for two days, the number of nurses required for each day may not be equal if patient needs differ. On January 21 and January 23, for instance, the patient censuses are equivalent (census = 13.0 patients). However, on January 23, the required hours of direct care are 1.6 hours more. The reason for this difference is seen in the distribution of patients across the various acuity levels; on January 21, a higher percentage of patients are in the low acuity categories. Again despite similar census patterns, more staff members are needed on January 23.

As seen in the above example, the patient acuity system translates the acuity levels of the patients into a time estimate for the direct care hours required of the FTEs. This direct time estimate can then be translated into the standard from which the number of FTEs need can be determined. The ability to develop required care hours from automated patient classification systems can save significant time and money. The methods used to first assign the time levels associated with each census and acuity level, and the methods used to convert these standards into the number of FTEs needed are discussed in the next section.

The Development of Internal Workload Standards

Workload standards can be either adopted from external agencies or developed internally. Although externally developed standards have the advantage of lower cost, internally developed standards often result in more accurate staffing decisions. The desired balance between costs and accuracy is a decision that rests with each institution and should not be generalized. An important component of the decision, however, should be a retrospective analysis of past staffing problems and their costs to the institution.

Before staffing can begin, workload standards must be adopted; as noted, developing them internally often results in more adequate staffing. The first step in the internal development of these standards is careful identification and documentation of the activities in the department or unit being examined. All activities performed should be carefully identified and documented, to reduce the possibility of misinterpreting the data, and also to improve the usefulness of the data in future evaluations (Page and McDougall, 1989; p. 71). Flow and process charts can document activities adequately.

It is also helpful to classify all the activities recorded as either variable or fixed. Fixed activities are those that do not vary with the volume of services. Examples include routine janitorial work, inventory checks, and team meetings. Variable activities do fluctuate with the services rendered and include x-rays, recording of medical records, and billing. Activities also can be classified as either direct or indirect. Direct care activities occur as care of the patient; indirect activities are

support services, for instance, documenting medical records, scheduling, x-ray transport, and code cart checks.

After identifying the activities of the department, the times to perform them must be estimated. It is not feasible, however, in terms of costs and time to examine all activities within a department, and it also would seem fruitless to develop time standards for activities that occur only rarely or that require little time. But whatever activities are chosen must be representative of the workload of the entire department. Some departments use an 80/20 rule, choosing indicators from the 20 percent of activities that make up 80 percent of the volume; data on service volume can often be obtained from the hospital's billing system. However, some departments naturally require more specific and detailed time estimates than others. Remember that the more detailed the desired estimates, the greater the financial and time commitments for data collection and analysis, and therefore the better the case for using external standards.

Departments that offer a wide variety of procedures without similar service times should examine each activity separately. For example, orthopedic surgeon A, who lives in a small town and faces a relatively constant service mix, could develop standards based on the average time to set a broken leg. However, orthopedic surgeon B, who does a number of knee replacements and hip surgeries, would find that surgeon A's method would severely underestimate the time required for his work. Therefore, surgeon B should develop categories of services (broken legs and arms, knee and hip replacements, back surgeries, and like).

Many methods are available to measure the time necessary to perform the activities detailed in step one of the staffing process. These methods include estimation, historical averaging, predetermined time systems, work sampling, engineered time study, stopwatch methods, continuous work sampling, and micro motion study. More specifically:

- Estimation is low in cost and takes minimal time; biased by the estimator; does not always consider current internal and external conditions.
- Historical averaging is easiest and least expensive, and therefore widely accepted; can be imprecise and perpetuate inefficiencies. Example: a unit worked 10,000 hours to treat 2,000 patient days. Thus, 5,000 nursing care hours per patient day are needed.
- Logging is a low-cost data collection method where staff members log their activities and the times needed to complete them. It can be used to identify time values for patient classification system categories; can be used to determine total time involvement by classification, by nursing plan, by diagnosis, or by standards of care; this method is often time-consuming and prone to recording errors or bias.

- Time studies and work sampling are random observations that measure time spent doing certain activities (see Chapter Six for detailed discussions); often done by an outside source, for example a consultant or industrial engineer (Kirk, 1986; p. 5).

After the estimate of the total hours necessary for the given activity is made, it is divided by total volume to determine the workload standard. For example, if personnel in the radiology department work 1,500 hours to perform 3,000 x-rays, the workload standard would be 30 minutes per x-ray performed (1,500 hours/3,000 x-rays). Again, a standard such as this could be obtained from industry or from professional publications, which provide ratios that should then be adjusted for the unique characteristics of the individual institution. Whatever the source of a standard, it is used to compute the required number of FTEs.

Utilization of FTEs. Another important issue for staffing levels is the expected utilization of employees—that is, setting the performance expectations for the unit or department (Page and McDougall, 1989; pp. 75–76). In actuality, many operational factors prevent 100 percent utilization. Such factors may be controllable or uncontrollable. Controllable factors are staff scheduling, avoidable delays, scheduling of vacations, and reducing downtime by letting unnecessary employees go when the workload permits. Uncontrollable factors affecting utilization include substantial work fluctuations due to changes in census, physicians' ordering patterns, sick leave, and market constraints limiting the availability of part-time staff. The factors influencing the desired utilization of any specific department must be established by the health care manager.

Page and McDougall (1989), although noting that utilization targets are difficult to determine, suggest three possible estimation methods: 1) Review the historical levels of utilization among administration, management engineering, and department management to negotiate an acceptable target. 2) Quantify delays and downtime, decide what delays are unavoidable and determine utilization based upon those delays, allowing for acceptable levels of downtime. 3) Calculate an "overall weighted average utilization based upon the distribution of work load by shift and the accepted utilization levels by shift." An example of this third method, for a hospital laboratory, is presented in Table 7.4.

As mentioned above, the standard can be either based on acuity or procedurally based. There are subtle differences in how each method is used, so we present an example of each. Example 7.1 establishes the required staff for a laboratory. Example 7.2 uses an acuity-based standard to establish the staffing for a medical/surgical unit.

TABLE 7.4. WEIGHTED AVERAGE UTILIZATION FOR A LABORATORY BASED ON WORKLOAD FLUCTUATIONS BY SHIFT.

Shift	Percent of Work Load (A)	Expected Utilization (Percent) (B)	Weighted Utilization (A * B)
Morning	45	95	.428
Afternoon	35	85	.298
Evening	7	90	.063
Night	13	85	.111
Total	100		0.900

Weighted Average Utilization Target = 90 percent.

Source: Adapted from Page and McDougall, 1989.

TABLE 7.5. WORKLOAD STANDARDS FOR MICROSCOPIC PROCEDURES IN LABORATORY.

Variable Activities	Volume (# of Procedures per 30-day Period)	Workload Standard (Hours per Procedure)	Standard Hours for 30-Day Period
Procedure 1	350	.12	42.00
Procedure 2	222	.30	66.60
Procedure 3	185	.45	83.25
Procedure 4	462	.26	120.12
Procedure 5	33	.84	27.72
Procedure 6	12	.88	10.56
Procedure 7	96	.362	34.75
Procedure 8	892	.46	410.32
Procedure 9	26	1.9	49.4
TOTALS	2255		844.72

Source: Adapted from Page and McDougall, 1989.

EXAMPLE 7.1

A teaching hospital's laboratory routinely performs nine microscopic procedures. Average monthly volume of each procedure has been determined from the historical data. An earlier time study also revealed the workload standard for each procedure, as shown in Table 7.5.

Solution: The first step in setting staff levels for a procedure is to discover the number of procedures to be performed (1). By multiplying the volume for each procedure by the workload standard, a time estimate for each activity is made. The sum of the standard hours represents the total time needed to perform the

TABLE 7.6. CALCULATION OF STAFFING REQUIREMENTS FOR MICROSCOPIC PROCEDURES.

Step	Description	Results
1	Total volume of activities (tests)	2255
2	Total direct procedure hours	844.72
3	Indirect support hours [.21 × (1)] (assume 0.21 hours per procedure)	473.55
4	Subtotal variable hours required [(2) + (3)]	1318.27
5	Department utilization target [from Table 7.4]	90.0%
6	Total variable hours required (normalized) [(4) ÷ (5)]	1464.74
7	Constant hours (30 days at 12.28 hours per calendar day)	368.40
8	Total target worked hours required [(6) + (7)]	1833.14
9	Total target FTEs required [(8) ÷ 173.33] [40 hrs./wk. * 52 wks) ÷ 12 months = 173.33)	10.58
10	Vacation/holiday/sick FTE allowance [(9) * 9.8%] (percentage varies by hospital department)	1.0
11	Total Required Paid FTEs [(9) + (10)]	11.58

Source: Adapted from Page and McDougall, 1989.

procedures (2). Because this total represents only the direct procedure hours of the technicians, it must be augmented by the indirect (support) hours, which in this example are estimated at 0.21 hour per procedure. Table 7.6 depicts these calculations. ■

The sum of the direct and indirect hours (4) gives us the variable hours required for all procedures. This sum must be adjusted for the utilization level that was determined in Table 7.4. After the adjustment—made by dividing (4) by (5)—we get a normalized total variable hour estimate, meaning that it is based upon a utilization target of 100 percent "for purposes of being able to compare staff requirements of one department with those of other departments" (Page and McDougall, 1989; p. 79).

Next, the number of constant hours must be determined (7). Constant hours represent the time spent in fixed activities (meetings, inventories, etc.). By adding (6) to (7), we determine the target for worked hours required (8). The total targeted work hours are divided by 173.33 (hours per FTE worked per month) to compute the total target FTEs required (9). However, quantity (9) must be adjusted for vacation, sick days, and holidays. It is estimated that the adjustment factor is 9.8 percent, giving a leave/absence allowance of 1.0 FTE. By adding this allowance (10) to the total target FTEs (9), we determine the total number of FTEs required in the laboratory, 11.58 FTEs.

Determination of FTEs for Nurse Staffing. Determination of the FTEs required to staff a nursing unit requires several steps. First, the minutes of required care are determined using the following formula:

$$\text{Minutes of Care Required} = (\text{Average Census}) * (\text{Average Required Minutes per Patient}). \quad [7.1]$$

This equation then should be divided by the number of minutes available to work per nurse per day (equals 8 hours/day * 60 minutes/hour, or 480 minutes available) to determine the number of unadjusted FTEs. Thus, in the second step, unadjusted FTEs are calculated using the next formula:

$$\text{Unadjusted FTEs} = \frac{\text{Total Minutes of Care Required}}{\text{Minutes Available to Work per nurse per Day}}. \quad [7.2]$$

However, this method of calculation assumes 100 percent utilization of the staff, an assumption that is clearly unrealistic for the reasons mentioned earlier. Suppose that the administration has established a utilization standard of 0.75; that is, 75 percent of each employee's time will be spent in unproductive activities, or activities unrelated to direct patient care. The number of minutes available to work per nurse per day (example, 480 minutes) must be adjusted by the utilization standard; hence in the third step, core level FTEs are determined with this formula:

$$\text{Core Level FTEs} = \frac{(\text{Average Required Minutes per Patient}) * (\text{Average Census})}{(\text{Utilization Standard}) * (\text{Available Work Minutes})}. \quad [7.3]$$

Example 7.2 below illustrates the calculations.

EXAMPLE 7.2

The nursing manager would like to determine the number of nursing staff needed for the medical/surgical unit. Table 7.2 and Table 7.3 provide census and acuity information for a medical/surgical floor.

Solution: Table 7.2 provides information on the daily census for January 2005. Table 7.3 aggregates the monthly data to provide the average census over a 25-month period. Notice that the mean values presented in Table 7.3, are the same as those found in the January 2005 row in Table 7.3. It is important to realize that the core staffing levels in this example are found through a retrospective analysis of average monthly census and required hours per patient day.

When determining a core staffing level, there are two particular calculations of interest: average census and average required hours per patient day for the 25-month period. Examining those numbers, we see that the medical/surgical unit

should staff for an average of fourteen patients daily, requiring 4.1 hours of direct care, on average.

The first step of the staffing calculation is to find the total number of minutes of care required, using formula [7.1]:

$$\text{Minutes of Care Required} = (\text{Average Census}) * (\text{Average Required Minutes per Patient})$$

$$\text{Minutes of Care Required} = (14 * 4.1) * 60 \text{ minutes} = 3{,}444 \text{ minutes.}$$

The second step uses formula [7.2] to divide the number of minutes available to work per nurse per day (480 minutes) to determine the number of unadjusted FTEs required.

$$\text{Unadjusted FTEs} = \frac{14 * 4.1}{480} = 7.0, \text{ which in this case is 7 nurses.}$$

The third step determines the core level FTEs, using formula [7.3].

$$\text{Core Level FTEs} = \frac{14 * 4.1}{0.75 * 480} = 9.6 \quad \blacksquare$$

In this example, the core level of FTEs, assuming a 0.75 utilization standard, equals 9.6 FTEs.

Coverage Factor. One other adjustment must be made to make sure that the core staffing levels are as accurate as possible. The above calculation assumes that employees will be available to work 365 days per year, without vacations, sick days, or holidays. To adjust for these factors, we must calculate a coverage factor. An example of the coverage factor adjustment is found in Table 7.7. The first step in its determination is subtracting weekend days per year and benefit days from the required coverage days per year (365 in most any health care organization), to arrive at a total of available days per FTE (line 5). By dividing the total number of required days per year by the total available days, we obtain a coverage factor. This coverage factor is then multiplied by the unit FTE requirements to calculate the total unit FTE requirements.

$$\text{Final Core Level FTEs} = \text{Core Level FTEs} * \text{Coverage Factor.} \quad [7.4]$$

For instance, under 5/40 plan, final unit requirements would be:

$$\text{Final Core Level FTEs} = 9.6 * 1.55 = 14.9 \text{ or } 15 \text{ nurses.}$$

This example illustrates how the coverage factor is affected by scheduling and institutional policies. When ten-hour shifts are used (the 4/40 plan), the coverage factor is elevated due to the greater number of weekend days per employee.

TABLE 7.7. THE EFFECT OF SHIFT ALTERATIVES ON STAFFING—THE COVERAGE FACTOR.

Assumptions		5/40 or 2/12 & 2/8 Plans	4/40 or 4/36 Plans
(1) Required Coverage Days per Year		365	365
(2) Weekend Days per Year		104	156
(3) Benefit Days			
• Vacation		10	10
• Sick Days		7	7
• Holidays		7	7
• Other		1	1
(4) Total Allowance Days of FTE	(2) + (3)	129	181
(5) Total Available Days of FTE	(1) − (4)	236	184
(6) Coverage Factor	(1) ÷ (5)	1.55	1.98

Shift Alternatives	Unit FTE Requirement	Coverage Factor	Total Unit FTE Requirements
5/40	9.6	1.55	15
4/40	9.6	1.98	19
4/36	9.6	1.98	19
2/12 & 2/8	9.6	1.55	15

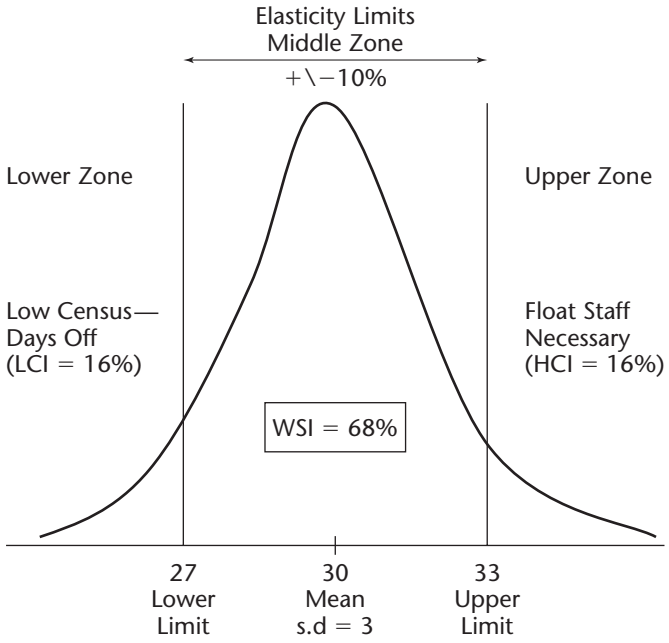
Under the 4/40 plan, final unit requirements would be:

$$\text{Final Core Level FTEs} = 9.6 * 1.98 = 19 \text{ nurses.}$$

The consequence is a higher total unit FTE requirement, and consequently higher costs. (Further discussion on this subject is found in the section on scheduling.) The coverage factor is further affected by institutional policies on holidays, vacation, sick leave, training and continuing education, and by vacancies and employee turnover.

Reallocation through Daily Adjustments. Once the final core level of FTEs is established, it must be adjusted on a daily, shift-by-shift basis to make sure that proper staffing levels are available to meet patients' requirements. Figure 7.2 illustrates an elasticity zone in which the core level staff is expected to handle patient needs. As long as the workload stays within this zone, no additional staff is necessary. However, when workloads are greater than ten percent of the standard, float staff must be hired, often at a premium. Similarly, on low census days, employees can be given time off or encouraged to catch up with in-service continuing education. The workload stability index (WSI) is a measure of how often workload stays within the limits where no additional staff or time-offs are necessary (Shukla, 1991).

FIGURE 7.2. DISTRIBUTION OF DAILY WORKLOAD ON A NURSING UNIT.



Source: Adopted from Shukla, R. K. *Theories and Strategies of Healthcare: Technology-Strategy-Performance,* Chapter Four, Unpublished Manuscript, 1991.

If development of internal standards is prohibitively expensive for your organization, it is possible to adopt externally developed standards.

External Work Standards and Their Adjustments

External standards can be either of two types, industry based or professionally based. Industry standards can be adapted to a particular institution if adjusted carefully for factors such as case mix. Industry standards have the advantage of being available at much lower cost than the development of institutional standards. They are extremely credible in most cases, having been evaluated by industry experts (Kirk, 1986).

One of the first professional standards was published in 1979, by the Oncology Nursing Society (ONS) with the collaboration of the American Nurses Association, in a manual entitled *Outcome Standards for Cancer Nursing Practice.* Updated in 1987, this publication aimed to provide nurses with the tools to

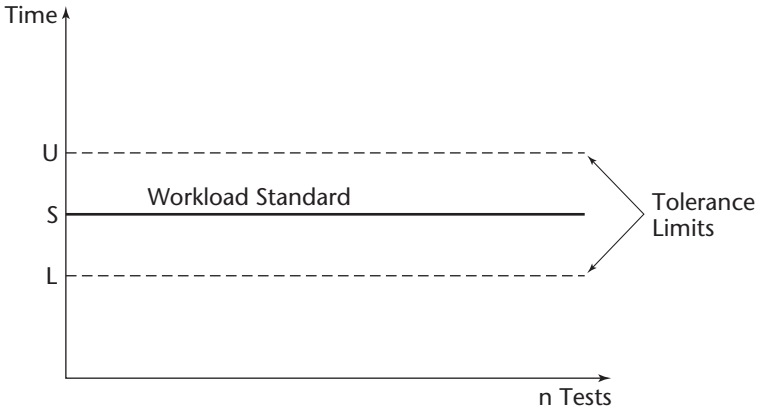
determine the degree of nursing care a patient should receive (Lamkin and Sleven, 1991, p. 1242). Other groups that have developed professional standards are the Nurses Association of the American College of Obstetrics and Gynecology (*Guidelines of Perinatal Care* (1988); *Standards for Obstetric, Gynocologic, and Neonatal Nursing* (1986); *Considerations for Professional Nurse Staffing in Perinatal Units* (1988)) and the American Association of Critical-Care Nurses (AACN) (*Standards for Nursing Care of the Critically Ill* (1989)). Many of these professionally published manuals make relatively specific recommendations–for example, the AACN publication's statement: "utilization of at least 50 percent RN staff on each shift . . . [and a] nurse patient ratio [reflecting] the patient's acuity and required nursing care. Staffing patterns should be reviewed regularly by the Critical Care Committee to ensure the delivery of safe care." (Lamkin and Sleven, 1991, p. 1242).

To avoid the possibility of inaccuracies when using industry standards or professionally determined staffing standards, and the costs that inappropriate staffing level may incur, such external standards must be evaluated and adjusted for the unique characteristics of your particular organization. A partial list of factors referred by the ONS is as follows:

- Size and design of facility.
- Average length of stay.
- Non-nursing responsibilities.
- Nursing responsibilities.
- Intensity/acuity levels of patients.
- Reliability of patient classification system.
- Clinical expertise of available staff.
- Organized system of patient education.
- Staff mix.
- Research and data management responsibilities.
- Patient transport responsibilities.
- Physician practice patterns.
- Facility census patterns.

Regardless of the standard developed, whether internal or external, it is important for the manager to thoroughly understand a department and its operations before applying standards. What work is currently done and by whom? Where are the potential bottlenecks? How satisfied is the staff with the current system? One of the best ways to answer these questions is through direct interviews or surveys with the department or unit employees. Not only can direct observation and employee contact improve the development of a new staffing or scheduling plan; it also helps the employees accept any changes that occur if they have participated in planning them. Again, a careful look at the factors suggested above can greatly benefit the development and application of work standards.

FIGURE 7.3. WORKLOAD STANDARD TOLERANCE RANGES.



It is important to recognize that no standard is absolute. Some room must be left for flexibility in staffing. Figure 7.3 demonstrates how statistical analysis can reveal whether the staff is meeting the standards. The number of hours to provide a service *n* times over a particular period of time in a specific unit serving clients of similar acuity levels should be plotted. When the times used lie outside the upper and lower tolerance limits, it is the manager's responsibility to determine the reason. It certainly should not be assumed that the problem lies with the staff; it is possible that the standard is unfair or outdated and should be reevaluated.

Work standards, once adopted, can be used to evaluate the productivity of the organization, a department, or even an individual employee. Without the development of such standards, the success of workload management programs aimed at improving organizational productivity cannot be assessed.

Productivity and Workload Management

Productivity is traditionally measured as the ratio of outputs to inputs (see Chapter Nine). The outputs generally consist of an organization's performance expectations (profit, quality of care, services provided, and so on); inputs include labor hours, materials, and others. Productivity measurement is important for staffing decisions, and staffing decisions can affect not only the organization's productivity, but the quality of care rendered, as well.

Departmental productivity is often measured as the ratio of the required, or standard, hours (for example, those found in Table 7.3, which are developed using the patient acuity system) to the number of hours actually worked. Thus, departmental productivity is a measure of the effective utilization of the unit's staff.

Two very important staffing considerations that profoundly influence employee utilization are the appropriateness of employee skills and the matching of these skills to the appropriate job description (Page and McDougall, 1989; p. 61). For instance, registered nurses would not be used effectively if they were to change all patients' bedding or spend the majority of their time filling out medical records. Such jobs would be more efficiently handled by less expensive nurse's aides or licensed practical nurses, thereby freeing time for an RN to perform more complicated medical duties for which an aide or LPN may not be trained. Therefore, when staffing a department, the health care manager must take not only numbers of employees into account, but also skill levels.

Other factors that affect productivity are worker satisfaction and work organization. Job satisfaction or the lack of it can significantly affect organizational costs: hiring, firing, training, and low productivity arising from dissatisfaction can elevate costs dramatically. Job satisfaction can be evaluated by examining three areas: retention, recruitment, and transfers. It is generally assessed through a survey that includes a staff profile at both at the professional and the personal level, satisfaction with current scheduling, preferences in terms of shifts or units, perceived flexibility, and attitude toward benefits. The important point is that the health care manager should aim to keep the staff as happy as possible, and that carefully made staffing and scheduling decisions support that goal.

Work can also be organized so as to improve effectiveness. Work simplification procedures can identify unproductive activities and eliminate them. Changes in facility layout can reduce travel time and improve traffic flow. Enhanced environmental conditions such as lighting and temperature can enhance productivity and staff satisfaction, and patient satisfaction as well.

When attempting to improve productivity through workload management, the health care manager must be aware of potential problems. Problems related to staffing and scheduling operations include workload volume fluctuations, workload scheduling, skill mix, and staffing patterns (Page and McDougall, 1989; p. 61).

Workload volume fluctuates daily and seasonally with significant effect on productivity calculations. Page and McDougall (1989) cite an instance in which a hospital's operating room was affected by three surgeons who were avid hunters. Every year, all three surgeons were absent for the first week of hunting season, significantly reducing the productivity of the operating room staff; yet staffing patterns had not been adjusted for what should have been a predictable volume change.

Appropriate workload scheduling can help a department become more productive. Leveling the workload, that is, reducing the peaks and valleys so common in any service industry with random service and arrival pattern, can often be accomplished with sophisticated workload scheduling software. Techniques used to schedule the hospital employees are discussed in the next chapter.

Summary

Staffing patterns must involve matching the human resources available to the fluctuating demand for their services. When an efficient match is maintained, productivity is enhanced. Alternative staffing patterns can improve flexibility, reduce costs, maintain continuity of patient care, and increase worker and patient satisfaction. Options for changing current staffing patterns are presented under Scheduling in Chapter Eight. In sum, workload management operations can significantly affect organizational productivity.

Exercises

Exercise 7.1

A mammography center performs ten different procedures. The volume of each procedure during an eight-month period and the standard hours per procedure are shown in Table EX 7.1.

TABLE EX 7.1

Procedure Description	Volume	Standard Hours
SC BX Breast IM Guide	220	.20
SC PLC CLIP Breast	195	.25
SC PLC Wire Breast	121	.50
SC PLC Wire Breast Add	24	.60
Mammo Spec Board	103	.75
Mammogm DIAG UNI	1,494	.25
Mammogm DIAG BI	1,505	.33
Mammogm SCR BI	8,924	.33
XR NDL/WIRE Breast LOC	136	.45
XR Surgical Specimen	318	.75
XR STERO Breast BIOP	226	.75

The target utilization rate for the center is 85 percent. Indirect support time is 0.20 hour per procedure, and total administrative hours by all staff average ten hours per day. The fringe benefits comprising vacation/holiday/sick compensation amount to 10 percent of required FTEs.

a. Calculate the standard hours per month.
b. Determine the indirect support hours per month.
c. Determine the variable hours per month.
d. Normalize the variable hours per month.
e. Determine the total required hours.
f. Determine the target FTE level.
g. Determine the required FTEs with fringe benefits.

Exercise 7.2

Utilize the information from exercise 6.2, where pre- and post-examination processing of patients in an outpatient clinic involves various tasks performed by clerks and nurses.

a. Excluding the wait times by patients, recalculate the standard time.
b. If there were an average of 1,800 patient visits to the outpatient clinic, what would be the standard hours per month?
c. If the target utilization rate of the facility is 80 percent; the indirect support time per visit is 0.10 hour; and the total administrative time by all staff in a given day is five hours, what is the target FTE level for the clinic?
d. If fringe benefits account for 9 percent of the target FTEs, what are the required FTEs?

Exercise 7.3

Utilize the information from Exercise 6.3, where the standard turn-around-times (TAT) for handling stat laboratory tests were estimated. The automated machine times for these tests and the monthly volumes are given in Table EX 7.3.

TABLE EX 7.3

Lab Test	Machine Time	Monthly Volume
Hem 8	25	2,200
Hem 18	25	2,200
Apter	25	1,800
AMY	25	3,200
Ca	25	2,400
Glucose	25	2,400
Chem 7	25	2,200
K	15	2,000
HCG	20	1,800
ALP	25	1,000
ALT	25	1,500
B	25	1,000
AST	25	800
BBSP	25	900

a. Recalculate the standard time for each test by subtracting the machine time.
b. Determine the standard hours per month for staff handling these tests.
c. If the target utilization rate of the facility is 90 percent; the indirect support time per test is 0.05 hours; and the total administrative time by all staff in a given day is seven hours, what is the target FTE level for this part of the laboratory?
d. If fringe benefits account for 9.5 percent of the target FTEs, what will be the required FTEs?

Exercise 7.4

In a staff model HMO, the requirement for MDs' time is estimated to be 11,000 minutes per day. The utilization target for MDs is 90 percent. Human Resources' benefit plan for them includes eleven holidays, ten sick days, and twenty-one paid vacation days per year. Determine the core level of MD FTEs for the HMO.

Exercise 7.5

In the emergency department of a medical center, the requirement for staff MDs' time is estimated to be 20,000 minutes per day. The utilization target for MDs is 95 percent. The medical center's benefit plan for staff MDs includes ten holidays, ten sick days, and twenty-one paid vacation days per year.

a. Determine the core level of MD FTEs for the emergency department.
b. Determine the final core level of MD FTEs if all staff are scheduled for eight-hour shifts, using a 5/40 scheduling plan.
c. Determine the final core level of FTEs if MDs work on a 4/40 scheduling plan.

Exercise 7.6

Table EX 7.6 depicts the average RN minutes needed on a daily basis in various units.

TABLE EX 7.6

ICU	CCU	SURG	MED	PED	OB/GYN
7,000	8,000	8,500	9,000	7,500	6,500

a. Assuming an 85 percent utilization level and that everything else is constant, how many RN FTEs should be hired to satisfy the patient care demand in each unit?
b. The FTEs hired for SURG, MED, PED, and OB/GYN are scheduled for eight-hour shifts on a 5/40 plan, and they will get ten holidays, six sick days, and fifteen paid vacation days per year. How does this information affect your FTEs?
c. The FTEs hired for the ICU and CCU are to be scheduled for ten-hour shifts on a 4/40 plan, and ICU and CCU nurses get the same benefits as do other unit nurses. How does this information affect your FTEs?

Exercise 7.7

For Famous Healthcare System (FHS), consultants from O&A determined the average daily patient demand for various nursing professionals. Table EX 7.7 depicts the average number of minutes for Registered Nurses (RNs), Licensed Practical Nurses (LPNs), and Nursing Aides (NAs) needed daily in various patient care departments of FHS.

TABLE EX 7.7

Departments	RN Minutes	LPN Minutes	NA Minutes
ICU	7,000	3,500	1,500
CCU	8,000	4,750	2,500
Surgical	10,500	6,500	4,000
Medical	12,500	7,500	4,500
Pediatric	9,500	3,500	2,500
OB/GYN	10,500	7,500	4,000

FHS decided that utilization targets for RNs, LPNs and NAs should be 85 percent, 80 percent, and 80 percent, respectively. FHS' human resources benefit plan for RNs has seven holidays, five sick days, and eighteen paid vacation days per year. The benefit package for LPNs has seven holidays, five sick days, and fourteen paid vacation days per year. The NA benefit package has seven holidays, five sick days, and ten paid vacation days per year. FHS wants to reevaluate staffing levels according to the patient demand measurements provided by O&A, as follows:

a. Determine the core level of FTEs for each department.
b. Determine the final core levels of FTEs for the Surgical, Medical, Pediatric, and OB/GYN departments if all staff are scheduled for eight-hour shifts using a 5/40 scheduling plan.
c. Determine the final core levels of FTEs for the ICU and CCU departments if RNs and LPNs work on a 4/40 and NAs work on a 5/40 scheduling plan.