Second Edition

QUANTITATIVE METHODS IN HEALTH CARE MANAGEMENT

TECHNIQUES AND APPLICATIONS

Yasar A. Ozcan

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To my wife, Gulperi, and my daughters, Gunes and Nilufer

FOREWORD

I would like to congratulate Professor Yasar Ozcan on producing this excellent, comprehensive textbook, *Quantitative Methods in Health Care Management.* The field has needed such a textbook for a very long time, and Professor Ozcan is eminently qualified in bringing it to us.

The last textbook in this area was written over twenty years ago. To all of us in health services research and management, we know that health care delivery today bears little resemblance to that era. So too, the use, types, and depth of quantitative methods and techniques have progressed greatly in this time period. Professor Ozcan brings us not only the latest and best methods and techniques, but also illustrates their uses through current cases and examples.

And what I like best about this textbook is that it has been written by one of the leading and most knowledgeable health care management professors in the world. Professor Ozcan has been at the forefront in developing and applying many of the methods in the book, and as founding editor of the journal *Health Care Management Science,* he draws on the latest knowledge available from other areas.

For those of us who teach quantitative methods in health care management courses, this book will make our task far easier. More importantly, it will provide our students with a comprehensive text that they can draw on in their health care management careers. In addition, this text is a welcome, comprehensive, and up-to-date addition to the work of current managers and to all those who say, "There must be a better way to deliver health care."

Indeed there is, and the application of the methods and ideas in this book will provide many, many answers.

William P. Pierskalla, Ph.D.
Distinguished Professor and Dean Emeritus,
The Anderson School, UCLA,
and Ronald Rosenfeld Professor Emeritus,
The Wharton School, University of Pennsylvania

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Writing this book could not have been achieved without the help and encouragement of many individuals. I take this opportunity to thank them; if I miss anyone, it is through authorial oversight only, as all the help received was deeply appreciated. First of all, I thank my colleague Ramesh K. Shukla, who provided valuable insights and material for the productivity chapter. Many thanks go to my graduate students from the MSHA Class of 2007 and MSHA Class of 2006 who received the first draft of the manuscript and pointed out many corrections. Similarly, graduate students from the MSHA Class of 2005 lent their real-life experiences with quantitative techniques and associated materials and data, which are used in the examples and exercises throughout the text. In that vein, more specifically, I thank Adrian Amedia, Joani Brough, Mark Cotter, Sandy Chung, Suzanne Coyner, Alan Dow, and Paulomi Sanyal for their resourcefulness.

I would like to acknowledge Dorothy Silvers for her diligent editing of the manuscript from cover to cover. I extend my sincere thanks as well to Jossey-Bass/Wiley staff members Andrew Pasternack and Seth Schwartz, for their cooperativeness and help in the production of this manuscript.

No book can be written on time without the support and encouragement of loved ones. I am indebted to my wife, Gulperi Ozcan, who became my sounding board for every example in this book. Moreover, she extended her support throughout the development of the manuscript even as I deprived her of my time in favor of my desktop. I thank her for the sustained support she has given me throughout my academic career and our personal life.

Yasar A. Ozcan, Ph.D.
May 15, 2008
Richmond, Virginia

THE AUTHOR

Yasar A. Ozcan, Ph.D. is a professor in the Department of Health Administration, Virginia Commonwealth University (VCU), where he has served as a faculty member for over thirty years. Dr. Ozcan teaches quantitative health care management courses in graduate professional programs in health administration, and methodology courses at the doctoral level. He has served twice as president of the Health Applications Section in the Institute of Operations Research and Management Science. Professor Ozcan is the founding Editor in Chief of a highly regarded journal, *Health Care Management Science,* and coeditor of the *Journal of Central Asian Health Services Research.*

Dr. Ozcan has been principal and co-principal investigator on various federal and state grants and contracts. He has also provided management consultancy services to health care facilities and managed care organizations.

Dr. Ozcan's scholarly work is in the areas of systems productivity, technical efficiency, financial efficiency, and effectiveness. Specifically, he has applied data envelopment analysis to measure efficiency across the range of health care facilities and practices, including hospitals, nursing homes, health maintenance organizations, mental health care organizations, physician practices, and other facilities. He has presented numerous papers in professional meetings and published extensively in these areas.

Dr. Ozcan has long been active in distance education, having taught quantitative techniques, the content of this book, both in the traditional and on-line graduate programs at VCU since 1988.

INTRODUCTION

This book is written to meet the need for a quantitative methods curriculum in health administration or health care management programs. It is designed so that it can be used for one-semester courses in graduate programs as well as for advanced undergraduate programs in health administration. Practical and contemporary examples from the field make it a useful reference book for health care managers, as well.

The quantitative techniques offered in this book are those more amenable to the health care management environment and those most frequently used. The second edition employs the use of Excel. Although the simpler examples are demonstrated in the text, their Excel solutions are also provided. As techniques increase in sophistication, as for example in queuing models, Excel template solutions are preferred to lengthy formulas and look-up tables. The second edition also incorporates *learning objectives* at the beginning of each chapter and *key terms* at the end of each chapter to facilitate the appropriate pedagogy for learning. Because the intent of the book is to make students into able users of quantitative methods for decision making, the interpretation of the results from hand-calculated or Excel solutions to guide for informed decision making is the foremost goal. Thus, students who have had basic algebra and introductory statistics courses should be able to follow the contents of this book.

The book has fifteen chapters including the introductory chapter. The presentation of quantitative techniques starts with forecasting, which provides the data for many of the other techniques discussed, as well as for planning in health care facilities. The chapter on decision making provides the decision techniques not only for single attribute decision theory, but also for the multi-attribute methods often used in health care management decisions, especially in evaluating new contracts or in requests for proposals.

Chapters Four and Five provide techniques for facility location and layout. The techniques discussed for layout also can be used to improve flows in facilities. Hence, in Chapter Six, reengineering is introduced as the means to identify bottlenecks in operational processes and to correct them. Chapters Seven and Eight cover staffing and resource scheduling management in health care facilities; surgical suite resource management is highlighted. These two chapters can be assigned and covered together in one session. Chapter Nine, on productivity, not only presents the traditional productivity concepts and their measurements in both inpatient and outpatient settings, but also discusses more contemporary methods of productivity measurements as conducted through data envelopment analysis.

Chapter Ten explains linear programming and its use in resource allocation. Furthermore, integer programming, an extension of linear programming, is discussed and illustrated for staff scheduling. Supply chain management in health care has become popular in recent decades, and the first part of Chapter Eleven discusses that; the second part of the chapter is devoted to traditional techniques for inventory management. Quality control, essential above all in health care, is discussed in Chapter Twelve. Types of control charts and their developments are illustrated. Several approaches to quality control, including total quality management, continuous quality improvement, and six-sigma, are discussed. The tools for quality improvement are presented.

Project management is the subject of Chapter Thirteen, where program evaluation and review technique/critical path method (PERT/CPM) techniques are discussed in detail, with examples of project compression. The last two chapters cover queuing and simulation techniques with emphasis on capacity decisions using those tools. Simple queuing methods are shown with detailed examples. More sophisticated ones are illustrated by Excel solutions.

The sequence of chapters has a certain logic. For example, in Chapter Four, the location of a new facility is identified; and in Chapter Five, layout of that facility can be explored. On the other hand, Chapter Five can be also used in an independent layout analysis for existing facilities to improve flow and productivity. Similarly, Chapters Six, Seven, Eight and Nine are built to feed the knowledge onward. Chapters Fourteen and Fifteen address capacity issues using different techniques. Regardless of this sequence, however, the chapters can be selected in any order and presented to students based on the professor's preferences.

Developing exercises for the techniques explained in each chapter has been a consuming task. Any errors and oversights in that process are solely mine. I will appreciate reader comments to improve or correct the exercises, as well as suggestions for incorporating additional material in future editions.

There are on-line resources to accompany this book. On-line resources (password protected) are available to professors who adopt the book and to the students. Professors' resources include PowerPoint lectures, solutions to exercises, prototype course syllabus, Excel templates, and additional exercises with solutions. Student resources include solutions to selected exercises, Excel templates, a subset of additional exercises with solutions, and other study guide materials. These resources can be accessed via www.josseybass.com/go/ozcan2e.

CHAPTER

1

INTRODUCTION TO QUANTITATIVE DECISION-MAKING METHODS IN HEALTH CARE MANAGEMENT

LEARNING OBJECTIVES:

- Recognize the quantitative techniques for decisions about delivering health care of high quality.
- Describe the historical background and the development of decision techniques.
- Describe the health care manager's role and responsibilities in decision making.
- Review the scope of health services and follow recent trends in health care.
- Describe health services management and distinct characteristics of health services.

In today's highly complicated, technological, and competitive health care arena, the public's outcry is for administrators, physicians, and other health care professionals to provide high quality care at a lower cost. Health care managers must therefore find ways to get excellent results from more limited resources. The goal of this book is to introduce aspiring health care managers to operations research models that allow decision makers to sort out complex issues and to make the best possible use of available resources. Such models are used, for example, to forecast patient demand, and to guide capital acquisition and capacity decisions, facility planning, personnel and patient scheduling, supply chain, and quality control. They use mathematical and statistical techniques: multivariate statistical analysis, decision analysis, linear programming, project evaluation and review technique (PERT), queuing analysis, and simulation, to name a few.

This book presents all these techniques from the perspective of health care organizations' delivery of care, rather than their traditional manufacturing applications. This chapter covers a brief historical background and the development of decision techniques and explains the importance of health care managers using these techniques. Finally, the scope, distinctive characteristics, and current trends of health services are emphasized. After reading this chapter, you should have a fair understanding of how important quantitative techniques are for decisions about delivering health care of high quality.

HISTORICAL BACKGROUND AND THE DEVELOPMENT OF DECISION TECHNIQUES

Beginning in the 1880s, the scientific management era brought about widespread changes in the management of the factories that had been created at an explosive rate during the Industrial Revolution. The movement was spearheaded by an efficiency engineer and inventor, Frederick Winslow Taylor, who is regarded as the father of modern scientific management. Taylor proposed a "science of management" based on observation, measurement, analysis, and improvement of work methods, along with economic incentives. He also believed that management's tasks are to plan, carefully select and train workers, find the best way to perform each job, achieve cooperation between management and workers, and separate management activities from work activities. Taylor's work was based on his idea that conflicts between labor and management occur because management has no idea how long jobs actually take. He therefore focused on time studies that evaluated work methods in great detail to identify the best way to do each job. Taylor's classic 1911 book, *The Principles of Scientific Management,* explained these guiding principles: (1) development of science for each element of work; (2) scientific selection and training of workers; (3) cooperation between management and employees; and (4) responsibility shared equally between workers and management (Taylor, 1911). Other early contributors to scientific methods of management were Frank and Gillian Gilbreth, who worked on standardization, and Henry Gantt, who emphasized the psychological effects that work conditions have on employees—he developed a time-based display chart to schedule work. Quantitative inventory management was developed by F. W. Harris in 1915. In the 1930s, W. Shewhart and associates developed

statistical sampling techniques for quality control (Stevenson, 2002; p. 23). World War II prompted the growth of operations research methods, and development of project management techniques; linear programming and queuing methods followed in the 1950s. After the 1970s, the development and wider use of computers and management information systems (MIS) reshaped all these techniques because large amounts of data could be analyzed for decision making in organizations. Tools for quality improvement such as total quality management (TQM) and continuous quality improvement (CQI) became very popular in the 1980s and 1990s; then came supply chain management and productivity improvement techniques, in particular re-engineering.

THE HEALTH CARE MANAGER AND DECISION MAKING

A health care manager can be a chief executive officer (CEO) or chief operating officer (COO), or a middle-level manager to whom the duties are delegated. At the top management level, a health care manager's responsibilities include planning for capacity, location, services to be offered, and facility layout; those responsibilities are strategic. The health care manager also is ultimately responsible for overseeing service production through supply chain management, quality monitoring and improvement, and organizing health services to be either produced or outsourced. Finally, the health care manager is responsible for patient and personnel scheduling, and for optimally staffing the facility and directing job assignments and work orders. Regardless of whether health care managers are directly involved or delegate these responsibilities, their ultimate responsibility remains. Generally, operational decisions are delegated to mid- and lower-level decision makers, while strategic decisions are evaluated at the organization's top levels. With the integrated delivery systems (IDS) movement, health care organizations are becoming larger and more complex, so health care managers are in dire need of the most recent, reliable information derived from quantitative data analysis in order to make informed decisions. Information technology (IT) has become integral to management decision processes.

INFORMATION TECHNOLOGY (IT) AND HEALTH CARE MANAGEMENT

If they are to analyze their current situations and make appropriate changes to improve efficiency as well as the quality of care, health care managers need appropriate data. The data, from various sources, are collected by information technology embedded in systems either internal or external to the health care organization. For example, decisions about the location of a new health facility will require analysis of data on the communities under consideration (such as census, epidemiological data, and so on). Decisions about nurse staffing will require internal data on patient admissions and acuity that are collected routinely by the hospital. This book identifies the sources of the data for various decision-making tools and emphasizes the use of IT for informed decision making by health care managers.

THE SCOPE OF HEALTH CARE SERVICES, AND RECENT TRENDS

According to the Organization for Economic Cooperation and Development (OECD) countries, their members' total expenditures on health services constituted from 5.3 to 14.7 percent of gross domestic product (GDP) in 2002, making that a very significant sector from a public policy perspective. Moreover, the statistics in Table 1.1 show an increasing trend in health care expenditures. The countries that spent about 4.3 percent of their budgets on health care in the late-1990s are now spending 50 percent more. The United States is the country spending the highest percentage of GDP on health care. Its percentage share of GDP was stabilized from 1998 to 2000 but has been increasing again during the last few years.

Health care, especially in the United States, is a labor-intensive industry with more than fourteen million jobs, constituting 10 percent of the workforce in 2006. As shown in Table 1.2, the health care work force is expected to reach close to seventeen million in ten years. That constitutes over 21 percent growth and is the fastest job growth area, with seven out of twenty occupations in health care (U.S. Department of Labor, 2006). The aging population—as well as the proliferation of medical technology and new treatments—contributes to this growth.

The health care industry seeks to match varying medical needs in the population. Its 580,000 establishments vary in size, complexity, and organizational structure, ranging from small-town, private practice physicians with one medical assistant to urban hospitals that employ thousands of diverse health care professionals. About 1.3 percent of the health care establishments are hospitals, but they employ over 35 percent of all health care workers. While 77 percent of health care establishments are physicians, dentists, or other health practitioners, those employ 26 percent of the health care workforce (see Table 1.2).

Advances in medical technologies, new procedures and methods of diagnosis and treatment, less invasive surgical techniques, gene therapy—all these increase longevity and improve the quality of life. Similarly, advances in information technology can improve patient care. For example, handheld order entry systems such as personal digital assistants (PDAs) and bar code scanners at bedside make health workers more efficient, and also minimize errors and thus improve the quality of care.

TABLE 1.1. Total Expenditures on Health as % GDP for 30 OECD Countries.

	1998	1999	2000	2001	2002	2003	2004	2005
Average	7.8	7.9	7.9	8.2	8.5	8.8	8.9	9.0
Minimum	4.3	4.6	4.8	5.4	5.3	5.4	5.5	6.0
Maximum	13.1	13.1	13.2	13.9	14.7	15.2	15.2	15.3

Source: OECD Health Data 2007.

TABLE 1.2. Distribution of Health Providers and Health Workers in Health Services: 2006, and Expected Growth.

Provider Type	Percent of Providers	Percent of Employment	Employment (in thousands)	Percent Change, 2006–2016
Hospitals, public and private	1.3	39.9	5,438	13.0
Nursing and residential care facilities	11.5	21.3	2,901	23.7
Offices of physicians	36.7	15.8	2,154	24.8
Offices of dentists	20.7	5.8	784	22.4
Home health care services	3.3	6.4	867	55.4
Offices of other health practitioners	19.3	4.2	571	28.3
Outpatient care centers	3.4	3.6	489	24.3
Other ambulatory health care services	1.4	1.6	216	32.3
Medical and diagnostic laboratories	2.3	1.5	202	16.8

Source: U.S. Department of Labor (2006).
www.bls.gov/oco/cg/cgs035.htm#nature

These advances usually add to costs, so cost containment is a major goal in the health care industry. To accomplish it, the health care industry has shifted the care of patients from hospital care to outpatient and ambulatory care. At the same time, managed care programs have stressed preventive care to reduce the eventual costs of undiagnosed, untreated medical conditions. Enrollment has grown in prepaid managed care programs: health maintenance organizations (HMOs), preferred provider organizations (PPOs), and point-of-service (POS) programs.

The health care industry has turned to restructuring to improve financial and cost performance. Restructuring is accomplished by achieving an integrated delivery system (IDS). An IDS merges the segments of health care delivery, both vertically and horizontally, to increase efficiency by streamlining financial, managerial, and delivery functions. More hospitals expected to be part of IDS in coming years (U.S. Department of Labor, 2004).

It is fair to conclude that the changes in the health care industry will continue and will affect the delivery of health services in terms of cost and efficiency as well as the quality of care.

HEALTH CARE SERVICES MANAGEMENT

Given such complexity in both the nature and the environment of health care, managers of such establishments face challenging day-to-day decisions as well as long-term and strategic ones. Their discipline, the management and improvement of the systems and processes that provide health care, must rely on decision tools—namely, the specific methods that can help managers analyze, design, and implement organizational changes to achieve efficiency as well as high quality of care (effectiveness) for patients.

Clearly, then, management of health care establishments requires reasoned inquiry and judgment. Therefore, health care managers must use proven scientific methods drawn from such disciplines as industrial engineering, statistics, operations research, and management science. However, it must be remembered that such quantitative tools do not, alone, shape the final decision, which may have to include other, qualitative factors to arrive at the right course of action.

An increase in the number of manager positions in health care is expected during the next decade. According to the U.S. Department of Labor statistics shown in Table 1.3, the growth in health care management positions is projected to be slightly higher than that in all health care occupations. In 2006, there were 579,000 managers employed in the health care industry, a level expected to increase by 21.3 percent within ten years. More specifically, in the top and middle management levels, the three subsections shown in Table 1.3, approximately 98,000 top executives are employed, constituting approximately 0.7 percent of the health care work force.

Future health care managers, whether in top administration or in administrative or clinical operations, will be making informed decisions using state-of-the-art decision-making techniques and the latest information from management information systems. To use those techniques successfully, however, they must also understand the distinctive characteristics of health care services.

DISTINCTIVE CHARACTERISTICS OF HEALTH CARE SERVICES

Health care operations have five major distinctive characteristics: (1) patient participation in the service process; (2) simultaneity; (3) perishability; (4) intangibility; and

TABLE 1.3. Health Services by Occupation in 2006, and Projected Growth.

Health Services Occupation	Employment (in thousands)	Percent Change, 2006–2016
Management, business, and financial occupations	579	21.3
Top executives	98	11.6
Professional and related occupations	5,955	21.3
Service occupations	4,334	27.1
Office and administrative support occupations	2,446	14.4
All health service occupations	13,621	21.7

Source: U.S. Department of Labor (2006). www.bls.gov/oco/cg/cgs035.htm#nature

(5) heterogeneity (Fitzsimmons and Fitzsimmons, 2004; pp. 21–25). Let us examine each of these characteristics to better understand the decision platforms in health care.

Patient Participation

In health care, as in any service industry, to evaluate performance (efficiency and effectiveness) a distinction must be made between inputs and outputs. Patients (or their health conditions) who receive care are among the inputs into the service process. On the other hand, after diagnosis and treatment, the patient's condition constitutes the effectiveness of the health care organization—that is, output. Hence, the health care organization and the patient interact throughout the delivery of care—a profound distinction of health care as compared to manufacturing industries.

Simultaneous Production and Consumption

As a service industry, health care is produced and "consumed" simultaneously. This point reflects the fact that health is not a product to be created, stored, and sold later. (Will science achieve that via gene therapy?) One of the drawbacks of that simultaneity of "production" and "consumption" is the challenge it presents for quality control—that is, ensuring the effectiveness of the service. In manufacturing, a product can be inspected and, if found defective, not be offered for sale; meanwhile the process that is producing bad outputs is corrected. However, in health care, due to simultaneity, an

instance of poor quality care cannot be "recalled," even though the process resulting in poor care can be corrected for future patients.

Perishable Capacity

Health care organizations design their services to serve with certain capacity over a given time. If the designed capacity is not used during that period, the opportunity to generate revenue from that capacity is lost. For example, consider a hospital with fifteen operating rooms that are staffed and open for twelve hours. If the surgeries are not scheduled appropriately to fill the open slots, or if a large amount of time is wasted by the turnover of the cases, a portion of the available capacity, and thus of potential revenues for that day perishes. Similarly, consider a physician's office with an available ten-hour schedule for patient visits. If the office does not receive appointments to fill all those time blocks, the practice's capacity for that day will be reduced, as will the revenues.

The Intangible Nature of Health Care Outputs

The output in health care does not comprise a tangible product on hand like food bought from your favorite fast-food restaurant, where you can judge the quality of the food as much as the promptness of the service. In health care, it is not so obvious what the patient has paid for. For one thing, since a healing process takes time, the opinions of patients about the service quality of their care are formed over time. Moreover, health care is not something that can be tested or handled before deciding on it. Although health care monitoring groups, as well as health care facilities in their marketing, may provide information about the quality of an organization's services, one patient's experience may nevertheless not equal that of another receiving the same service because patients' conditions and perceptions are never identical.

The High Levels of Judgment Called Upon, and the Heterogeneous Nature of Health Care

Although some routine health care tasks can be automated (recording patient history via IT), there remain a wide range of tasks that require a high level of judgment, personal interaction, and individual adaptations, even in a given service category. For example, a surgeon and an anesthetist must make specific decisions before operating, to plan the surgery for the particular condition of patient. The heterogeneity of patients' conditions, already noted, often mandates considerable specialization in the delivery of care.

Even given these distinctive characteristics of health care, managers work together with clinicians to standardize health organizations' operations for both efficiency and effectiveness. Examples of such standardization are the diagnostic and treatment protocols developed for the care of various diseases.

SUMMARY

Contemporary health care managers must understand the distinctive characteristics of the health care services and use state-of-the-art decision-making techniques with the latest information available to plan and organize their facilities for best quality patient care. The remaining chapters of this book will discuss and show the use of state-of-the-art decision-making techniques and their applications in health care.

KEY TERMS

Health Care Manager
Decision Techniques
Health Care Providers
Perishable Capacity

CHAPTER

2

FORECASTING

LEARNING OBJECTIVES:

- Describe the need for forecasting in health care operations.
- Review the various approaches to forecasting.
- Differentiate the data driven and opinion- or judgment-based forecasts.
- Recognize what type of forecasting approach should be taken for various health care forecasting situations.
- Develop accuracy checks and controls for forecasts.
- Analyze and use forecast information in operations or in strategic decisions.

Every day, health care managers must make decisions about service delivery without knowing what will happen in the future. Forecasts enable them to anticipate the future and plan accordingly. Good forecasts are the basis for short-, medium-, and long-term planning and are essential input to all types of service production systems. Forecasts have two primary uses: to help managers plan the system and also to help them plan the use of the system. Planning the system itself is long-range planning: about the kinds of services supplied and the number of each to offer, what facilities and equipment to have, which location optimizes service delivery to the particular patient population, and so on. Planning the use of the system is short-range and medium-range planning for supplies and workforce levels, purchasing and production, budgeting, and scheduling.

All of the previous plans rely on forecasts. Forecasting is not an exact science, however; its results are rarely perfect, and the actual results usually differ. For the best possible forecasts, a health care manager must blend experience and good judgment with technical expertise.

All forecasts have certain common elements regardless of the technique used. The underlying assumption is that past events will continue. It also is a given that errors will occur because of the presence of randomness and that actual results are more than likely to be different from those predicted. Forecasts of a group of items (aggregate forecasts) tend to be more accurate than those for individual items. For example, forecasts made for a whole hospital would tend to be more accurate than a departmental forecast because forecasting errors among a group tend to cancel each other. Finally, it is generally accepted that forecast accuracy decreases as the time horizon (the period covered) increases. Short-range forecasts face fewer uncertainties than longer-range forecasts do, so they tend to be more accurate. A flexible health care organization, which responds quickly to changes in demand, makes use of a shorter, more accurate forecasting horizon than do less flexible competitors, who must use longer forecast horizons.

STEPS IN THE FORECASTING PROCESS

Many forecasting methods are available to health care managers for planning, to estimate future demand or any other issues at hand. However, for any type of forecast to bring about later success, it must follow a step-by-step process composed of five major steps: (1) goal of the forecast and the identification of resources for conducting it; (2) time horizon; (3) selection of a forecasting technique; (4) conducting and completing the forecast; and (5) monitoring the accuracy of the forecast.

Identify the Goal of the Forecast

This indicates the urgency with which the forecast is needed and identifies the amount of resources that can be justified and the level of accuracy necessary.

Establish a Time Horizon

Decide on the period to be covered by the forecast, keeping in mind that accuracy decreases as the time horizon increases.

Select a Forecasting Technique

The selection of a forecasting model will depend on the computer and financial resources available in an organization, as well as on the complexity of the problem under investigation.

Conduct the Forecast

Use the appropriate data and make appropriate assumptions with the best possible forecasting model. Health care managers often have to make assumptions based on experience with a given situation, and sometimes by trial and error. In forecasting,