Basic Allied Health Statistics and Analysis

Gerda Koch

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Basic Allied Health Statistics and Analysis

2nd edition

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with Chapter by

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Contents

Preface

This textbook was designed and developed to provide health care students, primarily health information management and health information technology students, and health care professionals with a rudimentary understanding of the terms, definitions, and formulae used in computing health care statistics and to provide self-testing opportunities and applications of the statistical formulae. Though the textbook was developed with the health information student in mind, the material is applicable to all health care professionals and students enrolled in allied health statistics and analysis. The primary emphasis is on inpatient health care data and statistical computations, but most applications can be transferred to the outpatient or alternative health care setting as well. Written at a level that even the novice can read and comprehend, this textbook should be useful for students who have been afraid of or who have not understood statistical concepts.

Definitions, formulae, and terms are available in other books, but very few computational problems are included in these books. The major weakness a teacher encounters when teaching students is not so much that they cannot manipulate a formula, but rather that they have difficulties in selecting the appropriate number to be used in the formula. Statistical skills are best acquired and developed through actual use and analysis of data. This textbook provides many opportunities for computing various health care rates.

Although "statistics" is a term that creates a phobic state in some students due to its association with mathematics, the problems throughout this textbook can be accomplished with basic arithmetic skills (addition, subtraction, multiplication, and division) and computation is aided with the use of a hand-held calculator.

TEXT ORGANIZATION

The book has been divided into three main areas. The initial chapters provide an overview of statistical terms, mathematical review and an introduction to the health care setting. Various health care statistical formulae (census data, percent of occupancy, mortality rates, autopsy rates, length of stay and miscellaneous rates) are covered in the chapters that follow and form the major basis of the textbook. The last section introduces the reader to basic statistics and includes information on frequency distributions, measures of central tendency, and data presentation.

The chapters do not need to be studied in the order in which they are presented, though review questions are provided with reference to the chapter in which the material was introduced. Review questions are preceded by an asterisk (*) followed by a number, such as *(R5) to indicate that it is a review question of material studied in Chapter 5. Some instructors will choose to ignore these questions and others may want to include them. Review questions are provided to reinforce knowledge previously acquired.

A chapter test is included at the end of each chapter and two unit exams, covering a range of chapters, are also included. The answers to these questions have been transferred to the Instructor's Guide.

The appendix includes a section on (a)the main definitions used throughout the text, (b) formulae, (c) abbreviations, and (d)sample forms.

CHAPTER FEATURES

A chapter outline is provided at the beginning of each chapter and is followed by learning objectives. This is followed by a narrative presentation, often followed by an illustrative example and a self-test. Self-tests are included following the introduction of a new concept. The self-tests are numbered and the answers are provided in the appendix of the textbook. The textbook has been developed so that a reader can evaluate his or her grasp of the material as he or she progresses through each chapter. The major concepts are provided in summary form at the end of each chapter. A comprehensive test follows the chapter summary. The answers to the chapter tests are provided in the Instructor's Guide, and instructors may choose to provide students with these answers.

NEW FEATURES

This second edition has been updated and expanded and includes a new chapter, authored by Frank Waterstraat, on Data Presentation via Computer Technology. The majority of health care settings have access to software graphing packages and almost all charts and graphs are now generated via computer technology. A chapter has been added, providing an overview to health care settings, other than the hospital, as more and more health care is being provided outside the inpatient setting. In addition, vital statistics and epidemiologic rates are new to this second edition and other sections have been expanded.

INSTRUCTOR'S GUIDE

A guide for the instructor is a new feature to accompany this second edition. The guide provides teaching suggestions, additional problems and exam questions with an answer key, overhead masters, and sample reports and information which may be presented as supplementary class material.

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Gerda Koch, MA, RRA. As of the writing of this second edition, the author is a retired faculty member in health information management from Illinois State University. Included in her university teaching assignments was a course on health care statistics, and it was there that she began developing many of the materials which are incorporated in this textbook. Prior to her employment at the university, she worked in a hospital medical records department for ten years.

Frank Waterstraat, RRA, MBA is the Director of the Health Information Management Program at Illinois State University. He has had 13 years of experience as a department manager in both acute and ambulatory care settings. He has been a consultant to hospitals and long term care facilities as well. Currently he is completing his doctorate in Educational Policy at Illinois State University. His area of academic interest is health information technology. He has published several professional journal articles and made numerous presentations on computer related technology applied to the health care setting.

CHAPTER

1

Reporting Statistical Data

CHAPTER OUTLINE

A. Introduction
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LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Define "statistics."
2. Define "data."
3. Define:
   a. Demography and demographic variables
   b. Vital statistics
4. Distinguish clearly between:
   a. Population and sample.
   b. Variable and constant.
   c. Qualitative and quantitative data.
   d. Ungrouped and grouped data.
   e. Descriptive and inferential statistics.
   f. Nominal and ordinal data.
   g. Discrete and continuous data.
   h. Morbidity and mortality.
5. Identify abbreviations used in health care statistics.
6. Describe various uses of data.

People are exposed daily to some type of statistical data or statistical terms that are gathered and reported not only by the news media but also in the job arena. This is especially the case for those who work in the health care industry, where patient care data and statistics are compiled on a daily basis. Once we understand the meaningfulness of this data, we can become better managers and collectors of the data, thereby assuring appropriate uses for information.

A. INTRODUCTION

1. Statistics and Data

Statistics: A basic definition of statistics is "the mathematics of the collection, organization, and interpretation of numerical data, especially the analysis of population characteristics by inference from sampling."

Statistics is defined more broadly as a branch of applied mathematics, concerned with scientific methods for collecting, organizing, summarizing, and analyzing data. The term is frequently used to refer to recorded data, for example, reports that are issued regarding traffic accident statistics or the number of outpatients treated at an outpatient clinic. Statistics is also considered a branch of study that involves the theory, methodology, and mathematical calculation concerning the collection of various kinds of data.

Reasonable decisions and valid conclusions may be drawn based on the analysis of statistical data. Statistics therefore involves both numbers and the techniques and procedures to be followed in collecting, organizing, analyzing, interpreting, and presenting information in a numerical form.

Though the term statistics is a broad term, it is narrowed and defined by its representative data, such as accident statistics, hospital statistics, employment statistics, vital statistics, and several other descriptors.

Data: Data is defined as "information, especially information organized for analysis or used as the basis for a decision; numerical information." Data are those facts that any particular situation affords or gives to an observer. Some sources define data as raw facts and figures that are meaningless in and of themselves and refer to information as meaningful data—knowledge resulting from processing data.

The term data is generally and preferably the plural of the singular datum, though it is accepted in the singular construction as well. From this term references become more specific, for example, *data base* (also called *data bank*), which is a collection of data often arranged for ease and speed of retrieval. The preparation of information for processing by computers is referred to as *data processing*.

Enormous amounts of data and numbers are collected and tabulated daily in a hospital. A record is kept of most of the transactions that occur, including the number of patients admitted, the number of electrocardiograms performed, the number of babies born, the number of patients undergoing surgery, the number of patients who die, ad infinitum.

For this collected data to be useful and meaningful, various statistical methods and formulae must be applied.

Data are collected on inpatients, outpatients, emergency room patients, employees, and so on. Collected data must be compiled into a form that will have significance and that can be used to make comparisons for decision making.

2. Scope of Book

The purpose of this textbook is to introduce the reader to the terms, formulae, and computations used for hospital statistics, with the major emphasis on inpatient hospital statistics. Much of what applies to hospital inpatient statistics can be equally applied to outpatient data collection and statistical treatment of that data. As outpatient treatment has increased enormously during the past decade and as hospital inpatient admissions have declined, more and more data are handled daily, increasing the volume of numbers and data collected over a period of time—whether it be hourly, daily, weekly, monthly, quarterly, or yearly.

The major focus of this book is the statistical treatment of inpatient hospital statistics, with emphasis on definitions, formulae, and computations. It is to be assumed that the data referred to in this book are inpatient hospital data unless otherwise specified.

It is anticipated that the book's content and problems will be useful to hospital personnel whose function is the collection and interpretation of numerical data, especially health information personnel. Often the Health Information Department is the depository for medical information and the department is frequently responsible for compiling, collecting, and organizing data. This textbook provides material and problems to facilitate the processing and interpretation of these numerical data by the responsible personnel.

It should also be noted that those responsible for data collection should make sure to collect neither too much nor too little data. Data that are never used are not worth the added expense of collecting and processing them. In other words, cost effectiveness is achieved when the information is useful and of value to an individual or to a group.

B. STATISTICAL DATA TERMS AND DEFINITIONS

It is important to acquire a knowledge of common, universal terms and definitions which apply to an area of study. Throughout this textbook, the reader will be introduced to many terms and definitions, primarily related to the health care industry and the statistical concepts employed in health care. It is important that a term have the same meaning to all who use the term. Every area of study has its own terms whether it be the study of medicine, computers, a foreign language, or health care statistics. For effective communication it is important that all speak the same language and, to that end, the reader will be introduced to many terms throughout this text.

1. Population vs. Sample

Population: The term population refers to an entire group. A population is a set of persons (or objects) having a common observable characteristic.

Every ten years the United States Census Bureau conducts a population census. Each house and residence in the United States is sent a questionnaire to be completed and returned, indicating the number of inhabitants residing at that site. Sites failing to complete the questionnaire are visited by census takers in an attempt to get as accurate a count as possible. A hospital is also an example of a specific population—a group of people admitted for the purpose of receiving medical treatment and care. A population may also be comprised of all patients suffering from a specific disease or undergoing a specific form of treatment, such as radiotherapy.

Sample: A sample is a subset or small part of a population. Often information obtained from a sample is used to generalize from it to the entire population. A transcription supervisor lacks the time to check the accuracy of every report transcribed by each transcriptionist. It is virtually unfeasible to check every word on every report transcribed by all transcriptionists every day. Therefore, a sample is taken from the transcribed reports—say, two reports, or 5 percent of the transcribed reports—and the accuracy and quality of the transcriptionist's work is based on this sample.

The majority of the data in this textbook will focus on population statistics, in which all the patients in a specific hospital will be referred to as the population. When handling information such as mortality (also referred to as death) statistics, census data, and pregnancy data, all cases will be included in the statistical treatment rather than every fifth case or tenth case, which makes use of sampling techniques. When employing sampling statistics, it is common to *infer* that this sample is representative of a given population (like an employee's work) and *deductions* are made relative to this sample. Probability analyses and deductive statistics will not be included in this textbook.

2. Constant vs. Variable

Constant: A constant is something that assumes only one value; it is a value which is replaceable by one and only one number.

A constant is that which does not change and has one and only one value. A constant is one's date of birth or any value or specific that applies to everyone in the distribution.

Variable: A variable is something that can change, in contrast to a constant, which remains the same.

Variables are often expressed as symbols, such as X, x, Y, y, N, which can be replaced by a single number from a set of applicable numbers. Often it becomes desirable to compare variables and determine the relationship between them. For example, it may be useful to compare one variable, such as age, with another variable, such as occupation, or severity of illness, or a specific diagnosis.

3. Nominal vs. Ordinal Data

Nominal Data: The term nominal pertains to "name." Whatever distinguishing symbols are used to define a group or an individual is nominal data. These symbols often are numbers, though they can be words, designs or pictures as well. In the age of computers people constantly acquire new numbers that distinguish them from others. Examples of these distinguishing numbers are telephone numbers, zip code, social security number, driver's license number, and credit card numbers. None of these numbers represent an amount or quantity. Such numbers are used as identifiers and are referred to as nominal numbers. It is inappropriate to perform arithmetic operations on nominal data.

Ordinal: Ordinal refers to "order" or "rank." An ordinal number represents a specified (or ordered) position in a numbered series, such as an ordinal rank of seven. If it is stated that cancer is the third leading cause of death in the United States, three is the ordinal number. Some competitive events are judged based on certain criteria (diving, band competition, figure skating) in which the contestant(s) is rated and scored based on rank. Grouping into low, middle, or high scores involves the ordinal scale.

4. Qualitative vs. Quantitative Variables

Qualitative Variables: Qualitative variables yield observations that can be categorized according to some characteristic or quality. Examples of this type of variable include a person's occupation, marital status, education level, race, etc.

Quantitative Variables: Quantitative variables yield observations that can be measured. Examples of this type of variable are height, weight, blood pressure, serum cholesterol, heart rate, etc. Quantitative data can be subdivided into discrete and continuous data.

5. Discrete vs. Continuous Data

Discrete Data: Discrete data are always expressed as a whole number or integer. Discrete data are most commonly obtained by counting—the number of teeth in the mouth, the number of keratoses on the skin, the number of shares traded on the New York Stock Exchange. If the variable is fixed by counting essentially indivisible units, the variable is discrete. In other words, it is a number without a fractional or decimal subdivision.

Continuous Data: Continuous variables are those that fall into the category of "measured to the nearest." The underlying scale by which measurement can be subdivided could go on indefinitely, but most data are only subdivided to a designated degree. For example, if someone were asked to measure the distance from home to work, the distance could be recorded differently, depending on the specificity required. To illustrate, the distance to the nearest mile is two miles; to the nearest half mile, 2½ miles; to the nearest quarter mile, 2¼ miles; to the nearest eighth of a mile, 2⅜ mile. Data measured in decimal fractions, but recorded to the nearest whole number, are still continuous data. Height, weight, and age are all continuous variables. A person two months away from their 22nd birthday is actually closer to age 22 than to age 21, but in most instances that person would be considered to be age 21 until their actual 22nd birthday. An individual whose height measures 5 feet 4¾ inches is closer to being 5′5″ than 5′4″.

6. Ungrouped vs. Grouped Data

Ungrouped Data: Ungrouped data is a listing of all scores as they are obtained. Ungrouped data also refers to a distribution in which scores are ranked from highest to lowest or lowest to highest but each score has its own place in the array.

Grouped Data: Grouped data involves some type of grouping or combining of scores. The most common means of grouping is the counting or tallying of like scores. In this method, all identical scores are tallied and the number recorded after the score. If five pediatric patients were all admitted on the same day and two were 10 years of age, then two tally marks would be placed in the 10-year-old age column.

With a large range of scores, it often becomes necessary to combine some scores together and reduce the spread. Ages, even when recorded to the nearest whole number, would range from newborn to over 100 years of age. With a large number of scores, it becomes necessary to group and tally scores and thus narrow the range.

Ages are often grouped, and may include a range by decade or some other grouping, say, newborn to 4 years; 5 years to 13 years; 14 to 21; 22 to 34; 35 to 49; 50 to 64; 65 to 79; 80 to 100.

7. Descriptive vs. Inferential Statistics

Descriptive Statistics: Descriptive statistics describe and analyze a given group without drawing any conclusions or inferences about a larger group. Once data has been assembled and tabulated according to some useful categories, it then needs to be summarized to determine the general trend of the data. Descriptive statistics deal with data that are enumerated, organized, and possibly graphically represented. The decennial census carried out by the United States government is an example of descriptive statistics. That data gathered are obtained and then compiled into some type of table or graph.

Inferential Statistics: Inferential statistics give information regarding kinds of claims or statements that can be reasonably made about the population based on data from a sample. Inferential statistics are concerned with reaching conclusions. At times the information available is incomplete and generalizations are reached based on the data available. When generalizations about a population are made based on information obtained from a sample, inferential statistics are utilized. A common example relates to inferences about a population based on opinion polls. This type of statistical treatment is most frequently found in more advanced statistical texts.

8. Morbidity vs. Mortality

Morbidity: Morbidity data refers to disease statistics and is gathered to provide data on the prevalence of disease. Morbidity data is far more difficult to gather than mortality (death) data due to the lack of an adequate universal state and national reporting system. Additional information regarding morbidity data gathering is provided in the chapter which includes Vital Statistics.

Mortality: Mortality refers to death statistics. The death certificate identifies the state in which the death occurred and the date of death. An entire chapter is devoted to computation of death rates and additional information on death certificates is provided in the section on Vital Statistics in a future chapter.

9. Demographic Variables

Demography is the study of characteristics of human populations. Demographic variables include the size of a population and how it changes over time; the composition of the population such as the age, sex, ethnicity, income, and health status of its members; and geographic density. As inner city residents became more affluent, families fled the inner city and moved to the suburbs, leaving the less affluent behind. This emigration to the suburbs changed the demographics of the city. Demographic data are invaluable in program planning and disease control. Demographic data are also invaluable to hospital administrators in their attempt to provide the services most needed in their communities and the areas they serve.

10. Vital Statistics

Vital statistics refers to data that records significant events and dates in human life. This data includes births, deaths, marriages and divorces. Measures of illness and disease (morbidity) also fall under the umbrella term, vital statistics. A more detailed analysis and reporting of vital statistics information is provided in future chapters.

C. COMPUTERIZED DATA

I. Use

More and more data collections and computations are being carried out by computers, using both personal computers and on-line computers connected to a central mainframe. Local area networks (LANs) are increasingly being installed. As the size of a health care facility increases, the amount of data collected also increases and this collection is facilitated by computers. Even smaller institutions are finding it profitable to invest in computers that can be accessed at any time to print out the latest statistical information, such as the census, percentage of occupancy, and other facts that management needs for decision making.

2. Accuracy

Accuracy is important when entering data either manually or by computer. Quality control measures should be incorporated to maintain correct data entry and accuracy. One should always ask whether the resultant figure from any computation is plausible and, if not, recheck the data entries.

D. PATIENT DATA COLLECTION

1. Types of Data Collected

Computerization in health care facilities has increased dramatically during the past decade and this trend will continue well into the future, making it easier to collect more data. The increased amount of information can be useful in decision making. The types of patient data that are collected in health care facilities can be classified into six broad categories, as follows:

a. Dates

Examples of dates included in this category are the patient's date of birth, date of admission, date of discharge, date of a surgical procedure, dates of various forms of treatment (both inpatient and outpatient), and date of delivery (giving birth).

b. Counts

Examples of counts include the number of patients admitted on a certain date or discharged on a certain date, the number of CBCs (complete blood counts) performed or EKGs (electrocardiograms) or any number of other tests, the number of patients receiving physical therapy treatment or chemotherapy, the number of babies delivered live or aborted, the number of patients who died in the hospital or were treated in the emergency room.

c. Test Results

Laboratory tests are a major data collection component of inpatient and outpatient examinations. These include hematology tests such as CBC, WBC (white blood cell) differential, and RBC (red blood cell) morphology; blood chemistries such as blood glucose, BUN (blood urea nitrogen), and alkaline phosphatase; UA (urinalysis); CSF (cerebrospinal fluid) analysis; bone marrow tests; blood typing, serology, toxicology, and many more.

d. ***Diagnoses***

Patients upon admission are assigned an admitting diagnosis (also called provisional or tentative diagnosis). Discharge diagnoses are assigned at the time of discharge and include the principal diagnosis and other diagnoses and complications. Each consultant who sees the patient provides diagnoses for their specialty area. Surgeons assign preoperative and postoperative diagnoses at the time of surgery. Diagnoses are assigned code numbers from which a disease and procedure index/data base are generated. Counts can be made for a specific disease to ascertain how many patients were diagnosed with that disorder in the period specified.

e. ***Procedures***

If a patient undergoes a surgical procedure or diagnostic procedure, it is recorded, and most of these procedures are assigned code numbers as well. Totals can be generated for specific procedures (such as gastroscopies, mammographies, and hysterectomies) in a manner similar to that used for diagnoses.

f. ***Treatment Outcomes and Assessments***

Upon discharge, a note is often written on a patient's medical record about the condition of the patient at the time of discharge and whether the patient was discharged home in good condition, transferred to another facility (nursing home, another hospital), or expired. Results of treatment can be recorded and various modalities of treatment can be compared based on these data. Treatment outcomes of one institution can also be compared with those of another and serve as the basis for research studies.

E. ABBREVIATIONS

Certain abbreviations are routinely used by hospitals with regard to data collection and analysis. Listed below, for easy reference, are some common abbreviations used throughout this text.

1. Patient Care

AMA	against medical advice	(patient left without a discharge order)
DOA	dead on arrival	
ER	emergency room	
IP	inpatient	
NB	newborn	
OB	obstetrical	
OP	outpatient	

2. Statistical

ADM	admission	(patient admitted to the hospital)
DIS or DC	discharge	(patient discharged from the hospital)
A&D	admitted and discharged	(patient was admitted and discharged on the same day)
	Also called I&O *(in and out) in some facilities; others refer to such patients as "come and go." In this text they will be designated as A&D.*	
A&C	*adults and children*	
	This designation is used to refer to all patients other than newborns. It is used to separate patients into two categories—newborns and others. This designation is needed because many formulae require separate computations for the two groups—newborns vs. all other patients (A&Cs). The two populations have unique characteristics and need to be treated separately.	
TRF-in	transferred in	(patient transferred into a clinical unit)
TRF-out	transferred out	(patient transferred out of a clinical unit)
$>$	greater than	
$<$	less than	
c̄	with	(from the Latin word *cum*, meaning "with")
s̄	without	(from the Latin word *sine*, meaning "without")
Σ	summation	(The uppercase Greek letter sigma means summation—it indicates that whatever follows the sign is to be added.)

3. Clinical Units (Some of the More Common Designations)

CCU	coronary care unit
ENT	ear-nose-throat
GYN	gynecology
ICU	intensive care unit
MED	medical care unit
NEURO	neurology/neurosurgery
OB	obstetrics
ONCO	oncology
OPHTH	ophthalmology
ORTHO	orthopedics
PED	pediatrics
PSYCH	psychiatry
REHAB	rehabilitation
SURG	surgical care unit
UROL	urology

4. Non-Official Abbreviations

Throughout this text there will be abbreviations used which may not be used in all health care facilities but which facilitate computations that will be carried out in the various chapters of the text. Rather than stating the same words over and over, using an abbreviation facilitates brevity (or conciseness). Complete explanations describing each of these terms will be included in the chapters in which they are used. They are listed here for easy reference. For the sake of brevity, the following abbreviations will be used:

Cor	coroner/medical examiner case
CTT	census-taking time
DD	discharge days
DIPC	daily inpatient census
HP	hospital pathologist
IPSD	inpatient service day
LOS	length of stay

F. USES OF DATA

Data are used in a variety of ways, for example, to justify the opening or closing of clinical units in a hospital and to assess and justify the need for new equipment, facilities, and staff. Data are invaluable to physicians in determining the proper diagnosis and treatment of their patients. Data are also essential when assessing the quality of care administered by the hospital staff.

Quality assessment is a hospital-wide function. It applies not only to patient care but is also incorporated in other departments, such as patient accounts, housekeeping, and security and food service. Whether to validate the accuracy of an employee's work or to assess the quantity of work performed in a designated period of time, data serves as the primary means of performance evaluation. As health care costs keep rising and as patients are faced with higher co-payments and lower deductibles, patients will demand better quality for their medical dollars. As the crisis in health care continues, health care facilities will need quality data to justify expenditures and to demonstrate quality of care. A greater emphasis will be placed on quality assessment and improvement. TQM (total quality management) and CQI (continuous quality improvement) are two processes that orginated in the manufacturing and business sectors and have been adopted by healthcare entities to maximize efficiency and quality of care. Data collected by the health care facility will become increasingly important in quality assessment and in demonstrating the need for facilities, staff, equipment, and services.

G. SUMMARY

1. Statistics is a broad term and makes use of data. Descriptive statistics and inferential statistics are representative types of statistics.
2. Data is information. Similar information gathered about a group can be organized in a data base. The processing of the information collected is referred to as data processing. Data terms include discrete and continuous data, grouped and ungrouped data, nominal and ordinal data, and computerized data. A great variety of data can be collected, including dates, test results, diagnoses, procedures, and treatments.
3. A population includes an entire group. A sample is a subset of a population.
4. A variable is something that can change. A constant assumes only one value.
5. Variables are subdivided into qualitative and quantitative variables.
6. Data which reports disease statistics is referred to as morbidity data; mortality data reports death statistics.
7. Demographic data is data on human populations and incorporates factors such as age, sex, ethnicity, income and health status of its members.

8. Vital statistics references data on human events. The primary concern of vital statistics is the individual and the major events in an individual's life—birth, death, marriage, divorce, and disease.
9. Abbreviations are used for the sake of brevity and are especially common in the health care arena. The abbreviations most commonly used in statistical computations are listed in this chapter.
10. Data has many uses and the proper collection and interpretation of data will become increasingly important as health care reimbursement dwindles and emphasis on quality assessment increases.

H. CHAPTER 1 TEST

1. Indicate whether the data represented in each of the following examples is part of a population or a sample:

a. Twenty-five cases of TB have been reported in the past year and a patient care evaluation study is to be carried out using data from all 25 cases.	Population	Sample
b. Sixty gastroscopies have been performed during the past two months and a study is to be carried out regarding various variables. Twenty-five of these cases will be reviewed.	Population	Sample
c. A total of 388 chest x-rays were performed during the past month. A quality control review is to be carried out on 10% of the group.	Population	Sample

2. Indicate the terms for:

   a. A value that can change ____________________

   b. A value replaceable by only one number ____________________

3. For each of the following, indicate if the data is nominal or ordinal.

a. Educational level	Nominal	Ordinal
b. Fitness status based on a rating scale	Nominal	Ordinal
c. Medical record number assigned by the hospital	Nominal	Ordinal
d. License plate number	Nominal	Ordinal
e. Placement (finish) in the 50-yd dash	Nominal	Ordinal

4. Indicate whether the following represent quantitative or qualitative variables:

a. Type of insurance	Quantitative	Qualitative
b. Place of birth	Quantitative	Qualitative
c. Number of hospital admissions	Quantitative	Qualitative
d. Number of chemotherapy treatments	Quantitative	Qualitative
e. Blood pH	Quantitative	Qualitative
f. Exercise engaged in for fitness	Quantitative	Qualitative
g. Urinalysis glucose level	Quantitative	Qualitative
h. Condition of patient at time of discharge	Quantitative	Qualitative

5. Indicate whether the data associated with the following are discrete or continuous data:

a.	Birth weight	Discrete	Continuous
b.	Cost of hospital stay	Discrete	Continuous
c.	Number of times a patient sees her physician during the year	Discrete	Continuous
d.	Number of children in a family	Discrete	Continuous
e.	Platelet count	Discrete	Continuous
f.	Deaths reported in November	Discrete	Continuous
g.	Minutes needed to walk a mile	Discrete	Continuous

6. Indicate the term for the type of data on which:
   a. Mortality statistics are computed. ______________________
   b. Morbidity statistics are computed. ______________________

7. Fifty students completed a medical terminology course at State University. The scores on the final exam were recorded as follows:

93	75	98	74	77	54	78	57	72	99	86	63	72	77	70
44	66	73	48	82	84	50	66	81	68	95	90	91	60	72
71	88	44	38	92	67	75	82	81	66	70	90	55	97	72
74	84	55	49	100										

   a. Rank the individual scores from best to worst.

   b. List each individual score only once and place a tally mark after each score.

   c. Using the grouping below, place a tally mark after each interval for each of the final scores.

98–100	82–85	66–69	50–53
94–97	78–81	62–65	46–49
90–93	74–77	58–61	42–45
86–89	70–73	54–57	38–41

8. Identify the following abbreviations:
   a. NB
   b. Σ
   c. A&D
   d. A&C
   e. DOA
   f. IP
   g. LOS
   h. ICU
   i. >

CHAPTER

2

Mathematical Review

CHAPTER OUTLINE

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Explain the terms:
   a. Fraction
   b. Decimal
   c. Percentage
   d. Rate/Ratio/Proportion
2. Distinguish between the numerator and denominator of a fraction.
3. Average a set of numbers.
4. Round data to a specified number.
5. Convert a number from one form to another form:
   a. Fraction to percentage.
   b. Ratio to percentage.
   c. Decimal to percentage.
   d. Percentage to decimal.
   e. Percentage to fraction.

The use of the word *data*, as explained in the previous chapter, refers to numerical information and most commonly is information that has been organized in some way so that it can be analyzed and used as a basis for a decision. Once numbers have been collected, they are often arranged for ease and speed of retrieval. This organized data is a data base, a term heard frequently in a health care setting. Considerable data are compiled on both inpatients and outpatients, especially today when computers facilitate both the collection and arrangement of data.

The individual numbers gathered and collected on a patient become more meaningful when they are combined and compared with those of other patients, especially patients with similar conditions, ages, or other similarities. Data can be converted into usable information by using various mathematical and statistical formulae. This chapter reviews basic mathematical terms and computations needed to compute the rates and formulae in the chapters that follow.

A. FRACTIONS

Fraction: A fragment or part of a whole; small part; bit.

Example: If a pie is divided into six equal slices and an individual eats one slice, that individual has eaten one-sixth of the pie. If two slices of pie are eaten, one-third of the pie would be consumed (2/6 = 1/3). Three of the six slices being eaten results in half the pie being devoured (3/6 = 1/2).

Example: Substituting hospital data, if there are twelve beds set up and available on a clinical unit and eight of them are occupied by patients, then two-thirds (8/12 = 2/3) of the beds on that unit are filled but one-third (4/12 = 1/3) are still available.

SELF-TEST 1: Eighty-five babies are delivered during the month of May. Of these, 43 were born to a Caucasian female, 25 to an African American female, 12 to a Hispanic female, and five to an Oriental female. Indicate what fraction of these 85 babies was born to each race in May.

1. Numerator

Numerator: The top number (number above the line) of a fraction.

Example: In the fraction 6/16, 6 is the numerator.

SELF-TEST 2: Indicate the numerator for the following fractions:

a. 3/13 b. 10/18 c. 6/5

2. Denominator

Denominator: The bottom number (number below the line) of a fraction.

Example: In the fraction 5/15, 15 is the denominator and 5 is the numerator.

SELF-TEST 3: Indicate the denominator for the following fractions:

a. 7/17 b. 3/10 c. 9/8

3. Quotient

Quotient: The number resulting from division of one number by another. With fractions, the quotient is obtained by dividing the numerator by the denominator. The more correct terminology is that the quotient is determined by dividing the dividend (numerator in a fraction) by the divisor (denominator of a fraction).

Example: Twenty cookies are to be divided among 15 people. To find how many cookies each person receives, 20 is divided by 15, resulting in a quotient of one-and-one-third cookies for each person (20/15).

SELF-TEST 4: Find the quotient for each of the following:

a. 600/25 b. 3/8 c. 18/40

B. DECIMALS

Decimal: An amount less than 1. A decimal is a fraction based on divisions that are powers to the negative base 10 (10 to the –1 power would be 1/10). (0.10 = 1/10; 0.01 = 1/100; 0.001 = 1/1000, etc.)

Example: If a pan of brownies is divided into ten pieces and eight are eaten, then 0.8 of the brownies in the pan were eaten (8/10 = 0.8).

Example: If ten residents of a city with a population of 10,000 are diagnosed with pertussis, then 0.001 have been afflicted.

Example: If a pie is cut into eight pieces and six of the eight slices are consumed, then three-quarters or 0.75 of the pie has been eaten (6/8 = 0.75).

SELF-TEST 5: What is the decimal equivalent of each of the following?

a. 6/60 b. 4/1000 c. 9/200

C. PERCENTAGES

Percentage: The number of times something happens out of every one hundred times. A percentage is a specific rate followed by a percent sign; it is a proportion of a whole.

Example: If 40 out of every 100 hospital employees have attained a four-year college degree, then it can be said that 40% of all employees at that hospital have earned a bachelor's degree.

Example: A total of 125 mammograms were performed in February, of which 25 were reported to show some type of abnormality. Therefore, a total of 20% (25 ÷ 125 or 25/125 = 0.20 or 20%) showed an abnormality.

SELF-TEST 6: Find the following percentages:

a. 12/50 b. 4/10

c. 3/1000 d. 45/8640

D. RATES

Rate: Rate has many meanings. It can mean a value or price (as in 50 cents a pound); it can be a unit of something (as in the rate of speed is 30 mph, or the birthrate is 20 births per every 100 teenagers, or the interest rate is 8.6%). A rate is also a ratio, proportion, or rank. Most commonly a rate is expressed as a percentage.

Example: A bank advertises the interest rate for a savings account as 5%. A hospital reports an 85% occupancy rate. Statistics might show that the infection rate at a certain hospital during the previous year was 8%.

SELF-TEST 7: The newborn nursery reports that 120 infants were born at the hospital during the month of May. Five of these infants died shortly after birth and the rest were discharged. What is the newborn death rate?

E. RATIO/PROPORTION

Ratio: A relationship between things or of one thing to another thing; it is also a rate or proportion. A ratio is generally expressed as a fraction (for example, 8/10 or 4/5). All rules that apply to fractions apply equally to ratios.

Ratios are also written with the numbers side-by-side and separated by a colon (8:10 or 4:5 or 65:100). The following are equivalent: 8/10; 4/5; 40/50; 80/100; 20:25; 12:15.

Example: Seven out of ten people admitted to the hospital are found to be over 50 years of age. This ratio could be written as 7/10 or 7:10.

Proportion: A relationship of one portion to another or to the whole, or of one thing to another. A proportion is a ratio.

SELF-TEST 8: One hundred operations were performed this past month. If 20 of these were orthopedic procedures, 12 were gynecological, 18 were ophthalmological, 22 were urological, and the remainder were general surgeries, what was the ratio for each surgical category?

F. AVERAGING

Average: A number that typifies a set of numbers of which it is a function. Statistically speaking, an average is referred to as a mean, or arithmetic mean, to distinguish it from the median and mode, which are also used statistically as measures of central tendency (see Chapter 11 for measures of central tendency).

Formula to Compute an Average: Add (summate) all scores in a distribution and divide by the number of scores in the distribution.

$$\text{Average} = \frac{\Sigma \text{ (Sum) of all scores}}{N} \qquad (N = \text{number of scores in the distribution})$$

Example: A student has taken ten math tests. The scores for these tests are: 100, 95, 85, 90, 78, 92, 87, 81, 72, 94. Summing the ten scores yields a total of 874. This total is then divided by 10 (number of tests taken), which results in an average math test score of 87.4 (or 87).

Example: A hospital's ten-day admission figures are reported as follows: 10, 15, 12, 8, 6, 18, 16, 5, 9, 13. To find the average number of patients admitted during this ten-day period, add all the admission figures (112) and divide by the number of days (10). The result is 11.2 (or 11), which indicates that during that period the hospital averaged eleven admissions per day.

SELF-TEST 9

1. The surgical center of a hospital lists the number of operations performed each day as follows: 6, 10, 8, 9, 5, 12, 7.

   Determine: Average number of operations performed each day during that week.

2. A hospital's yearly death records reveal the following monthly figures: 3, 4, 1, 2, 6, 2, 5, 8, 1, 4, 6, 3.

   Determine: Average number of deaths reported each month.

3. A total of 575 stress electrocardiograms were performed in May.

   Determine: Average number of stress EKGs performed daily in May.

4. A total of 1050 patients were seen in the ER during the first six months of a non-leap year.

   Determine: Average number of patients seen daily in the ER during the first six months of the year.

5. The following number of newborn babies were reported for the week: 2, 2, 4, 1, 3, 1, 3.

   Determine: Average number of babies born each day.

G. ROUNDING DATA

Why Round? When working with data, the result does not always compute to a whole number. When the scores in the previous section were averaged, the resultant average often included a decimal fraction. For instance, when averaging 9 + 10 the result comes to 9.5. In another instance, the number beyond the decimal point could continue indefinitely, as when averaging 6, 9, 7. Adding the three scores yields a total of 22 (6 + 9 + 7) and dividing by 3 results in an average score of 7.33333, etc., extending indefinitely. Often data must be rounded to a usable number.

Carried To. When dividing fractions, it is important to specify the decimal place to which the division should be carried out. It is generally better to carry out the division too far than not far enough. With the availability of hand-held calculators, the division can be carried out well beyond the place needed for most calculations. A division should be carried at least one place farther than the specified (*corrected*) decimal place for the final answer and rounded off to that specified place.

Example: In the above paragraph the average score (determined by dividing 22 by 3) was found to be 7.333333, etc. If asked to carry the division to 3 decimal places, the score would be reported as 7.333.

Corrected To. Once the quotient appears on the calculator display, it must often be shortened to an acceptable, specified length. Seldom are hospital data carried beyond two or three decimal places. When data are to be *corrected* to two decimal places, the calculation must be *carried* to three decimal places—at least one place beyond the requested place. If the answer is to be correct to the nearest whole number, it must be carried to one decimal place; if it is specified that the answer be correct to one decimal place it must be carried to two decimal places, and so on. This extra place is necessary to round the answer to the *correct* digit.

Example: Using the above scores, if the final result is to be corrected to two decimal places, the answer is 7.33 (as the third place number is less than 5). If the "carried to" result had been 7.335, then the "corrected" score is recorded as 7.34 since the third place number is 5 or greater.

When to Increase or Round-up. If the last digit is five or greater, the preceding number should be increased one digit. If the last digit is less than five, the number remains the same. Be sure to note to what decimal place the computation should be "correct to" and then carry the answer one additional place and round the final answer, based on this additional digit.

Example: If 365.6 is to be rounded to the nearest whole number, the answer becomes 366 (since 0.6 is 0.5 or greater).

Example: If a computation results in an answer of 7.65 but the answer is to be "correct to" one decimal place, the answer becomes 7.7 (since the number following 6 is 5 or greater). (7.84 becomes 7.8.)

Example: If 17.655 is to be corrected to two decimal places, the answer becomes 17.66. (45.653 becomes 45.65.)

SELF-TEST 10

1. Round to the nearest whole number:

a. 65.4	d. 70.5	g. 38.499	j. 10.05
b. 65.5	e. 7051.4	h. 595.85	k. 15.555
c. 65.6	f. 0.6	i. 148.475	l. 55.505

2. Round correct to one decimal place:

a. 12.35	d. 0.005	g. 83.95	i. 6.555
b. 27.625	e. 456.955	h. 1.05	j. 76.049
c. 31.6511	f. 698.99		

3. Round correct to two decimal places:

a. 65.699	d. 953.799	g. 17.999	i. 100.055
b. 68.636	e. 125.9995	h. 79.995	j. 1.1548
c. 0.005	f. 65.666		

4. Round to the nearest

a. hundred	3256
b. tenth	5.781
c. thousandth	0.0045
d. hundredth	46.7385

e. million 3,502,378

f. ten 2184.73

g. hundredth 43.87500

h. thousand 45,679.88

H. CONVERSION TO ANOTHER FORM

1. Fraction to Percentage

Formula:

$$\frac{\text{Numerator}}{\text{Denominator}} \times 100$$ (Add a percent sign to the result.)

Example: To convert 60/80 to a percentage, divide 60 by 80, and then multiply the quotient by 100, which equals 75% [(60 ÷ 80) × 100 = 75].

Example: A test has five questions. A student answers two of the five correctly (2/5). Converting this to a percent, divide 2 by 5, and then multiply the quotient by 100, which gives a 40% score [(2 ÷ 5) × 100 = 40].

SELF-TEST 11: Convert the following fractions to percentages—correct to one decimal place.

a. 5/8	b. 65/83	c. 1/7
d. 7/8	e. 70/200	

2. Ratio to Percentage

Formula: Convert ratio to fraction and proceed as in #1 above.

Example: One out of eight nurses indicated that he or she had worked a double shift the previous month. To convert this information to a percentage, divide 1 by 8, and then multiply the quotient by 100, which gives 12.5%, or 13% when rounded up [(1 ÷ 8) × 100 =12.5].

SELF-TEST 12: Convert the following ratios to a percent—correct to the nearest whole percent.

a. 1:3	b. 7:11	c. 5:6
d. 11:17	e. 15:60	

3. Decimal to Percentage

Formula: Move decimal point *two* places to the right of the decimal point and add the percent sign.

Example: To convert 0.50 to a percentage, the decimal point is moved two places to the *right* (from 0.50 to 50.) and the number is followed by a percent sign (50%).

Example: Converting 0.001 to a percent, the decimal is moved two places to the right to give 0.1%. Note that since the answer is less than 1%, the decimal point remains even though it is moved two places to the right. (0.001 = 1/1000 × 100/1 = 1/10% or 0.1%.) It is common practice to use a zero in front of a decimal point if the answer is less than 1; also zeros are eliminated to the right of the decimal point if they are not followed by another number. (50.100 becomes 50.1 or 50.1%.)

SELF-TEST 13

1. Convert the following decimals into percentages without rounding:

a. 1.25	b. 0.635	c. 0.3
d. 0.03	e. 0.006	f. 0.8235
g. 0.0162	h. 0.55	

2. Convert the following decimals into percentages, correct to the nearest whole number (no decimal).

a. 3.25	b. 0.45677	c. 0.005
d. 0.5555	e. 0.0166	f. 0.0449

4. Percentage to Decimal

Formula: Cross out the percent sign and move the decimal point two places to the *left* of the decimal point.

Example: To convert 65% to a decimal, eliminate the percent sign and move the decimal point from 65. to .65.

SELF-TEST 14: Convert the following percentages to a decimal:

a. 5%	c. 0.5%
b. 11.4%	d. 125%

5. Percentage to Fraction

Formula: Cross out percent sign and place the entire number (percentage) in the numerator and place 100 in the denominator.

Example: To change 55% to a fraction, eliminate the sign and place 55 in the numerator and 100 in the denominator.

NOTE:

Fractions are often converted to their lowest form. In this example both 55 and 100 can be divided by 5, resulting in a fraction of 11/20, but either form is acceptable.

SELF-TEST 15: Convert the following percentages to the lowest fraction:

a. 75%	b. 87.5%	c. 33.33%
d. 112.5%	e. 20%	f. 84%
g. 50%	h. 98%	

I. COMPUTING WITH A PERCENTAGE

When computing with a percentage, the percentage is converted to a decimal, as above, and used in that form.

Formula: Change percentage to decimal and multiply by N (total number in the distribution).

Example: If 60% of all patients admitted to the hospital have a blood glucose test, how many patients were administered a blood glucose test in the past year, out of 6000 admissions? Convert 60% to 0.60 and multiply by 6000 = 3600 patients.

Example: A hospital has 80% of its 120 beds filled. To find how many empty beds are present, change 80% to 0.80 and multiply by the number of beds (120 × 0.8 = 96 beds) and subtract from 120 (120 – 96 = 24). Alternatively, it can be said that if 80% of the beds are filled, 20% are empty. This 20% number can also be used for the computation (0.20 × 120 = 24 empty beds).

SELF-TEST 16

1. Convert 25% to the *lowest* fraction.
2. Convert 62.5% to the *lowest* fraction.
3. Convert 60% to the *lowest* ratio.
4. Convert 0.5% to a decimal.
5. Convert 3% to a decimal.
6. Convert 12% to a decimal.
7. A hospital reports that, in January, 40% of its patients had a blood glucose test. If there were 1050 patients in the hospital in January, how many had a blood glucose test?
8. If it is reported that two-thirds of all patients on a given day will have a CBC, how many out of every 100 patients will have a CBC? Correct your answer to the nearest whole number.
9. A health information management department has 28 full-time employees and 18% are home with the flu. How many employees are working?
10. A Salmonella outbreak occurs in a hospital and 8% of the patients and staff are diagnosed with the illness. If the hospital has 350 employees and the present patient count is 225, how many people (patients and staff) have been diagnosed with Salmonella—correct to the nearest whole number?

J. SUMMARY

1. A fraction is a part of a whole written as one number over another number. The numerator is the top number; the denominator is the bottom number. The quotient is obtained by dividing the top number by the bottom number.

2. A decimal is an amount less than one and is preceded by a decimal point; it is the fractional amount obtained by dividing the numerator by the denominator of a fraction.
3. A percentage is a decimal multiplied by 100; the percentage number is followed by a percent sign.
4. A rate is a quantity measured with respect to another measured quantity; it is often defined as the number of times something happens divided by the number of times it could happen.
5. A ratio (also known as a proportion) is the relationship between items or to other items.
6. An average is a measure of central tendency obtained by totaling the scores and dividing the total by the number of scores in the distribution.
7. Rounding is a common practice and specifies the number of places to which the computation should be carried out beyond the decimal point, rounding *up* if the final number is 5 or more.
8. Computations can be converted from one form to another—fraction, ratio, or decimal to percentage; percentage to fraction or decimal.
9. When computing with percentages, the percent is converted to a fraction or decimal before proceeding with the computation.

K. CHAPTER 2 TEST

1. Compute the following averages:
   a. Ten patients were discharged yesterday. Two of these discharged patients were hospitalized three days, two were hospitalized four days, and the rest were in for 5, 7, 8, 1, 9, and 2 days, respectively. What was the average number of hospitalized days for this group, correct to one decimal place?

   b. During the past week, the following number of cases of measles were reported state-wide each day: 7, 5, 12, 18, 22, 14, 9. What was the daily average, correct to one decimal place?

   c. A hospital reports the following number of autopsies performed each month by the hospital pathologist: 10, 9, 12, 12, 7, 14, 8, 11, 9, 11, 13, 7. What was the average number performed monthly, correct to the nearest whole number?

2. Round to two decimal places:
   a. 40.636 b. 40.666 c. 40.699
   d. 10.999 e. 18.555 f. 0.095

3. Round to the nearest whole number:
   a. 40.499 b. 70.555 c. 67.9
   d. 7770.4 e. 0.5 f. 55.5

4. Round to the nearest
   a. hundred 4455
   b. tenth 4.657
   c. thousandth 0.0055
   d. million 4,500,000
   e. hundredth 63.895
   f. ten 77.499
   g. thousand 87,485.7

5. Convert to a percentage—correct to one decimal place:

a. 60:80	b. 2/5	c. 0.03
d. 0.66	e. 1.08	f. 7/8
g. 6/50	h. 6:9	

6. Convert to the lowest fraction:

a. 60/100	b. 80%	c. 35/65
d. 33/99	e. 10%	f. 5:100

7. Convert to a decimal—correct to two decimal places:

a. 1/12	b. 2/15	c. 45/65
d. 73%	e. 10:90	f. 4 out of 4

8. Given the following rate, ratio or proportion, determine the decimal equivalent and the corresponding percentage.

Rate/Ratio/Proportion	***Decimal Equivalent***	***Percentage***
a. 2/100		
b. 6/25		
c. 16:84		
d. 360/900		

9. Given the following percentages, determine the corresponding decimal equivalent and ratio.

Percentage	***Decimal Equivalent***	***Ratio***
a. 83.33%		
b. 87.5%		
c. 66.67%		
d. 40%		
e. 0.50%		
f. 0.025%		

10. Compute the following—correct to the nearest whole number.
    a. If six out of ten patients admitted to the hospital are discharged in three days or less, how many out of 12,689 recorded admissions were hospitalized over three days?

    b. A hospital discharged 2895 patients in January. If three percent developed a hospital-based infection, how many were affected?

    c. A hospital reported 14,444 discharges during the past year. If 35% of these patients were seen in consultation, how many discharged patients were seen by a consultant?

CHAPTER

3

Health Care Overview and Statistical Data Collection

CHAPTER OUTLINE

I. Health Care Overview
   A. Health Care Facilities/Health Care
      1. Hospital (Acute Care) (Short Term Care)
      2. Long Term Care Facility (LTC); Extended Care Facility (EFC); Nursing Home (NH)
      3. Specialized Facilities
      4. Outpatient (OP) Care
         a. Terms
         b. Ambulatory Care
         c. Home Care (HC)
         d. Hospice Care
         e. Respite Care
   B. Payers (Payment Providers)
      1. Insurance Carriers
      2. PPO (Preferred Provider Organization)
      3. HMO (Health Maintenance Organization)
      4. Self-pay
   C. Bed/Bassinet Classification
      1. Beds
         a. Beds by Age Classification
         b. Other Beds
      2. Bassinets
   D. Medical Care/Medical Staff/Medical Service Units
      1. Medical Care Unit
      2. Medical Staff/Service Unit
      3. Basic Service Classifications
      4. Expanded Medical Care Staff/Service Units
      5. Assigning Service Classification
   E. Transfers
      1. Intrahospital Transfer
      2. Discharge Transfer
      3. Additional Discharge Options
II. Statistical Data
   A. Data Collection
      1. When Collection Takes Place

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Define:
    a. Ancillary service/care
    b. Primary Care Center
    c. Incident Report
    d. Respite Care
2. Identify the following abbreviations:
    a. SNF
    b. ICF
    c. PPO
    d. HMO
3. Distinguish between:
    a. Inpatient care and Outpatient care
    b. Acute care and Long Term Care
    c. Bed statistics and Bassinet statistics
    d. Intrahospital transfer and discharge transfer
    e. Child and adolescent for hospital statistical purposes
    f. Retrospective and concurrent methods of data collection
    g. Emergency Room/Department and Trauma Center
4. Assign basic service classifications.
5. Name several sources of statistical data.
6. Identify the major requesters of statistical data.
7. Identify the aspects included in Vital Statistics.

Health care has undergone a myriad of changes in the past decade and all indications point to the trend continuing in the years ahead. Formerly patients were admitted to the hospital for the majority of medical care that could not be provided by the physician in the physician's office. Although hospitals still are the site for the majority of health care procedures, the trend has shifted dramatically from the inpatient to the outpatient setting. Although the primary focus of this textbook is the computation of the most commonly used statistical rates employed for hospital inpatients, many of the rates can be adapted to the outpatient or alternative care setting as well. Each health care facility has a need for evaluating the data it collects and hopefully the skills and understandings developed in the coming chapters will aid in this task. As inpatient care declines and outpatient care increases, employment also shifts to outpatient and alternative care settings with practitioners needing an overview of various health care facilities and commonly used terms. This chapter provides that information as well as an overview of data collection and a section on vital statistics, though formulae for computing rates are presented in subsequent chapters.

I. HEALTH CARE OVERVIEW

As mentioned, health care services are offered in a wide variety of settings, some residential and others ambulatory. A sampling of both types follows.

A. Health Care Facilities/Health Care

1. Hospital (Acute Care) (Short Term Care)

The *Glossary of Health Care Terms* defines a hospital as a health care institution with an organized medical and professional staff and with inpatient beds available round-the-clock, whose primary function is to provide inpatient medical, nursing, and other health related services to patients for both surgical and non-surgical conditions and that usually provide some outpatient services, particularly emergency care. For licensure purposes each state has its own definition of "hospital." Hospitals come in all shapes and sizes and provide a great variety of services.

2. Long Term Care Facility (LTC); Extended Care Facility (ECF); Nursing Home (NH)

The major difference between a LTC facility and a hospital is in the level of care. Long term care patients are not in an acute phase of illness but require inpatient care. Patients are assigned a LTC bed and receive round-the-clock care by professional staff.

a. SNF (Skilled Nursing Facility)

A Skilled Nursing Facility provides the highest level of LTC. SNFs are no longer just nursing homes for elderly patients, but provide additional care for discharged hospital inpatients who continue to need skilled nursing care. Therefore, they serve a dual population—those with long stays (possibly years) versus those who may remain for days or weeks as they continue their convalescence from an acute episode. Many of these patients formerly remained in the hospital until they made a complete recovery. In the present health care environment, a patient recovering from a stroke or hip replacement surgery may continue care in a skilled nursing facility prior to being discharged home.

b. ICF (Intermediate Care Facility)

An Intermediate Care Facility also provides Long Term Care but provides a more limited degree of support and nursing services than are provided in the SNF. Persons with a variety of physical or emotional conditions may still need institutional care but require less skilled nursing care.

c. RCF (Residential Care Facility) or Life Care Center

A Residential Care Facility is a care facility that provides custodial care to those unable to live independently. The residents may suffer from physical, mental or emotional conditions.

3. Specialized Facilities

A specialized facility treats a unique population. As with hospitals, the treatment can be on an inpatient or outpatient basis. Included are some examples of specialized facilities.

a. Rehabilitation Facilities
b. Psychiatric Facilities
c. Substance Abuse Treatment Facilities

d. Children's Hospitals
e. Cancer Treatment Centers
f. Burn Facilities
g. Dialysis Centers

Many of the statistical formulae in this text can be adapted to meet the needs of each of these alternative care facilities. It is important to remember that the definition of terms be understood by everyone using the data and that the data collected be accurate and uniformly obtained. For statistics to serve their purpose, the figures must be relevant and reliable if the results or analysis are to be accurate. Statistics are only as accurate as the original data from which they are obtained. The kind and extent of data collected and the uses made of the data vary from one health care institution to another. Data compiled and compared must be based on uniform collection and reporting.

4. *Outpatient (OP) Care*

Presently, the majority of care is on an outpatient or ambulatory basis due to increasing costs of inpatient care. Health care costs have risen much faster than inflation, and employers, who pay a large percentage of the health premiums for their employees, have sought ways to keep a lid on escalating health care expenses.

a. Terms

(1) ENCOUNTER

An encounter is professional contact (being physically present) between a patient and a provider who delivers services or is professionally responsible for services delivered to a patient. The professional may be a physician, pharmacist, x-ray technician, medical technologist, or any other health care professional who is physically present and provides a service, such as analyzing a specimen or interpreting an image of the patient for a referring physician.

(2) OCCASION OF SERVICE

An occasion of service is a specific act of service provided a patient. Each test, examination, treatment or procedure that a patient undergoes is one occasion of service. A chest x-ray is an occasion of service as is a barium enema.

(3) VISIT

An outpatient visit is a single appearance for service(s) in a health care facility. A visit may involve one occasion of service or a number of related or unrelated services. A patient scheduled and undergoing blood work, an EKG and an x-ray, all to be performed during the same scheduled appearance, is credited with an outpatient visit.

A health care facility needs to maintain data on each encounter and on the number and types of these encounters. Ambulatory care facilities must have appropriate procedures to record data on outpatient visits, encounters, and occasions of service so that accurate patterns of care are appropriately documented and readily available for analysis.

Increased longevity has resulted in an increase in chronic illness, which can most generally be treated on an ambulatory basis. Rehabilitation services have increased and new programs are constantly being established. For cost containment, there has been an increase in community health clinics, which may or may not be associated with the hospital.

There is no standard or uniform way of classifying outpatient care. Outpatient services include:

b. Ambulatory Care

(1) ANCILLARY SERVICES (ADJUNCT OR AUXILIARY SERVICES)

A patient is referred by his/her physician for diagnostic tests: laboratory (GTT); radiology (barium enema); or therapeutic services (physical therapy, occupational therapy, chemotherapy).

(2) PRIMARY CARE CENTER

Care provided by a Primary Care Center is very similar to care provided in physician's offices. Many hospitals have set up and staffed such facilities either on their premises or as a satellite (off site) operation. Basic health care is provided by a primary care physician (family practice, internist, or pediatrician).

(3) EMERGENCY CARE/DEPARTMENT

Most hospitals have some type of Emergency Department (ER). Certain hospitals are also designated as Trauma Centers (Level I, Level II) which are equipped to handle the most life-threatening emergencies. Since care in a hospital ER is very costly, there have been increased restrictions placed on the use of these facilities by employee benefit plans. Patients enrolled in HMO and PPO plans must often have preauthorization for the plan to pay for care in an ER. Due to these restrictions, along with an increase in freestanding Primary Care Centers and, in some cases, expanded physician office hours, there has been a decrease in non-emergency care being administered in the ER.

(4) AMBULATORY SURGERY FACILITIES

More and more surgical procedures are performed on an ambulatory basis. In ambulatory surgery facilities, surgical services are provided by professional staff to patients who do not require an inpatient bed. The facilities may be located at the hospital or in a satellite facility.

c. Home Care

Many hospitals have established home care departments that provide professional services in a patient's home. A hospital may also contract with an independent home care provider to provide these services. Home care helps to maintain or restore health, or to minimize effects of illness and disability. It is a cost-effective means to allow patients to remain at home as opposed to some form of residential or institutionalized care.

d. Hospice Care

Hospice care is care for the terminally ill and their families. Many hospitals provide outpatient hospice care and some also maintain an inpatient hospice unit, should inpatient care be required.

e. Respite Care

Respite means a short interval of rest or relief. Respite care provides relief to a caregiver by providing care to the person being cared for. For example, a family caring for an ill parent at home may require care for the parent during the interval of time when they will be away to attend a wedding. The care provided by the relief provider is known as respite care.

B. Payers (Payment Providers)

Hospitals often track their financial data by payer or payer class. Many hospitals will keep statistics on Medicare and Medicaid patients. Medicare is national health insurance for senior citizens, age 65 or older; Medicaid is a national program, administered on the state level, provided to those who qualify, most often welfare recipients. Each state sets eligibility and payment standards for Medicaid recipients. Listed below are several types of payers.

1. *Insurance Carriers*

There are both private and governmental insurance providers. Many employers provide their employees with health insurance such as Blue Cross/Blue Shield. In addition to Medicare and Medicaid (both governmental carriers), the government also provides insurance to the military through Champus. Payment is also provided by Workers' Compensation and liability insurance companies.

2. *PPO (Preferred Provider Organization)*

Employers with a substantial number of employees may contract with a hospital and other providers to offer services at a negotiated, reduced cost. The benefit package usually includes physician and hospital services as well as other services. Subscribers are free to use providers other than those affiliated with the PPO, but generally need to pay the added cost out-of-pocket.

3. *HMO (Health Maintenance Organization)*

The fastest growing type of insurance is provided by HMOs. A fixed premium is paid by members in return for services covered under the plan. HMOs were designed to provide preventive care in hopes of reducing health care costs. On enrollment, the patient chooses a primary care physician who will coordinate care and make referrals as needed to specialists.

4. *Self-Pay*

Patients without insurance are billed directly.

C. Bed/Bassinet Classification

Hospitals provide inpatient services to those who have been assigned a bed or bassinet (isolette, incubator). Separate statistics are often computed for those occupying beds versus those occupying bassinets.

1. *Beds*

Adults and children are included in inpatient bed statistics. The majority of hospitals combine adults and children into one group, though some hospitals separate the two groups for statistical purposes. Sometimes hospitals designate three age classes—adults, children, and adolescents.

a. Beds by Age Classification

(1) ADULT—THOSE ABOVE THE AGE OF CHILDREN.

(2) CHILDREN

No age standard has been universally accepted as the age limit for classifying a patient as a child. The term child and pediatric patient are not synonymous terms. Technically, pediatric patients are those cared for by a physician from the pediatric medical staff unit. However, a child treated for leukemia by an oncologist on the oncology medical staff unit would be included in "children" data. Whenever adult and children data are to be reported separately, the hospital must state the upper age limits for a "child." United States hospitals have not set a universal age limit separating adults and children. Most often the dividing line is the 14th birthday; that is, a child who is age 13 or younger (under the age of 14) is assumed to be a child. Some facilities include 14-year-olds as children. Standards should be established by the facility that keeps separate statistics on children.

(3) ADOLESCENT

No universal age limit applies to adolescents but most facilities use 13 or 14 as the lower limit and the late teens or early twenties as the upper limit. In most instances adolescents are included in adult statistics.

b. Other Beds

(1) TEMPORARY BEDS

Beds used on a temporary basis for treatment are not included in bed statistics. Temporary beds include:

(a) Treatment beds—beds temporarily occupied during treatment.
(b) Disaster beds. Disaster beds are beds set up in lounges, hallways and rooms not normally occupied by beds, during times of disaster (such as an earthquake or plane crash).
(c) Delivery room beds
(d) Recovery room beds
(e) Observation beds. Observation beds are temporary beds used on an outpatient basis. A patient assigned an observation bed may remain under observation for a 24-hour period, during which time the patient is an outpatient. If the patient remains beyond 24-hours the patient is admitted and becomes an inpatient.

(2) SWING BEDS

Swing beds are hospital beds (for adults and children) that may be used flexibly to serve as either acute or Long Term Care beds. Swing beds are most common in rural hospitals with less than 50 beds or staffed and operating with 49 or fewer beds.

2. *Bassinets*

Bassinets are the beds or isolettes in the newborn nursery. Newborn statistics are generated from bassinet data. Since a newborn is a patient born in the hospital at the beginning of his current inpatient hospitalization it excludes other babies even though they occupy a similar bassinet. Also, only those babies with signs of life at birth are newborns. A stillborn infant or dead fetus is not a newborn and is not included in bassinet data. Also, a stillborn is not considered a hospital admission.

D. Medical Care/Medical Staff/Medical Service Units

There are several terms used to indicate where hospital care is provided, which medical specialties provide the care, and which medical services were administered during a patient's hospitalization. The terms medical care unit, medical staff unit, and medical service unit are often used to indicate where and by whom the care or service was provided. Since the major emphasis of this text is to prepare students for statistical computation of standardized formulae that apply to health care settings, these terms will not be explained in great detail. Mention is made of these terms because each patient is assigned or classified by service designations during their hospitalization and statistics are then generated based on the classification. In this manner a health care facility keeps track of how many patients received care for kidney failure, deep vein thrombosis, foot amputation for diabetic gangrene, or were assigned to the orthopedic service for a fracture of the head of the femur.

1. Medical Care Unit

There are often two aspects to the term medical care unit: (a) Physical Layout and (b) Functional Aspect.

(a) Physical Layout

The term care unit primarily refers to the layout of the facilities or beds. A care unit is an assemblage of beds or newborn bassinets where care for a particular type of condition (for example, orthopedic care) is provided. To facilitate care and provide appropriate care to each patient, whether a neurology patient or pediatric patient, the patients are assigned to the unit where the appropriate care can best be provided and obtained. A unit designated as 3 South is referred to by its location on the third floor.

(b) Functional Aspect

Often the unit is designated by medical staff organization. The care unit is synonymous with the department, division, or specialty into which the medical staff is divided. Hospitals may refer to a care unit by the type of care provided as in psych unit, eye wing, or ortho unit.

2. Medical Staff/Service Unit

Medical staff are often divided into units by specialty. Medical care unit and medical staff/service unit designations can vary greatly from hospital to hospital. Medical care and medical services are provided by the physicians on the medical staff, assisted by nurses, and other professionals (social workers, psychologists, medical technologists, x-ray technicians, pharmacists) and technical personnel (housekeeping, dietary), who provide services under the direction of a physician. The physicians write the orders that are then carried out by the appropriate departmental staff. Among the factors affecting medical staff unit assignments are:

(a) Size of the hospital. The larger the facility, the more services are likely to be provided.

(b) Number of physicians on the medical staff and the degree of specialization of these physicians.

(c) Type of treatment rendered to patients.

(d) Type of medical staff organization. The organization of each medical staff into medical staff units is stated in its bylaws, and the rules and regulations of the medical staff.

3. ***Basic Service Classifications***

A hospital lacking formal organization into medical staff/service units is to assign patients into one of four basic units or service classifications.

(a) Medical

All patients not classified in any of the following categories is classified a "medical" patient.

(b) Surgical

An assignment is made to "surgical" if the surgical operation was performed in the operating room. The primary exception to this rule is obstetrical surgery. A patient delivering by C-section is counted and classified as an obstetrical patient (not surgical), though the surgery is included as a surgical operation in operating room statistics.

(c) Obstetrics

Any patient being treated for a pregnancy condition, whether she delivers or not during the hospitalization, is an obstetric patient. A patient having a disease or condition of pregnancy, labor and the puerperium, whether normal or pathological is an OB patient. Obstetric patients may be subdivided into:

(1) Delivered in the hospital, whether liveborn or fetal death, or
(2) Admitted after delivery, or
(3) Not delivered.

(d) Newborn

A liveborn delivered in the hospital is a newborn. As stated previously, a newborn must be alive at birth and be born in the hospital.

4. ***Expanded Medical Care/Staff/Service Units***

A major teaching hospital or other large city hospital may have a large number of medical care/staff/service unit classifications. In addition to the four basic medical staff units, as many as 60 "standard" staff units are used.

The term "special care unit" is also used to designate a specialized type of treatment provided by that unit. Examples of special care units include burn, cardiac care, cardiovascular surgery, neonatal intensive care, renal dialysis, and intensive care units. Special care units are medical care units.

Medical staff units can include dermatology, obstetrics/gynecology, otorhinolaryngology, physical medicine and rehabilitation, neurology, general surgery, neurosurgery, orthopedic surgery, urology, psychiatry, and pediatrics.

5. ***Assigning Service Classification***

Medical care units do not ordinarily correspond to medical staff units. For example, medical care units are often classified into medical, obstetrical, newborn, pediatrics, intensive care, and surgery, whereas the medical staff or service classifications may be medical, surgical, orthopedics, obstetrics/gynecology, and otorhinolaryngology.

Each patient is assigned a service classification and statistics are generated based on these service classifications. It is more appropriate to compare a urology patient with another urology patient than to compare a CVA (cerebrovascular accident) patient to a pediatric patient. When abstracting service designations upon discharge, only those units into which the medical staff is formally organized should be used. Some facilities classify patients to a service or disease service by the primary or most significant diagnosis and operation. For statistical considerations throughout this text it will be assumed the medical staff units and service classifications are identical to the medical care units.

E. Transfers

Patients are occasionally transferred after their initial admission either to another medical care unit or occasionally to another health care facility. A patient transferred within the admitting facility is called an intrahospital transfer and the latter is a discharge transfer.

1. *Intrahospital Transfer*

An intrahospital transfer is a change in medical care/staff unit, or responsible physician, of an inpatient during hospitalization. In larger hospitals care on a specific medical care unit may be restricted to patients with the appropriate diagnosis. Also, levels of care change and a seriously ill patient assigned to the Intensive Care Unit will likely be transferred to a lesser level of care prior to discharge.

Records are kept concerning the number of days on each medical care/staff unit. Reports should clearly indicate whenever patient transfers occur during hospitalization and to which medical care/staff unit the patient was transferred. It is important to record transfers on all units. A patient listed as transferred in (TRF-in) has been admitted to the unit. A patient who was transferred out (TRF-out) was discharged from the unit and reassigned to another unit. It is important to credit the proper medical care/staff unit for all intrahospital transfers. In this way the number of days of care on each medical care/staff unit can be tabulated.

2. *Discharge Transfer*

A discharge transfer is the disposition of an inpatient to another health care facility at the time of discharge. The patient may be transferred for many reasons including a need for more specialized care than can be provided at the current facility or to continue convalescence at a lower level of care. Pertinent medical record data is sent with the patient to the new facility to aid in continuity of care.

3. *Additional Discharge Options*

At the time of discharge a notation is included in the patient's medical record as to the disposition of the patient. A patient who was not transferred most likely was discharged home (routine discharge), left AMA (against medical advice), or died (expired in the hospital).

II. STATISTICAL DATA

A. Data Collection

1. When Collection Takes Place

The two most commonly used terms to indicate when data collection occurs or occurred are retrospective data collection and concurrent data collection. For instance, some hospitals code the data in the patient's medical record retrospectively and others do it concurrently.

a. Retrospective Collection

Data collected upon or following discharge is called retrospective data collection. Data that is collected after the medical record has been received in the health information management department is recorded retrospectively.

b. Concurrent Collection

Data collected during the inpatient stay is called concurrent collection. In the concurrent method, collectors visit the nursing station and collect data from the inpatient record.

2. Recording Data

a. Manual

Data entered on work sheets and later processed is designated as manual data entry. A worksheet often is provided and data is entered under columnar headings.

b. Direct Computer Entry

Data entered directly into the computer is much more efficient and eliminates what is called "dual data entry" in which data is first entered onto a worksheet and then entered into a computer. If data is to eventually be entered into a computer anyway it saves time and is more cost effective if it is entered directly by the department generating the data. For example, often a nurse needs to record TPR (temperature, pulse, and respirations) in the medical record. Rather than making each entry first on a sheet of paper and then entering the data into the computer, time can be saved by direct entry.

3. Amount of Data Collection

Just because computers make data collection and storage easier than via the old manual methods is not reason enough to collect as much data as possible. Computers not only aid data entry but serve to store and retrieve increasing amounts of data. Just as accurate and adequate data is of utmost importance, it is also important to avoid collecting unnecessary data. An annual review should be carried out to determine what statistical reports are needed. When undertaking the review, the following should be considered.

a. What reports are needed routinely in-house by the administration and medical staff?
b. What reports are required by outside agencies?
c. What ad hoc data requests are made?
d. Are there data needs not being met; in other words is there data that could prove valuable to or aid the organization?

B. Sources of Statistical Data

There are innumerable sources from which statistical data can be gleaned. Listed are a few sources.

1. Medical Record

The patient's medical record is a primary source of statistical data. The medical record provides information such as admission and discharge dates, age, sex, diagnoses, operations and procedures, attending physician, consultants, expected payer, etc.

2. Abstracts

Information from the patient's medical record is often summarized in an abstract. A case abstract is data condensed into a more concise form from a larger whole. For instance, when a cancer registrar completes an abstract on a newly diagnosed cancer patient, the registrar transfers information from the patient's medical record to a form known as an abstract. An abstract may also be completed on an inpatient admission at the time of discharge. Abstracted data is entered in a database and reports can then be generated. For example, many states have a centralized cancer registry and the abstracted reports from all the hospitals in the state are used to generate cancer statistics.

3. Ancillary/Additional Reports

An ancillary unit, as previously mentioned, is an organized unit of a hospital other than an operating room, delivery room, or medical care unit, with facilities and personnel to aid physicians in the diagnosis and treatment of patients through the performance of diagnostic or therapeutic procedures. Ancillary services include the medical laboratory, radiology, pharmacy, and physical therapy to name a few. Ambulatory surgery and the Emergency Department are valuable sources of statistical data as well.

4. Admission, Transfer, Census and Discharge Lists

A daily admission list provides census information. Census data indicates the number of hospitalized patients at a given time each day and is a major source of data for statistical formulae. The census includes admissions, transfers, and discharges. Census calculation is covered in Chapter 4.

A list of deaths and discharges is prepared daily on information reported the previous day. This information becomes the basis for calculating death rates, autopsy rates, and length of stay, all of which are covered in a future chapter.

The department responsible for providing these lists (admission, transfer, death and discharges) varies from hospital to hospital, though it most commonly falls under the jurisdiction of the admitting office, business office, nursing service or the medical record/health information management department.

5. Incident Reports

The primary means to assess risk in the hospital is the incident report. Mistakes occurring during treatment have the potential of ending in a law suit filed against the institution. A hospital hopes to minimize or eliminate potentially compensable events (PCEs) through investigation of untoward incidents. Medication errors and falls are examples of potential problems and these risks or incidents are investigated and identified through completion of an incident report. Data can be collected from these reports to identify trends and take necessary corrective action.

C. Requesters of Data

1. *Administration and Governing Board*

The hospital CEO (chief executive officer) and the governing board of the hospital are highly dependent on statistical reports. They not only compare current data with past data, but use the data to plan for the future. In addition to patient care, their main concern is financial, utilization, and personnel data.

With increased concern regarding health care costs, the demand has increased for financial data as related to clinical data. Administration may request information on a regular basis to include:

(a) Cost of disease entities,
(b) Costs per physician,
(c) Costs per medical staff unit.

2. *Medical Staff*

The physicians on the hospital's medical staff use statistical data to assess and appraise their own performance.

3. *Outside Agencies*

Local, state and national agencies request statistical information. The data is used for accreditation and licensure. Also, certain funds (grants, for instance) may be disbursed based on statistical data. Some of the agencies requesting data include AHA (American Hospital Association), JCAHO (Joint Commission on Accreditation of Healthcare Organizations, AMA (American Medical Association), PRO (Professional Review Organization), IRS (Internal Revenue Service), SSA (Social Security Administration), insurance companies, local and state welfare departments.

4. *Other Organizations*

Increasingly, hospitals and physicians are being rated regarding the quality of care they provide. Some organizations collect statistical data that is used to provide ratings as to the best hospitals and physicians in the United States. Data not rendered as confidential information is used by a variety of organizations.

D. Vital Statistics

As mentioned in Chapter 1, vital statistics are data that record significant events and dates in human life. Births, deaths, marriages, and divorces are recorded and certificates issued. Morbidity data is discussed in Chapter 9. Mortality rates and their computation are described in Chapter 6.

The United States does not have a uniform birth and death certificate, as registration and certification fall under the jurisdiction of each state. State laws require that these vital events (births, deaths, marriages, divorces) be registered with the state. Although the actual birth certificate may vary in appearance from state-to-state, there are key elements that are present on all certificates and each state may add elements they feel are vital. Nationwide birth and death registration has been present since 1933.

The National Center for Health Statistics collects a sample of 10% of the births and deaths in each state and this data is used to publish the monthly *Vital Statistics Report*. An annual report is also published with tables and demographic characteristics. Another report, *Vital Statistics of the United States* has data on marriage and divorce.

1. ***Birth Certificate***

   Since over 90% of births occur in hospitals, the hospital is the primary source for the information recorded on a birth certificate. Birth certificates serve as proof of citizenship, age, birthplace, and parentage. Physicians and hospital personnel provide the information that is recorded on the birth certificate. Accuracy and completeness are paramount in completion of the certificate. (A sample birth certificate is provided in the appendix.)

2. ***Death Certificate***

   Death certificates are required for burial and cremation and to settle estates and insurance claims. All deaths that occur in the hospital require the attending physician to provide whatever information is requested, though the certificate is generally filed by the funeral director. Though the cause of death is frequently stated on a death certificate, the true cause of death can only be ascertained through an autopsy. Autopsies have declined in frequency recently due to the added expense of the procedure. Some families, however, request an autopsy, though the expense is generally borne by them. Death rates and autopsy rates are discussed in later chapters. (A sample death certificate is provided in the appendix.)

3. ***Fetal Death Certificate***

   Death certificates are also issued in certain circumstances for fetal deaths. A fetal death is death prior to complete expulsion or extraction from the mother of a product of human conception, fetus and placenta, irrespective of the duration of pregnancy. After expulsion or extraction there are no signs of life—no breathing, no heart beat, no pulsation of the umbilical cord, and no definite movement of voluntary muscles. State laws vary on requirements for reporting fetal deaths. The fetal gestation period is primarily used for certification requirements. Most states require a death certificate for fetal deaths with a gestation period of 17 to 21 weeks or more. Some states require a certificate if delivery included multiple births in which a liveborn is present and some require a certificate if the fetus is to be interred. (A sample fetal death certificate is provided in the appendix.)

SUMMARY

1. Health care is offered in a wide variety of both Inpatient (IP) and Outpatient (OP) settings.
2. Hospitals provide care to the acutely ill patient, whereas a Long Term Care Facility extends a lesser level of care.
3. Long Term Care Facilities are classified as SNF, ICF and RCF.
4. Many facilities offer specialized care to include rehabilitative, substance dependency, cancer, and burn care to name a few.

5. OP or ambulatory care has increased dramatically in the past decade, including ambulatory surgery.
6. Primary Care Centers have relieved hospital Emergency Rooms from caring for non-emergencies, such as colds, upset stomachs, minor cuts, and abrasions.
7. Through Home Care many non-acutely ill patients can avoid placement in a Long Term Care facility.
8. Hospice Care provides care for the terminally ill and their families.
9. Health care insurance is no longer primarily meted out on a fee-for-service basis but rather is provided through PPOs and HMOs.
10. Adults and children are assigned beds; newborns are assigned bassinets. Some statistical evaluations require separate data for the two groups and in other instances they are combined within the same formula.
11. A child most often is a youngster under the age of 14, but no universal dividing line between adults and children has been established.
12. Temporary beds are not counted in bed statistics.
13. The four basic service classifications in a hospital are medical, surgical, obstetric, and newborn.
14. Medical staff units provide care on medical care units and patients are assigned a service classification at the time of discharge.
15. Intrahospital transfers occur when a patient is transferred from one medical care unit to another medical care unit; discharge transfers involve a transfer to another health care institution.
16. Accurate and adequate data collection is extremely important, but it is also important to avoid collecting unnecessary data.
17. Incident reports assess untoward risks.
18. Vital statistics are data that records significant events and dates in human life–birth, death, marriage, and divorce. Vital statistics include reporting of morbidity data and mortality data.

CHAPTER 3 TEST

1. Distinguish between the care provided in a/an:
   a. Hospital (acute care facility) vs SNF.

   b. SNF vs ICF.

   c. ICF vs RCF.

   d. Emergency Room vs Trauma Center.

2. Distinguish between:
   a. Medicare and Medicaid insurance.

   b. An HMO and a PPO.

   c. Retrospective and concurrent data collection.

3. Describe the type of care provided by a Primary Care Center.

4. Name:
   a. An ancillary service. ________________
   b. A primary care physician. ________________
   c. The four basic service classifications. ________________
      ____
      ____
      ____
   d. A discharge option other than a routine discharge or discharge transfer. ________________
   e. The age most often used as the dividing line between adults and children. ________________
   f. An outside agency that requests hospital statistical data. ________________
   g. A vital statistics certificate for which hospital data may be required. ________________
   h. The group which may require a death certificate, other than those receiving a standard death certificate. ________________

5. State the term for:
   a. A facility, associated with the hospital, but often located off site rather than on campus. ________________
   b. Care provided to the terminally ill. ________________
   c. Hospital beds which may be assigned as LTC beds. ________________
   d. Temporary beds in which the maximum occupancy period is 24 hours. ________________
   e. Care administered so as to provide relief to a care giver. ________________
   f. A transfer between medical care units. ________________
   g. A count of hospitalized patients at a specified time each day. ________________
   h. A report filed regarding the investigation of treatment errors and inappropriate care. ________________
   i. Data that records "significant events in human life." ________________
   j. The period (length of time) for carrying a developing offspring in the womb from conception to expulsion. ________________

6. Identify the initials AMA as related to discharge.

7. Is an adolescent included in adult or children statistics? adult children

8. a. Is there a uniform United States birth certificate? yes no
   b. Is there a uniform United States death certificate? yes no

CHAPTER

4

Census

CHAPTER OUTLINE

A. Census Collection and Terms
   1. Census
   2. Inpatient Census
   3. Hospital Patients
      a. Inpatients
      b. Outpatients
   4. Hospital Departments
   5. Hospital Units and Services
   6. Census Taking
   7. Admitted and Discharged the Same Day (A&D)
   8. Census/Inpatient Census
   9. Daily Inpatient Census (DIPC)
   10. Inpatient Service Day (IPSD)
   11. Total Inpatient Service Days
   12. Deaths/Discharges
   13. Census Calculation Tips
   14. Beds/Bassinets
B. Average Census
   1. Average Daily Inpatient Census (Average Daily Census)
   2. Other Formulae for Census Averages
   3. Example
C. Summary
D. Chapter 4 Test

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Distinguish between
   a. Census, inpatient census, and daily inpatient census.
   b. Intrahospital transfer vs. interhospital transfer.
   c. A&C (adults and children) vs. NB (newborns).
   d. Patients included in a bed count vs. bassinet count.
2. Define
   a. "IPSD" (inpatient service day).
   b. "A&D" (admitted and discharged).
   c. "Period" as used with regard to statistical computation.
3. Describe when a census is to be taken.
4. Identify deaths that are excluded from inpatient statistics.
5. Be able to compute
   a. Daily census.
   b. Period census.
   c. Average census.

The term *census* is familiar to the majority of the U.S. population because the U.S. Census Bureau takes a population census every ten years. Information is gathered regarding the number of people in each household. Information requested includes sex, age, race, marital status, and place of residence. The United States has been conducting a population census every decade since 1790. More than four-fifths of the world's population is counted in some kind of census. Facilities of all types—including hospitals, nursing homes, homeless shelters, day care centers, and so forth—enumerate census data. This data is kept daily, weekly, monthly, and for other specified intervals.

A. CENSUS COLLECTION AND TERMS

1. Census

The *American Heritage Dictionary* defines census as "an official, usually periodic enumeration of population." A census is a count—a count of people. This count can be of the population as a whole or a subgroup such as a hospital or even a clinical unit within a hospital.

2. Inpatient Census

The *Glossary of Health Care Terms* defines inpatient census as "the number of inpatients present at any one time."

3. Hospital Patients

Two major designations are used for hospital patients. They are (a) inpatients and (b) outpatients (also referred to as ambulatory care patients). Statistics are compiled separately on patients in these two categories.

a. Inpatients

A hospital inpatient is a patient who has been formally admitted to the hospital and to whom room, board, and continuous nursing service is provided in an area of the hospital where patients generally stay at least overnight. Inpatients (IP) are admitted to the hospital and assigned a hospital bed on a clinical unit.

Other facilities that provide inpatient care, such as extended care facilities, also compile statistics on their patients (or residents as they are occasionally referred to in long term care facilities).

b. Outpatients

Outpatients (OP) receive service on a more limited basis and are not assigned an inpatient hospital bed. A hospital outpatient is defined as a hospital patient who receives services in one or more of the facilities of the hospital when not currently an inpatient or a home care patient.

Outpatient admissions usually are for laboratory tests such as CBC (complete blood bount), chemistry profile, GTT (glucose tolerance test), lipid profile, x-rays, physical therapy, and even outpatient surgery. These data are recorded separately to evaluate services received by patients and services rendered by the health care facility.

4. Hospital Departments

A hospital consists of many departments that provide a wide range of services to patients. A few of the typical hospital departments are health information, patient accounts, clinical laboratory, radiology, physical medicine and rehabilitation (PM&R), and outpatient surgery.

5. Hospital Units and Services

The terms medical care/staff/service unit were discussed in the previous chapter. As previously mentioned, smaller hospitals generally have fewer administrative units than larger hospitals and the most common services or units are medical, surgical, obstetrics, newborn and pediatrics. Age may also be a factor in designating medical care units with separate units designated for newborns and pediatric patients.

6. Census Taking

Census taking is the process of counting patients. Each day a hospital keeps track of the number of patients treated both as inpatients (IPs) and outpatients (OPs) and the services administered to patients. Throughout this book the census applications will apply to inpatients, but some of these statistics can also be applied to outpatient data.

a. Time of Day

The most important factor is *consistency*. A hospital needs to establish the time of day when all nursing units will take and report the census and this must be consistent every day and on all units. Usually midnight is chosen as "census-taking time" (CTT), because this is a time of day when activity has usually decreased, compared to the busier times of the day. However, if another time should be selected, it should be adhered to every day and on all nursing units.

b. Reporting

Today, the majority of hospitals are computerized to various degrees. In many hospitals the census is automatically generated by a computer program based on admission, discharge, and transfer data entered into the computer throughout the day. Those facilities that do not have such a program have a designated person on each unit to count the patients present on the unit at the designated "census taking time" (CTT). The time when the census is taken must be consistent on all units and at the same time each day. All patients must be accounted for. If the census is done manually, a form is completed that includes a listing of patients admitted since the last census was taken, the patients discharged since the previous census, the patients who died in the past 24-hour period, and the patients who were transferred—either transferred-in (TRF-in) to the unit from another nursing unit in the hospital or transferred-out (TRF-out) to another nursing unit.

Example: Mary Jones is a patient on the medical unit and is taken to surgery at 8 A.M. Following surgery Mary is transferred to the surgical unit. Mary would be listed as a TRF-out on the census for the medical unit and as a TRF-in on the census for the surgical unit.

c. *Central Collection*

The data collected on each unit is processed centrally so that the hospital census can be established. This central area may be nursing service, administration, admitting, the health information department, or any other centralized reporting area. It is the responsibility of this designated area to make sure that the data is correct, that it corresponds to the total daily admissions and discharges, and that the inclusive intrahospital totals of transferred patients be equal—that is, that the total of all patients transferred in (TRF-in) to units equals the total of those transferred out (TRF-out).

d. *Transfer Data*

(1) Intrahospital Transfer

An Intrahospital transfer, as mentioned in the previous chapter, is a transfer within a health care facility from one clinical unit to another clinical unit. If Sue Smith is transferred out of one nursing unit, she would have to be transferred in to another unit unless she was discharged. Thus the *total* intrahospital TRF-ins would always have to equal the intrahospital TRF-outs. If there is a discrepancy, the central collection area must play detective to find out where the mistake occurred.

NOTE:

The TRF-in and TRF-out totals on one specific clinical unit may not be equal because a unit may receive more than they lose or vice versa, but the total *within a hospital (all units combined) must be equal.*

(2) Discharge Transfer

Since these patients will no longer be cared for at the hospital, they are discharged and will be listed on the census form as a discharge rather than as a transfer. However, hospitals often record on the face sheet where the patient went at the time of discharge—such as home, transferred to a nursing home, transferred to another hospital—and the name of the hospital or nursing home to which the patient was transferred.

(3) Counting Transfers

A transfer is counted as a census patient only on the unit on which the patient is present at census-taking time (CTT).

Example: The following occurred on March 1. Sally Smith was admitted to the medical unit. It was found that she needed emergency surgery and she was taken to surgery, from which she was transferred to the surgical unit. Her condition worsened and she was transferred to ICU. There her condition stabilized and she was transferred back to the surgical unit. Where will Sally be counted at the end of the day at the census-taking time? Sally will be listed as a TRF-out on the medical unit; TRF-in to the surgical unit as well as TRF-out of the surgical unit; TRF-in and TRF-out of ICU; and again listed as TRF-in on the surgical unit, where she is counted as an inpatient for the March 1 census report at the CTT.

NOTE:

A patient may only be counted as present on one *unit even though the patient may have been on other units at different times of the day.*

7. Admitted and Discharged the Same Day (A&D)

The abbreviation A&D represents patients who are admitted and discharged on the same day. These patients are not to be confused with OPs, who are also treated on the same day but are not considered inpatients. Remember that an IP is assigned an inpatient hospital number and is admitted to a hospital bed (called a bed count bed) and receives all the services accorded an inpatient. With the increase in outpatient treatment and services for many conditions formerly requiring inpatient care, the term A&D can be confusing. The number of A&D patients will generally be small, but there will be some who die, some who are transferred to another hospital, and even some who leave against medical advice, all of whom could fall into this A&D category. Since they have been treated and given service at your hospital, they will need to be included in certain census reports.

8. Census/Inpatient Census

When the term hospital census or inpatient hospital census is used it refers only to the inpatients present at census-taking-time (CTT). It excludes any additional patients that may have received service on a unit during the day but who are no longer present at CTT. In another section the term "Daily Inpatient Census" (DIPC) is discussed, and mention is made as to how the hospital receives credit for treating these A&D patients not present at census-taking-time (CTT).

9. Daily Inpatient Census (DIPC)

The term daily inpatient census refers to the number of inpatients present at the census-taking time each day *plus* any inpatients who were admitted and discharged (A&D) after the census-taking time the previous day.

A patient admitted after the census was taken (say, midnight of March 2) and discharged before the census was taken the following day (March 3) would not be counted in the March 3 census because the patient was no longer present at CTT. However, the patient had received service in the hospital as an inpatient on March 3 even though the patient is no longer present at CTT. This patient is an A&D and will be included in the Daily Inpatient Census. For example, if Mary Morse is admitted at 8 A.M. on March 2 and discharged at 10 P.M. the same day, Mary will no longer be in the hospital at CTT or counted in the hospital census but she did receive service on March 2, service for which the hospital should be credited. Thus, the Daily Inpatient Census (DIPC) is the census total (March 2 in this example) *plus* any A&Ds for that date (such as Mary Morse, who was an A&D on March 2).

10. Inpatient Service Day (IPSD)

An inpatient service day is a unit of measure denoting the services received by *one* inpatient during *one* 24-hour period.

The 24-hour period is the 24 hours between census-taking times. Assuming midnight is the CTT, any patient who received inpatient service during that 24-hour period counts as one inpatient service day. Other terms occasionally used for inpatient service day are "patient day," "inpatient day," "census day," or "bed occupancy day"—with inpatient service day the preferred term. The term inpatient service day includes not only a patient present at census-taking time but also a patient admitted and discharged the same day.

An inpatient service day total is the sum of all inpatients who received service on a specific day. Each inpatient receiving service on a specific date is recorded as one inpatient service day and the total of all inpatients receiving service on that date is the inpatient service day total for that date. Based on these definitions, it is seen that the Daily Inpatient Census (DIPC) and Inpatient Service Day total (IPSD) compilations will be identical. Remember that these are daily figures—totals for one specific day.

a. *Unit of Measure vs. Totals*

(1) Unit of Measure

A unit is the smallest amount to be measured, and in the statistical reporting to follow, a "unit" is represented by the singular term "day" as opposed to the plural "days," which is a total of the individual units. Each individual patient is credited with an inpatient service day for service in the hospital on a certain date. As previously mentioned, this includes a patient present at census-taking time (CTT) as well as a patient admitted and discharged (A&D) the same day.

(2) Totals

Units of measure get combined into totals that are used for statistical purposes. Each patient is one"unit," but it is important to know the total amount of service rendered on a particular day or for a specific period of time.

(a) PER DAY

If each patient is one unit and 150 patients received service in the hospital on a specific date (say June 3) there would be a total of 150 inpatient service days for June 3. Note the use of the plural days as compared to the use of day for a unit designation.

(b) PER PERIOD

More than one day comprises a period and any combination of days makes up a period. A period may be two days; it may be one week or two weeks; it may be a month, half-month, two months; it may be a year, half-year, five years. Generally period designations are in weeks, months, or years. It may be necessary to compare one year's totals with those of the previous year or compare last month's data with the current month, and so on. The period to be totaled is specified and all the inpatient service days are added together to get the total.

Example: If 150 patients received care on Sunday, 152 on Monday, 145 on Tuesday, 155 on Wednesday, 152 on Thursday, 148 on Friday and 149 on Saturday, then a total of 1051 inpatient service days (IPSD) of care were provided for the week (total of all seven days).

b. *Synonymous Figures*

The value for Daily Inpatient Census (DIPC) and Inpatient Service Days (IPSD) will be identical. Both terms incorporate the same data—census-taking time (CTT) total plus inpatients admitted and discharged the same day (A&Ds). Whenever hospital statistics are computed, the DIPC or IPSD totals are used rather than census (CTT) totals because they are more representative of service rendered by the hospital.

c. **WATCH OUT:**

Do not confuse the terms

Census/Inpatient Census with

Inpatient Service Day/Daily Inpatient Census (IPSD/DIPC)

The terms census or inpatient census are only counts at CTT. They do not include inpatients admitted and discharged the same day. The terms Inpatient Service Day (IPSD) or Daily Inpatient Census (DIPC) include the A&Ds as well as inpatients present at the time of the census count.

11. Total Inpatient Service Days

Total inpatient service days refers to the sum of all inpatient service days for each of the days in the period under consideration.

a. *Daily Recording—Recording of Daily Inpatient Census (DIPC) and Inpatient Service Days (IPSD)*

The beginning census is the census taken at census-taking time the previous day. To this number one patient day is *added* for each admission. Also, one patient day is *subtracted* for each discharge that occurred during that day (during the 24 hours following the previous census). Transferred-ins (TRF-in) are *added* to the subtotal and transferred-outs (TRF-out) are *subtracted*. (*Note*: Hospital-wide, the TRF-ins will equal the TRF-outs, but in computing unit totals these will not necessarily be identical.) Then, to this subtotal, one inpatient day must be *added* for each patient who was both admitted and discharged (A&Ds) between the two successive census-taking hours. This final total, then, is most representative of the amount of service rendered by the hospital on that specific day.

b. *Example*

For illustrative purposes, let us say that 155 inpatients were present at CTT on June 1. Fifteen patients were admitted to the hospital as inpatients on June 2. Five inpatients were transferred-out of a clinical unit and transferred-in to another clinical unit on June 2. Eight inpatients were discharged on June 2 (before CTT). Two patients were admitted and discharged the same day.

Solution: Record the June 1 census (155); *add* the admissions (15); *subtract* the discharges (8); *add* the TRF-ins and *subtract* the TRF-outs (both should be equal and cancel out); *add* the A&Ds (2). A total of 164 inpatients received service on June 2 (155 + 15 – 8 + 2 = 164).

12. Deaths/Discharges

a. *Included*

Deaths are considered discharges and, although they are recorded separately, they are included in the total discharges *unless* the term *live* discharges is used. In this latter instance, the deaths must be added to the live discharges to get the total number of inpatient discharges. Thus the word "discharges" includes deaths and live discharges.

b. Not Included

(1) Fetal Death

A fetus that was not alive at the time of delivery was never a patient and is *not* included in inpatient hospital statistics. It is recorded and included only in specific formulae with the word "fetal" in them—fetal death rate and fetal autopsy rate. The term "stillborn" is still in use (though fetal death is preferred) in some facilities. A stillborn infant is classified as a fetal death.

(2) DOA

The abbreviation DOA stands for Dead on Arrival. As pointed out earlier, a patient who is brought to the hospital with no signs of life and is never revived was never an inpatient and therefore is not included in inpatient census data.

(3) OP Death

Only inpatients are included in inpatient hospital statistics. Outpatient data are maintained separately. An outpatient death would be recorded as part of the outpatient data. Remember that a patient must have been alive on admission to be considered an inpatient and be assigned an inpatient hospital bed.

13. Census Calculation Tips

In figuring census data, it is often helpful to use plus (+) signs and minus (–) signs in front of data to indicate whether a number should be added or subtracted from other numbers. Also, crossing out or drawing a line through data that are not relevant may also be helpful.

Example: Orthopedic ward—

		Statistic	***Applying Hint***
May 31	Midnight census	43	+ 43
June 1	Admitted	8	+ 8
	Discharged	2	– 2
	TRF-in	1	+ 1
	TRF-out	0	
	(A&D) 24-hour patients	2	x (may or may not be included)

Question 1. What is the census for June 1?

Solution: Placing a plus or minus in front of data helps identify which numbers to *add* and which to *subtract*, and, by lightly crossing out the two A&Ds, we indicate these are not to be included in the census. (Remember that the term "census" means the count at CTT and that A&Ds are *not* included in the census).

Answer: 50 (43 + 8 – 2 + 1 = 50)

Question 2. What is the Daily Inpatient Census for June 1?

Solution: The DIPC includes A&Ds and therefore the two A&Ds excluded above are included here. Thus, a plus 2 (+2) is added to the above total.

Answer: 52 (43 + 8 – 2 + 1 + 2 = 52) or (50 + 2 = 52)

Question 3. What is the Inpatient Service Day figure for June 1?

Solution: Since this value is identical to that for Daily Inpatient Census, the A&Ds are included and added as above.

Answer: 52 (See computation in Question 2.)

14. Beds/Bassinets

a. *Inpatient Classification Categories*

The two categories into which hospital inpatients are most commonly placed are

(1) Adults and Children (A&C)
(2) Newborn (NB)

Hospital patients are assigned to either a

(1) Bed (or)
(2) Bassinet

These designations are for statistical purposes and counts are conducted daily to find out how many of these beds and bassinets are occupied.

Hospitals are also set up and staffed for a certain number of beds and bassinets and the percentage of occupancy is determined using these figures as well.

b. *Beds*

Bed statistics include all patients *not* born in the hospital during that hospitalization. Inpatients admitted to an inpatient hospital bed are included in the category designated as "Adults and Children" (A&C). The majority of the A&Cs are exactly what the term describes and they occupy an inpatient hospital bed. However, babies born on the way to the hospital or at home and then admitted are assigned one of these so-called "beds" even though they are placed in a bassinet or isolette. This is done to evaluate services between the two levels of care.

c. *Bassinets*

Only babies born in the hospital are included in the category referred to as "Newborns" (NB). These are the babies included in "bassinet" statistics. Remember that babies born at home or en route to the hospital are not included in the newborn bassinet census even though they are admitted shortly after birth. The infants in this latter category are assigned a so-called "bed" and are not included in the bassinet census statistics.

d. *Adults and Children (A&C)*

This category includes any inpatient admitted to the hospital other than a newborn born in the hospital. When census data are recorded, the data for adults and children are kept separate from that of newborns. When just the word "inpatient census" or "inpatient service days" is used, it refers to the adults and children census data.

e. *Newborns (NB)*

Any live infant born in the hospital is considered a newborn and is included in the bassinet count and the newborn data statistics. Since the care required by these patients is quite different from that required by adults and children, the two groups are kept separate for statistical reporting and comparisons. Thus, a newborn must be (1) alive at birth and (2) born in the hospital. Newborns born elsewhere are considered hospital inpatients other than newborn.

SELF-TEST 17

1. Hospital census on May 3 is 456.

   On May 4:

On May 4:	Admissions	58
	Discharges	45
	A&D	6
	DOA	3

   Calculate:

   a. Census for May 4.

   b. Daily inpatient census (DIPC) for May 4.

   c. Inpatient service day (IPSD) figure for May 4.

2. Newborn nursery census for May 1 = 22

On May 2:	Births	4
	Discharges	2
	Fetal deaths	2
	TRF-in	0
	TRF-out	1

   Calculate: Census for May 2.

3. A hospital has a total of 100 patients at midnight (CTT) on July 1. On July 2 two patients are admitted in the morning and discharged in the afternoon. Another patient is admitted at noon but expires at 4:30 that same afternoon. A patient who was admitted two days ago is transferred to another hospital on July 2. No other patients are admitted or discharged on July 2.

   Calculate:

   a. Inpatient census for July 2.

   b. Daily inpatient census for July 2.

   c. Inpatient service day figure for July 2.

4. August 1—Inpatient census at midnight (CTT) = 150

August 2:	A. Adams	admitted	8 A.M.		
	B. Barnes	admitted	9 A.M.		
	C. Carlson	admitted	10 A.M.	discharged	6:00 P.M.
	D. Doran			discharged	3:30 P.M.
	E. Edwards			expired	11:15 A.M.
	F. Foster	admitted	1 P.M.		
	G. Foster	(NB—born at 8:45 P.M.)			
	H. Horn	DOA			

Calculate:

a. Inpatient census for August 2.

b. Daily inpatient census for August 2.

c. Inpatient service day figure for August 2.

5. The following inpatient service day figures are recorded for the month of April at Holy Family Hospital, a 50-bed hospital.

April	1	45	April	11	35	April	21	44
	2	30		12	41		22	48
	3	35		13	47		23	35
	4	25		14	48		24	36
	5	47		15	49		25	38
	6	48		16	50		26	42
	7	38		17	40		27	44
	8	42		18	41		28	40
	9	43		19	43		29	52
	10	36		20	47		30	41

Calculate:

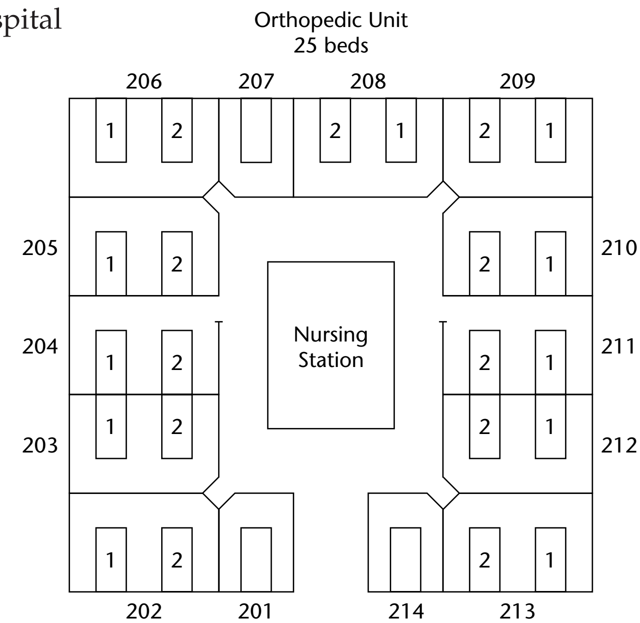
a. Inpatient service day total for April.

b. Inpatient service day value for April 20.

c. Inpatient service day total for April 7 through April 15.

d. Average daily inpatient census for April to the nearest whole number.

6. Storybook Hospital



Daily Census Report for: May 10

Beginning Census: 23 Final Census: ____________ IPSD Total: ____________

BED	ADMISSIONS	BED	DISCHARGES
203-1	Case, Carol	205-2	Jones, James
212-2	Adams, Anne	210-1	Lowe, Lawrence
208-1	Blake, Barbara	203-2	Morse, Marvin
209-2	Dunn, David		

BED	TRANSFER -IN	from	TRANSFER-OUT	to
213-1	Johnson, Judy	ICU	-0-	

A&D (Admitted & Discharged)	BED	DEATHS
-0-	206-1	Smith, Samuel

Calculate and record the final census and IPSD total for the orthopedic unit on May 10.

B. AVERAGE CENSUS

1. *Average Daily Inpatient Census (Average Daily Census)*

Average number of inpatients present each day for a given period of time.

Formula:

$$\frac{\text{Total inpatient service days for a period}}{\text{Total number of days in the period}}$$

a. Explanation

Average figures are often more representative than totals for a given period of time and, even though there are periods when a large number of patients are serviced, there may also be periods when the reverse is true. Evaluating census data is easier when comparing the average daily inpatient census rather than comparing daily census totals.

b. Separate A&C/NB Data

Since census data for adults and children and for newborns were recorded separately, the averages are also figured on the respective individual data bases rather than combined into one figure. Since finding an average involves dividing by the number of days in a period, that period will again need to be specified—for example, a week, month, three months, six months, or a year.

c. Days in Month

For computing averages, one needs to know how many days there are in each month. There are several methods for remembering this, including:

Jingle. Thirty days hath September, April, June, and November. All the rest have 31, save February, which has 28 in line and leap year makes it 29.

Knuckles. Make a fist with both hands, keeping the thumbs hidden. Start at the little finger side of either hand and begin with January, pointing to the top knuckle (MCP joint). Then name the months by pointing first to the knuckle and then to the depression between the knuckles. If the month lands on a knuckle, the month has 31 days. If it falls in a depression, it has either 28 or 30 days (any month except February would have 30 days).

d. Leap Year

To determine whether a year is a leap year, divide the year by 4 and, if the quotient is a whole number without a remainder, the year is a leap year. For instance, 1988 divided by 4 results in a quotient of 497 with no remainder, indicating 1988 was a leap year. However, if 1986 is divided by 4, the result is 496 with a remainder of 2; thus 1986 was not a leap year and had only 28 days in February rather than 29.

e. Rounding

When dividing numbers, the quotient does not always turn out to be a whole number, and therefore the rules for rounding will need to be followed. When the figures are large, it is usually adequate to carry out the answer to two decimal places and round the answer correct to one decimal place. Sometimes the results are also recorded correct to the nearest whole number.

f. Logical Answers

Whenever decimal points or percentages are involved, it is very important to watch the placement of a decimal point. Obviously, there is a great difference between 2.10, 21.0, and 210. Many errors can be averted by asking yourself if the answer makes sense. If you work at a 210-bed hospital and the average inpatient service days for the month of January are reported as 20.1, the answer is most probably incorrect because an average this low would probably jeopardize a hospital's existence and possibly lead to its demise. A result of 2010 is also absurd and therefore impossible. Thus, it is extremely important to watch placement of decimal points and to ask yourself if the answer is logical.

2. Other Formulae for Census Averages

a. A&C

Formula: Adult and Children Average Daily Inpatient Census (or) Average Daily Inpatient Census Excluding Newborns:

$$\frac{\text{Total inpatient service days (excluding newborns) for a period}}{\text{Total number of days in the period}}$$

b. NB

Formula: Average Daily Newborn Inpatient Census

$$\frac{\text{Total newborn inpatient service days for a period}}{\text{Total number of days in the period}}$$

c. ***Clinical Unit***

Formula: Average Daily Census for a Clinical Unit

$$\frac{\text{Total IP service days for the clinical care unit for a period}}{\text{Total number of days in the period}}$$

3. Example

In Question #5 on the Self-Test in the previous section (Holy Family Hospital with 50 beds), a total of 1250 inpatient service days were recorded for the month of April. To compute the average daily inpatient census for the month of April, one would take the 1250 IPSD total and divide by the 30 days in the month of April, which results in an average daily inpatient census of 41.7 patients (corrected to one decimal place) for the month of April for the 50-bed hospital.

SELF-TEST 18

1. St. Phillip's Hospital records the following:

	IP Service Days	***Bed Count***
January through April	43,725	400
May through August	59,218	500
September through December	65,383	550

Calculate: Average daily inpatient census for each of the three periods.

2. A 250-bed hospital with 20 newborn bassinets records the following inpatient service days for the month of March:

A&C:	7380
NB:	558

Calculate:

a. Average daily adults and children census.

b. Average daily newborn census.

3. A hospital reported the following statistics for September:

Counts	***Beds = 150***	***Bassinets = 15***	***Other***
Census (midnight of August 31)	A&C = 140	NB = 11	
Admissions	A&C = 310	NB = 90	
Discharges (live)	A&C = 300	NB = 92	
Deaths	A&C = 15	NB = 2	
Fetal deaths:			5
Inpatient service days	A&C = 4236	NB = 410	

Calculate:

a. Inpatient census for midnight of September 30.

b. Average daily inpatient census for September.

c. Average daily newborn census for September.

4. The following information is reported for three clinical units during the month of November:

	Pediatrics	*Orthopedics*	*Psychiatry*
Bed Count	***12***	***15***	***10***
Beginning census	10	12	6
Admissions	85	122	54
Discharges (live)	86	120	53
Deaths	1	3	0
Inpatient service days	344	433	284

Calculate:

a. Average daily inpatient census for each of the three clinical units.

b. Ending census (November 30) for each of the three clinical units.

c. Total inpatient service days for the three clinical units for the month of November.

C. SUMMARY

1. *Keep A&C Data Separate from NB Data*

   Census counts are occasionally combined, but IPSD totals are generally kept separate to facilitate statistical computations.

2. *Census/Inpatient Census*

   a. To determine: Count patients remaining at the census-taking time (CTT).

      (1) Count is taken on the clinical units.
      (2) Clinical units send their count to a central collecting department.
      (3) Intrahospital transfers are recorded.

      Record is kept of patients transferred-in (TRF-in) and transferred-out (TRF-out). Transfers present on the unit at CTT are counted.

      (4) A&Ds are *not* counted in a census or inpatient census.

   b. *DIPC/IPSD*

      Count patients present at CTT and add A&Ds. (Add to the census [#1 above] the A&Ds for that day.)

   c. *Total IPSD for the Period*

      Add IPSD figure for each day in the designated period. (Be sure to use IPSD figures rather than census figures.)

d. *Average Daily Inpatient Census (DIPC)*
Total the IPSD for the period and divide by the number of days in the period.
(1) Figure A&C and NB averages separately.
(2) Divide by the number of days in the period.
(3) Apply the same rules to determine the average DIPC for a clinical unit.

D. CHAPTER 4 TEST

Note: All calculations should be carried out correct to one decimal place.

1. Distinguish between "daily inpatient census" (DIPC) and inpatient census.

2. To find the average daily inpatient census, what is placed in the denominator?

3. When must a census be taken?

4. Must TRF-ins equal TRF-outs on a daily census report–
   a. on individual clinical units?

   b. hospital-wide (total from all units combined)?

5. A patient admitted to Unit A is transferred to Unit B the same day. On which unit is the patient counted at CTT?

6. When would a newborn (NB) be considered an A&D?

Note: For the remaining questions assume that the CTT is midnight.

7. Applegate Hospital records the following:

		A&C	***NB***	***Other***
May 31:	Census	141	10	
June 1:	Admissions	8	3	
	Discharged live	2	2	
	Deaths	1	0	
	Fetal deaths			2
	DOAs			2
	A&D	2	0	

Calculate:

a. Census for June 1.

b. IP census for June 1.

c. DIPC for June 1.

d. IPSD for June 1.

8. Three clinical units recorded the following information for April:

	Urology	***ENT***	***Ophth***
Bed count	18	16	24
Beginning census	15	12	20
Admissions	62	51	89
Discharges (live)	59	48	86
Deaths	1	0	1
IPSD	501	418	607

Calculate:

a. Census for April 30 for each clinical unit.

b. IPSD total for the three units combined for April.

c. Average DIPC for each unit for April.

9. A 65-bed hospital recorded the following data for May.

		IPSD			***IPSD***			***IPSD***
May	1	50	May	11	48	May	21	55
	2	50		12	56		22	58
	3	49		13	58		23	62
	4	54		14	56		24	65
	5	52		15	59		25	63
	6	51		16	60		26	62
	7	50		17	59		27	60
	8	43		18	58		28	60
	9	44		19	54		29	62
	10	46		20	55		30	63
							31	50

Calculate:

a. IPSD for May 20.

b. IPSD total for May 21 through May 31.

c. Average DIPC for May 21 through May 31.

d. Total IPSD for the month of May.

e. Average IPSD for the month of May.

10.

Jan 31:	Census	456
Feb 1:	Admissions	58
	Discharges	45
	A&D	6
	DOA	3

Calculate:

a. Census for February 1.

b. IPSD total for February 1.

c. DIPC for February 1.

11. A newborn unit reports the following:

Bassinet count	21
Last census	15
Births	5
Discharges	3
Fetal deaths	2
TRF-in	0
TRF-out	1

Calculate: Census at CTT.

12. St. Peter's Hospital reports:

A&C admissions for the year	998
A&C discharges for the year	989
A&C IPSD for the year	36,440

Calculate: Average A&C daily inpatient census for the year.

13. An 18-bed surgical unit reports the following:

Patients remaining at midnight	12
Next day—Admissions	4
Discharges	3
TRF-in	2
TRF-out	0
A&D	2

Calculate: Census at CTT.

14.

Day 1:	Census	125
Day 2:	Admissions	8
	Discharged live	4
	Deaths	2
	A&D	2

Calculate:

a. Ending census on day 2.

b. DIPC for day 2.

c. IPSD total for day 2.

15. May 31: Census 150

June 1:	***ADM/DIS***	***Time Admitted***	***Time Discharged***
	A. Adams	8:00 A.M.	4:50 P.M.
	B. Brown	9:00 A.M.	
	C. Carson	10:18 A.M.	
	D. Davis		11:55 A.M.
	E. Edwards	2.40 P.M.	7:00 P.M. TRF to another hosp.
	F. Frank		7:30 P.M.
	G. Grant	7:50 P.M.	11:39 P.M. Expired
	H. Hughes	8:19 P.M.	
	I. Ingals		9:15 P.M.
	J. Jones	11:45 P.M.	

Calculate:

a. IP census at midnight on June 1.

b. DIPC at midnight on June 1.

c. Census at midnight on June 1.

d. IPSD total at midnight on June 1.

16. Sunny Care Hospital

DAILY CENSUS REPORT

150 beds––18 bassinets

Date: May 2

Beginning Census: A&C 120 NB 14 Final Census: A&C ________ NB ________

Unit	***Beds/ BASS***	***Beg Census***	***ADM***	***TRF-IN***	***DIS Live***	***Deaths***	***TRF-OUT***	***Census***	***A&D***	***IPSD***
Medical	40	35	1	1	2	1	1	____	1	____
Surgical	28	23	2	1	3	0	2	____	0	____
Pediatrics	20	15	3	0	1	1	1	____	1	____
Orthopedics	20	16	1	0	2	0	0	____	1	____
Urology	18	15	0	1	1	0	0	____	0	____
Obstetrics	18	13	3	0	2	0	0	____	0	____
Newborn	18	14	4	0	3	0	0	____	0	____
ICU	6	3	2	1	0	1	0	____	0	____
TOTALS										
A&C	150	____	____	____	____	____	____	____	____	____
NB:	18	____	____	____	____	____	____	____	____	____

Complete the blanks above.

CHAPTER

5

Percentage of Occupancy

CHAPTER OUTLINE

A. Bed/Bassinet Count Terms
   1. Inpatient Bed Count or Bed Complement
   2. Newborn Bassinet Count
B. Rate Formula
C. Beds
   1. Unit vs. Totals
   2. Excluded Beds
   3. Disaster Beds
D. Bed/Bassinet Count Day Terms
   1. Inpatient Bed Count Day
   2. Inpatient Bassinet Count Day
   3. Inpatient Bed Count Days (Total)
E. Occupancy Ratio/Percentage
   1. Adults and Children (A&C)
   2. Newborn (NB)
F. Occupancy Percentage for a Period
   1. Bed (A&C)
   2. Newborn (NB)
   3. Clinical Unit
G. Change in Bed Count During a Period
H. Summary
I. Chapter 5 Test

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Define "bed count" and "bed complement."
2. Define "bassinet count."
3. Explain the "rate formula."
4. Identify the beds included and excluded in a bed count.
5. Compute bed occupancy percentage (A&C percentage).
6. Compute bassinet occupancy percentage (NB).
7. Compute occupancy percentage when there is a change in bed/bassinet count.

The census data in the previous chapter provided information about the number of patients receiving hospital service or the average number receiving service for a specified period. The percentage of occupancy provides a hospital with a ratio or percentage of the equipped and staffed hospital beds/bassinets that are occupied for a specified period of time. As previously mentioned a hospital is equipped and staffed for a designated number of beds and/or bassinets and statistical analysis is carried out to assess their utilization in terms of adult and children (A&C) occupancy or newborn (NB) occupancy.

A. BED/BASSINET COUNT TERMS

1. Inpatient Bed Count or Bed Complement

The number of available hospital inpatient beds, both occupied and vacant, on any given day.

2. Newborn Bassinet Count

The number of available hospital newborn bassinets, both occupied and vacant, on a given day.

Explanation: Hospitals are generally licensed for a certain number of beds. Hospital staffing (nursing staff, housekeeping staff, laboratory personnel, etc.) is based on the beds available and therefore it would *not* be cost effective to staff empty beds. Therefore, the number of beds set up and staffed for use may be a smaller number than the number of beds the facility is licensed to operate.

Adding/Decreasing: Hospitals often open and close nursing units based on need. During periods of diminished demand, a clinical nursing unit may be closed, and, during periods of peak demand, another unit may be opened. The opening of an additional unit will add to the bed count, whereas the closing of a clinical nursing unit will decrease the bed count (available beds). As units are opened or closed, the staffing needs for the hospital change as well.

Example: A medical unit may close in December and be reopened in January if a need exists. Many hospital administrative decisions are based on hospital occupancy percentages. Therefore, it is important that the occupancy figures be accurate. A hospital does not want to be overstaffed and lose money, nor does a community want to have an inadequate number of beds to meet the medical needs of its constituency, if such a situation can be avoided.

B. RATE FORMULA

All of the rates that follow can be determined by keeping in mind a general rule that applies to computing rates. A rate is:

$$\frac{\text{The number of times something happens}}{\text{The number of times it } \textit{could} \text{ happen}}$$

Example: A person is shooting baskets and takes 25 shots at the basket. The ball goes through the basketball hoop 15 times. It can then be said the individual scored 15/25 times or successfully completed 60% of the shots.

Hospital Example: A hospital offers an AIDS blood test to every hospital employee and 200 employees sign up for the test. The hospital has a total of 400 employees. Therefore, 200/400 employees signed up for the AIDS test, or it could be said that 50% of the employees will be tested.

School Example: There are 50 questions on a scheduled exam. You answer 40 questions correctly. Your score on the exam is 40/50 or 80% because 80% of the questions were answered correctly.

C. BEDS

1. Unit vs. Totals

Again, as mentioned earlier, the use of the singular form of the word "day" in a title indicates a unit of measure. The inpatient bed count day is a unit of measure indicating the number of beds that are set up, staffed, and equipped for patient care on a particular day.

The use of the word "days" is a total and indicates the total for the days in a period—week, month, three months, year, etc.

2. Excluded Beds

As mentioned in Chapter 3, some hospital beds are considered temporary beds in that the patient only occupies the bed while being examined or treated in another area of the hospital, while the patient is still assigned an inpatient bed on a clinical nursing unit. These temporary or excluded beds include beds in examining rooms, physical therapy beds, recovery room beds (following surgery), and beds in the Emergency Room (ER). Normally ER beds are occupied by outpatients during the time of treatment, after which the outpatient is released from the hospital. However, some patients are admitted (assigned an inpatient bed) after being seen in the ER. These patients are assigned a hospital bed and room on admission.

Example: A patient is admitted to room 205 (surgical unit) on December 3. On December 4 the patient is taken to surgery. Following surgery, the patient is taken to the recovery room before being returned to his/her assigned room of 205. The patient is considered to be a patient in 205 throughout this time even though the patient will have occupied a temporary bed in the operating room and recovery room. If, however, the patient is taken to ICU following surgery, the patient is TRF-out of 205 and TRF-in to ICU on December 4, as previously mentioned in Chapter 4 regarding census data.

3. Disaster Beds

Occasionally, at the time of a disaster (earthquake, train derailment, tornado, nuclear disaster, etc.) or during periods of epidemics (such as flu epidemics), all the regular hospital beds are occupied. Most hospitals have extra beds that may be available for set-up during these peak periods. In some instances these beds are set up in lounges, hallways, and other rooms that are not normally patient rooms. These extra beds *do not* become a part of the inpatient bed count, but the patients occupying the beds are counted in the census and census statistics that include inpatient service days.

D. BED/BASSINET COUNT DAY TERMS

A "bed count day" shares similarities with the concept of an inpatient service day, since it is thought of as one patient occupying one bed for a specified day/days. The term *bed count* applies to all the beds available for inpatient use that are set up and staffed.

1. Inpatient Bed Count Day

A unit of measure denoting the presence of one inpatient bed, set up and staffed for use and either occupied or vacant, during one 24-hour period.

2. Inpatient Bassinet Count Day

A unit of measure denoting the presence of one inpatient bassinet, set up and staffed for use and either occupied or vacant, during one 24-hour period.

3. Inpatient Bed Count Days (Total)

The sum of inpatient bed count days during the period under consideration.

E. OCCUPANCY RATIO/PERCENTAGE

Occupancy percentages (also called rates or ratios) state the percentage of the available beds or bassinets that are being utilized (occupied) on a specific day or for a designated period of time—that is, the percentage of use or utilization. The term occupancy ratio is synonymous with percentage of occupancy and occupancy percentage.

1. Adults and Children (A&C)

a. Inpatient Bed Occupancy Ratio

The proportion of inpatient beds occupied, defined as the ratio of service days to inpatient bed count days in the period under consideration.

b. Formula: Daily Inpatient Bed Occupancy Percentage

$$\frac{\text{Daily IP census (IP service days)}}{\text{Inpatient bed count for that day}} \times 100$$

c. Example

On July 1 the bed count was 200 and the bassinet count was 20. The IPSD total for the day was A&C = 160, NB = 15. To determine the daily inpatient bed occupancy percentage, 160 (IPSD) is divided by 200 (bed count) and the quotient (0.80) multiplied by 100 to convert the result to a percentage. Therefore, the daily inpatient bed occupancy percentage for July 1 was 80%, indicating that 80% of the beds were occupied on that date.

d. Explanation

Relating the formula for computing rates to computing bed occupancy ratio or percentage involves finding what percentage of beds are filled on a given date or for a period of time. As mentioned, the bed count has been established at the beginning of a period and is the number of beds available that are set up and staffed.

e. ***All Beds Occupied***

(1) *One Day*

If every hospital bed is occupied on a specific day, the bed occupancy percentage for that day would be 100%.

(2) *Period*

If every hospital bed is occupied during a certain period of time (say, one week) the bed occupancy percentage for that (one-week) period would be 100%. However, this is not generally the case nor would it constitute good management, because hospitals would plan to have a few beds available for emergency situations. Hospitals plan to have occupancy rates of 90%, but this is often not achieved, especially during the last few years as fewer patients have been treated on an inpatient basis and more and more patients have been treated as outpatients. Also, shorter stays are more commonly the rule. This trend has mandated greater utilization of outpatient treatment and shorter inpatient stays.

f. ***Disaster Beds and Occupancy Rates***

Occasionally disasters occur and every bed count bed is occupied. At such times additional beds are added, as already mentioned. When this occurs the bed count does *not* change, because these disaster beds are *not* included in the established bed count. However, the patient is counted, and therefore the bed occupancy percentage could be greater than 100%.

Example: The local hospital is a 200-bed hospital (200 beds being routinely set up and staffed daily). A tornado hits the area and all 200 beds are assigned and occupied. Five additional beds are set up and patients are admitted to these beds. The percentage of bed occupancy on that day would be 205/200—the number of inpatients present (205) divided by the bed count (200). This is an example of using an extremely rare circumstance to serve as an illustration of how it is possible to get a bed occupancy percentage of greater than 100%. Bed occupancies of greater than 100% would be extremely rare in the present day health care environment due to much shorter hospital stays. In addition, the likelihood is great that inpatient beds are available at another hospital in the area and patients are easily transferred to another facility. However, should a major cataclysmic disaster occur a hospital may need to utilize disaster beds.

g. ***Normal Occupancy Percentage***

In most cases, a hospital's bed occupancy percentage is less than 100%. In the general day-to-day operation of a hospital not all beds are occupied. A 200-bed hospital that has 180 patients on a specific day has a bed occupancy percentage of 180/200, or 90%. If on the following day the inpatient service day total is 175, the bed occupancy percentage falls to 175/200, or 87.5%. In this manner, the percentage of bed occupancy can be determined each day.

2. Newborn (NB)

a. ***Formula: Daily Newborn Bassinet Occupancy Percentage***

$$\frac{\text{Daily NB census (IP service days)}}{\text{NB bassinet count for that day}} \times 100$$

b. ***Example***

A NB nursery has 10 bassinets. On a specific day the daily NB census is 8 newborns. The daily newborn bassinet count for that day is 8/10, or 80%, occupancy.

SELF-TEST 19

Compute the answers correctly to *one* decimal place.

1. A 300-bed hospital has 185 of its beds occupied on February 20. What is the percentage of bed occupancy for February 20?

2. On May 5, a hospital with 85 beds has an inpatient service day total of 60 patients. What is the percentage of bed occupancy for May 5?

3. On September 10, an explosion occurs in a chemical plant and a daily inpatient census of 160 patients was recorded by the local 150-bed hospital. What is the bed occupancy percentage for September 10?

4. On January 8, the midnight census is 120. However, five patients were admitted and discharged that same day. The hospital has a bed complement of 130 beds. What is the bed occupancy percentage for January 8?

5. On March 6, a total of 12 bassinets are occupied out of a bassinet count of 15. On March 7 three babies are born live and one is stillborn. That same day two babies are discharged home with their mothers. What is the bassinet occupancy percentage for March 7?

6. The following statistics are recorded on the Neonatal Unit on June 8:

Bassinet count	12
Beginning census (midnight on June 7)	9
Births	3
NB discharges (live)	4
NB death	1
Fetal death	1

Calculate:

a. Inpatient service day total for the unit on June 8.

b. Bassinet occupancy percentage for the unit on June 8.

F. OCCUPANCY PERCENTAGE FOR A PERIOD

Generally, for long-term planning it is necessary to know the percentage of occupancy over a longer period of time than just a day. Individual day rates can vary greatly and it is more helpful to see the percentage for a period (a month, for instance) than to study the individual percentages for each day in that period (in this case, a month).

1. Bed (A&C)

Formula: Inpatient Bed Occupancy Percentage for a Period

$$\frac{\text{Total inpatient service days for a period}}{\text{Total IP bed count} \times \text{number of days in period}} \times 100$$

Example: Suppose Pleasantville Hospital is a 50-bed hospital. In June a total of 1410 inpatient service days were documented. To calculate the percentage of bed occupancy for the month of June, the total of 1410 IP service days is placed in the numerator and this is divided by 50×30 (or l500) and the final result multiplied by 100 to convert it to a percentage, or 94%.

Example: In June, 1200 inpatients were served in a 50-bed hospital. The numerator in this example is 1200 (IP service days) and the denominator is 50×30 (since there are 30 days in June). Thus 1200 divided by 1500 is 0.80, which is multiplied by 100, giving 80%.

Example: In September the bed count was 200 and the bassinet count was 24. The IPSD total for A&C for the month was recorded as 4520. Since there are 30 days in September, the percentage of occupancy for September would be 4520 divided by 200×30 or 4520 divided by 6000 times 100 for a percentage of occupancy of 75.3%.

NOTE:

Always be sure to use IP service days for the numerator rather than census-taking time (CTT) data.

2. Newborn (NB)

Formula: Newborn Bassinet Occupancy Percentage for a Period

$$\frac{\text{Total NB IP service days for a period}}{\text{Total NB bassinet count} \times \text{number of days in period}} \times 100$$

Example: Caring Hospital has a bassinet count of 30. During July, a total of 825 NB inpatient service days of care were given. To calculate the percentage of occupancy for the newborn bassinets, the total of 825 is divided by the product of 30×31 (or 930) and the result multiplied by 100 to convert it into a percentage. This results in a percentage of 88.7% $[(825 \div 930) \times 100]$.

3. Clinical Unit

Formula: Clinical Unit Occupancy Percentage for a Period

$$\frac{\text{Total IP service days for a clinical unit for a period}}{\text{IP bed count total for that unit} \times \text{number of days in the period}} \times 100$$

Example: The pediatric unit of a hospital has 15 beds. During the first week of October, the IP service day totals were 12, 11, 13, 9, 10, 13, 7. To find the occupancy percentage for the week, first total the IP service days (12 + 11 + 13 + 9 + 10 + 13 + 7), which equals 75. Then divide by the product of the bed count (15) × number of days

(7), which yields 105. Finally, multiply the quotient by 100 to convert it to a percent. The result is 71.4% [(75 ÷ 105) × 100].

SELF-TEST 20

Carry answers correctly to *two* decimal places.

1. A clinical unit with a bed count of 18 beds reports the following figures for December:

	IP Service Days
Dec. 1 through Dec. 10	165
Dec. 11 through Dec. 20	162
Dec. 21 through Dec. 31	180

Calculate:

a. Period with the highest bed occupancy percentage.

b. Inpatient bed occupancy percentage for the month of December.

2. St. Teresa Hospital records the following data:

	IP Service Days	*Bed Count*
January through April	18,850	175
May through July	17,340	200
August through October	13,220	150
November through December	8,880	165

Calculate: Period with the highest inpatient bed occupancy percentage.

3. The daily inpatient service day totals for a 50-bed hospital are as follows:

Feb.	1	40	Feb.	8	37	Feb.	15	38	Feb.	22	41
	2	41		9	48		16	48		23	45
	3	43		10	46		17	44		24	46
	4	50		11	43		18	49		25	37
	5	47		12	49		19	50		26	39
	6	46		13	39		20	47		27	43
	7	38		14	48		21	40		28	48

Calculate:

a. Inpatient occupancy percentage for February 14.

b. Day with the highest inpatient occupancy percentage in February, without figuring the individual percentages.

c. Inpatient bed occupancy percentage for February.

d. Dividing the month into four equal periods of seven days each, indicate the period with the highest inpatient bed occupancy percentage—Feb. 1 through

7; Feb. 8 through 14; Feb. 15 through 21; or Feb. 22 through 28—and the bed occupancy percentage for each period.

4. A newborn unit records the following data for April:

Bassinet count	14
IP service day total	388
Beginning census	12
Admissions	88
Discharges	88
Newborn deaths	1
Fetal deaths	3

Calculate:

a. Bassinet occupancy percentage for April.

b. *(R4) Census at the end of April.

5. November data for St. John Hospital:

Clinical Unit	*IP Service Days*	*Bed/Bassinet Count*
Medical	2850	100
Surgical	988	34
Pediatric	422	15
Orthopedic	502	18
Obstetric	544	20
Newborn	524	18

Calculate:

a. Bed/bassinet occupancy percentage for each clinical unit and the unit with the best inpatient occupancy percentage for the month of November.

b. A&C inpatient bed occupancy percentage for November for St. John Hospital.

G. CHANGE IN BED COUNT DURING A PERIOD

Occasionally a hospital changes its official bed or bassinet count during a period. A hospital may expand or decrease the number of available beds. This expansion or decrease is *not* a temporary change due to an emergency, as mentioned under disaster beds, but rather a fairly permanent change for a specified period of time. Sometimes a wing of a hospital is added (increasing the bed count) or a previous wing is converted to another function (office space or laboratory space, for example) and the beds in the wing would no longer be available for patient care.

Formula: Occupancy Percentage with a Change in Bed Count During a Period

$$\frac{\text{Total IP service days for the period}}{(\text{Bed count} \times \text{days}) + (\text{Bed count} \times \text{days})} \times 100$$

(Days refers to the number of days in the period.)

Example: Jubilee Hospital has decided to expand its facilities and add additional beds. The January through June bed count was 200 beds. On July 1, an additional 20 beds were added. The total number of inpatient service days for the first six-month period was 36,006 and for the second six-month period the total was 40,004. To compute the inpatient bed occupancy percentage, add the IP service days for the year (36,006 + 40,004 = 76,010) and divide by the sum of the two (bed count times days) periods (200 beds × 181 days) + (220 beds × 184 days) or 36,200 + 40,480 = 76,680. Carrying out the division (76,010 divided by 76,680), and then multiplying by 100, results in an inpatient bed occupancy percentage of 99.1%.

Example: Sunshine Hospital begins the year with an official bed count of 50 beds. On January 15 ten beds are officially eliminated for a bed count of 40 beds. The inpatient service day total for January was 1280. To find the inpatient bed occupancy percentage for January, divide the IP service day total (1280) by the denominator [(50 × 14) + (40 × 17) = 700 + 680 = 1380] or (1280 divided by 1380). Multiplying the result by 100 gives a 92.75% inpatient occupancy percentage for January.

SELF-TEST 21

Answers should be correct to *two* decimal places.

1. Expansion Hospital begins the year with a total of 150 beds and 10 bassinets.

   On March 1, 15 additional beds are added to the bed count, for a total of 165 beds.

   On April 1, an additional 5 bassinets are added to the newborn nursery, for a total of 15 bassinets.

   On July 1, the hospital expands again, this time adding another 15 beds and 5 bassinets, bringing the total counts to 180 beds and 20 bassinets.

   On October 1, another expansion occurs and 20 additional beds are added, for a total bed complement of 200 beds. The service day totals for the periods are as follows:

	IP Service Days		*Counts*	
Period	***Bed***	***Bassinet***	***Bed***	***Bassinet***
Jan. through Feb.	8550	555	150	10
Mar.	4775	288	165	10
Apr. through June	14,425	1242	165	15
July through Sept.	16,005	1666	180	20
Oct. through Dec.	17,704	1744	200	20

   Calculate:

   a. IP bed occupancy percentage for each quarter (Jan. through Mar.; Apr. through June; July through Sept.; Oct. through Dec.).

   b. Newborn occupancy percentage for each quarter.

   c. IP bed occupancy percentage for the year.

   d. Newborn bassinet occupancy percentage for the year.

   e. Quarter with the highest IP bed occupancy percentage.

2. Prairie Hospital, with a complement of 250 beds, finds it difficult to make ends meet due to low occupancy. The administration decides to close a wing of the hospital and the administrative closure is implemented on July 17, reducing the bed count to 200 beds. During July, 5710 IP service days of care were given.

   Calculate: Percent of IP bed occupancy for July.

3. A total of 76,006 IP service days of care were given at Blessing Hospital during a non-leap year. The bed counts changed from a count of 200 at the beginning of the year to 220 on March 15, and then to 230 on July 1. The count was reduced to 210 on November 15 and it remained at that level through the end of the year.

   Calculate: IP bed occupancy percentage for the year.

4. The newborn nursery rendered a total of 676 patient days of care during January. The bassinet count was 25 on January 1 but changed to 18 on January 22.

   Calculate: Bassinet occupancy percentage for January.

5. General Hospital reported the following for a non-leap year:

	IPSD		*Count*	
Period	***A&C***	***NB***	***Bed***	***Bassinet***
Jan. 1 through Jan. 31	4880	601	160	20
Feb. through March	10,115	1110	180	20
Apr. through June	16,662	2190	200	25
July through Sept.	15,558	2069	175	25
Oct. through Dec.	15,612	1722	175	20

Calculate:

a. IP bed occupancy percentage for January.

b. Bassinet occupancy percentage for February through March.

c. IP bed occupancy for the first half of the year (January through June).

d. Bassinet occupancy percentage for the second half of the year (July through December).

e. IP bed occupancy percentage for the entire year.

f. Bassinet occupancy percentage for the entire year.

g. Quarter with the highest IP bed occupancy percentage during the year.

h. Quarter with the highest bassinet occupancy percentage for the year.

6. On January 11, a 50-bed hospital added 10 beds, for a total of 60 beds. On January 21, another 10 beds were added, for a total of 70 beds. The inpatient service days for the period were 1800.

   Calculate:

   a. Inpatient bed occupancy percentage for January.

   b. If the hospital reduced the beds from 70 to 60 on February 1 and maintained that bed count through February, with a February IP service day total of 1250, what is the inpatient bed occupancy percentage for the entire period (January through February) if the year is a non-leap year?

H. SUMMARY

1. Bed count/bed complement includes beds set up and staffed, either vacant or occupied.
2. Bassinet count includes bassinets set up and staffed, either vacant or occupied.
3. Bed occupancy includes all adults and children admitted to the hospital. Beds are also assigned to newborns and infants not born in the hospital during that particular admission, such as babies born en route or admitted after being born and infants only hours or days old.
4. Bassinet occupancy includes only newborns born in the hospital during that admission and admitted to the neonatal unit.
5. Excluded beds from a bed count:
   a. Examining room beds—ER beds
   b. Treatment room beds—labor beds
      —recovery room beds
      —ER beds
      —observation beds
      —23 hours hold
      —physical therapy beds
      —outpatient surgery beds
6. Disaster beds. These beds are added during emergency situations (during a time of disaster), are temporary, and are *not* included in a bed count.
7. Rate. A rate is the number of times something happens divided by the number of times it could have happened.
8. Percentage of occupancy.
   a. Separate percentages are figured for A&C and NB. These are generally *not* combined.
   b. Be sure to use IPSD in the numerator.
   c. Daily percentage.
      Divide the IPSD by the bed/bassinet count.
   d. Period percentage.
      Divide the IPSD by the bed/bassinet count × number of days in the period.
   e. Change in bed count percentage.
      Divide the IPSD by the bed/bassinet count x number of days in the period + (beds × days) + (beds × days)—one for each period with a different bed count.
   f. Disaster beds. If all beds are occupied and temporary beds are set up (as in a disaster), the percentage of occupancy will be greater than 100%.

g. Clinical unit percentages are computed in the same manner as the bed/bassinet counts.

I. CHAPTER 5 TEST

Note: Compute all answers correctly to *two* decimal places.

1. Recorded for May for a 65-bed hospital:

	IPSD		IPSD		IPSD
May 1	50	May 11	48	May 21	55
2	50	12	56	22	58
3	49	13	58	23	62
4	54	14	56	24	65
5	52	15	59	25	63
6	51	16	60	26	62
7	50	17	59	27	60
8	43	18	58	28	60
9	44	19	54	29	62
10	46	20	55	30	63
				31	50

Calculate:

a. Percentage of occupancy for the month of May.

b. Percentage of occupancy for May 25.

c. Percentage of occupancy for:

(1) May 1 through May 10.

(2) May 11 through May 20.

(3) May 21 through May 31.

d. Percentage of occupancy for May if the bed count had increased to 70 beds on May 11 and to 75 beds on May 21.

2. Blessing Hospital

		A&C	NB	Surgical
Bed/bassinet count		100	10	25
Feb. 9:	Census	95	8	18
Feb. 10:	Admissions	8	2	4
	Disch. (live)	5	1	2
	Deaths	1	0	1
	A&D	2	0	0

Calculate:

a. A&C bed occupancy percentage for February 10.

b. NB bassinet occupancy percentage for February 10.

c. Surgical Unit bed occupancy percentage for February 10.

d. *(R4) Census for February 10.

3. High Hopes Hospital (Neonatal Unit: 16 bassinets)

Jan. 1:	Census	13
Jan. 2:	Births	4
	Disch. (live)	2
	Deaths (NB)	1
	Deaths (fetal)	1 (late fetal)
	A&D	1

Calculate:

a. *(R4) Census for January 2.

b. *(R4) IPSD total for January 2.

c. Bassinet occupancy percentage for January 2.

4. St. Vincent Hospital

	Bed		***Bassinet***		***Surgical***	
Period	***Count***	***IPSD***	***Count***	***IPSD***	***Count***	***IPSD***
Jan. through Mar.	160	12,405	18	1,378	25	2,180
Apr. through June	180	14,621	15	1,247	30	2,516
July through Sept.	200	15,777	20	1,615	30	2,601
Oct. through Dec.	175	14,813	25	2,084	35	2,913

Calculate:

a. Percentage of occupancy for each period for the following:

(1) Bed percentage

(2) Bassinet percentage

(3) Surgical unit percentage

b. Category (bed, bassinet, or surgical unit) with highest percentage of occupancy for the year.

5. Golden Valley Hospital

		A&C	NB	Orthopedic Unit (included in A&C)
Bed/bassinet count		80	10	12
Beginning census		74	7	6
March:	Admissions	105	57	47
	Disch. (live)	99	54	44
	Deaths	5	1	2
	A&D	45	3	4
	IPSD	1998	268	278

Calculate:

a. Bed (A&C) occupancy percentage for March.

b. Bassinet (NB) occupancy percentage for March.

c. Orthopedic unit occupancy percentage for March.

6. Comforting Hospital (for November)

	Count		
Units:	***Bed***	***Bassinet***	***IPSD***
Medical	58		1660
Surgical	32		886
Pediatrics	10		215
Orthopedics	18		498
Ophthalmology	25		702
Obstetrics	15		405
Newborn	____	12	324
Totals	158	12	

Calculate:

a. Percentage of occupancy for each unit for November.

b. A&C percentage of occupancy for November.

c. Percentage of occupancy for the entire hospital.

7. Hilltop Hospital

		Counts		IPSD	
Period	**Dates**	**Beds**	**Bassinets**	**Beds**	**Bassinets**
A	Jan. 1 through Feb. 15	90	12	3815	463
B	Feb. 16 through Mar. 31	100	8	4079	314
C	Apr. 1 through Apr. 30	110	10	2986	272
D	May 1 through June 30	85	14	4021	708

Calculate:

a. Percentage of bed occupancy for each period;

Percentage of bassinet occupancy for each period.

b. Percentage of bed occupancy for January through June;

Percentage of bassinet occupancy for January through June.

c. Period with the highest IP bed occupancy percentage.

8. Mountain View Hospital

Period	**Bed Count**	**IPSD**
Jan.	250	6250
Feb.	225	5984
Mar.	200	5888
Apr. through June	210	17,920
July through Sept.	200	17,561
Oct. through Dec.	180	16,007

Calculate:

a. Bed occupancy percentage for January.

b. Bed occupancy percentage for February through March.

c. Bed occupancy percentage for the first half of the year.

d. Bed occupancy percentage for the second half of the year.

e. Bed occupancy percentage for the entire year.

f. Quarter with the highest bed occupancy percentage for the year.

9. Holy Cross Hospital
Bed count: 50

		IPSD			***IPSD***			***IPSD***
June	1	45	June	11	35	June	21	44
	2	30		12	41		22	48
	3	35		13	47		23	35
	4	25		14	48		24	36
	5	47		15	49		25	38
	6	48		16	50		26	42
	7	38		17	40		27	44
	8	42		18	41		28	40
	9	43		19	43		29	52
	10	36		20	47		30	41

Calculate:

a. *(R4) Total IPSD for June.

b. *(R4) IPSD for June 7 through June 15.

c. *(R4) Average DIPC for June 1 through June 10.

d. *(R4) Average IPSD for June.

e. Percentage of bed occupancy for June.

f. Percentage of bed occupancy for June 29.

g. If the bed count had increased to 55 beds on June 15, calculate the percentage of occupancy for June.

10. Pine Ridge Hospital

Monthly Census Report

100 Beds 15 Bassinets

Month: February

	A&C									NB				
Day	Beg Census	ADM	TRF IN	DIS Live	Deaths	TRF OUT	Census	A&D	IPSD	Beg Census	Births	DIS Live	Deaths	Census/ IPSD
1	85	8	5	7	0	5	_____	0	_____	11	3	2	0	_____
2	_____	10	4	5	1	4	_____	1	_____	_____	1	4	0	_____
3	_____	7	3	9	0	3	_____	1	_____	_____	4	1	0	_____
4	_____	5	2	12	0	2	_____	2	_____	_____	2	6	0	_____
5	_____	12	1	8	0	1	_____	3	_____	_____	3	5	0	_____
6	_____	9	2	5	0	2	_____	1	_____	_____	5	2	0	_____
7	_____	11	4	7	1	4	_____	2	_____	_____	4	3	0	_____
8	_____	6	6	8	0	6	_____	4	_____	_____	6	4	1	_____
9	_____	7	3	11	0	3	_____	2	_____	_____	1	2	0	_____
10	_____	10	5	9	0	5	_____	3	_____	_____	2	3	0	_____
11	_____	9	2	8	0	2	_____	1	_____	_____	5	1	0	_____
12	_____	4	4	7	0	4	_____	0	_____	_____	2	4	0	_____
13	_____	6	1	10	1	1	_____	0	_____	_____	3	6	0	_____
14	_____	13	2	5	0	2	_____	1	_____	_____	4	1	0	_____
15	_____	8	3	11	0	3	_____	2	_____	_____	7	4	1	_____
16	_____	11	1	6	1	1	_____	0	_____	_____	5	4	0	_____
17	_____	5	0	8	0	0	_____	0	_____	_____	1	3	0	_____
18	_____	9	1	13	0	1	_____	3	_____	_____	2	5	0	_____
19	_____	6	5	11	0	5	_____	0	_____	_____	4	2	0	_____
20	_____	12	3	7	0	3	_____	0	_____	_____	3	7	0	_____
21	_____	14	2	9	1	2	_____	1	_____	_____	6	3	0	_____
22	_____	8	2	12	0	2	_____	0	_____	_____	5	2	0	_____
23	_____	16	6	8	0	6	_____	0	_____	_____	3	2	0	_____
24	_____	7	3	4	0	3	_____	4	_____	_____	1	4	0	_____
25	_____	6	4	13	1	4	_____	2	_____	_____	2	5	0	_____
26	_____	11	2	7	0	2	_____	0	_____	_____	2	3	0	_____
27	_____	9	3	11	0	3	_____	0	_____	_____	4	2	1	_____
28	_____	12	5	5	1	5	_____	3	_____	_____	5	1	0	_____

a. Complete the totals below:

TOTALS:	A&C		NB
Beginning Census	_____	Beginning Census	_____
Admissions	_____	Births	_____
Transfer-Ins	_____		
Live Discharges	_____	Live Discharges	_____
Deaths	_____	Deaths	_____
Transfer-Outs	_____		
Ending Census	_____	Ending Census	_____
IPSDs	_____	IPSDs	_____
Occupancy %	_____	Occupancy %	_____

b. If the bed count had been 120 beds from February 1 through February 14 and then decreased to 100 beds from February 15 through the 28th, what would be the bed occupancy percentage for February?

c. If the bassinet count had been 18 bassinets from February 1 through February 14 and the count decreased to 15 bassinets on February 15 and remained at 15 through February 28, what would be the bassinet occupancy percentage for February?

CHAPTER

6

Mortality (Death) Rates

CHAPTER OUTLINE

A. Terms
   1. Mortality
   2. Discharge
   3. Death
   4. Net vs. Gross
B. Death Rates
   1. Helpful Hints
   2. Gross Death Rate
   3. Net Death Rate or Institutional Death Rate
   4. Newborn Death Rate (Infant Death Rate or Infant Mortality Rate)
   5. Surgical Death Rates
C. Obstetrical: Terms/Classifications/Death Rates
   1. Terms
   2. Classifications
   3. Death Rates
D. Summary
E. Chapter 6 Test

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Distinguish clearly between
   a. Net vs. Gross
   b. Newborn death, infant death, and fetal death
   c. Direct and indirect maternal death
   d. Abortion, stillbirth, and fetal death
2. Describe what is included in a "discharge."
3. Identify deaths that are excluded in gross and net death rates.
4. Define the terms
   a. Mortality
   b. Delivery/undelivered
   c. Puerperium
   d. Neonate/neonatal
   e. Perinatal/postnatal
5. Compute the following death rates:
   a. Gross
   b. Net

c. Newborn
d. Postoperative
e. Anesthesia
f. Maternal
g. Fetal

6. Classify neonates by ACOG (American College of Obstetricians & Gynecologists) gestational age.
7. Classify fetal deaths by gram weight and gestational age.

Up to now all calculations have been carried out on data computed daily (rather than at discharge), by counting each patient who has received service on a specified day and totaling the daily total for various specified periods. Also, the inpatient bed and bassinet occupancy percentages were calculated on the basis of how many patients were present in the hospital each day.

The majority of the remaining statistical computations will be based on *discharge data* accumulated at the time of discharge. In other words, all the services a patient may need during his/her hospitalization cannot be ascertained precisely until the patient is discharged. However, once a patient leaves the hospital (upon discharge), this additional information is obtainable and evaluations can be made not only about services received (quantity) but also about the effectiveness or quality of that care.

A discharge occurs at the end of a patient's hospitalization. A discharge order should be written on a patient when the physician determines that the patient may be released from the facility. The absence of a discharge order may indicate that the patient left the hospital against medical advice (AMA), though the patient will be included in the discharge statistics. Another type of discharge is a death, so the term *discharge* includes those discharged either dead or alive. If the term *live discharges* is used, the deaths need to be added in to arrive at the total discharges for that date or period of time.

Inpatient deaths are those that occur during a patient's inpatient hospitalization and are included in the hospital's mortality (death) rate. Outpatient deaths are those that occur at a time other than during hospitalization as an inpatient. The patient who dies at home or en route to the hospital or during an outpatient procedure is an outpatient death.

A major change to keep in mind regarding statistical treatment is that, in computing death rates, newborns are combined with adults and children, instead of determining each category separately, as was done with census data. Unless the death rate specifies a specific group (such as a newborn death rate), all inpatient deaths should be included when computing death rates.

A. TERMS:

1. Mortality

Mortality refers to death or being fatal—a fatality. A mortal is subject to death or is destined to die. Mortality rates are death rates.

2. Discharge

A discharge is a termination of hospitalization. Each patient admitted to the hospital sooner or later leaves the hospital and is considered discharged. As mentioned previously, there are many discharge options including being discharged home, discharged to an extended care facility, transferred to another hospital, or expired during the hospitalization. A death is considered a discharge but deaths are recorded independently to facilitate death rate computation. A patient who leaves the hospital without a discharge order leaves the hospital AMA (against medical advice).

3. Death

a. *Inpatient Death*

A patient who expires while an inpatient in the hospital is an inpatient death. Hospital statistics only include inpatient deaths, which means the patient expires after admission as an inpatient to the hospital. That excludes outpatient deaths.

b. *Newborn Death*

A newborn death occurs only in those infants who have shown signs of life at the time of birth. Therefore, any infant or fetus born dead is a fetal death, never newborn death. Any sign of life, no matter how tenuous, results in a liveborn infant and should the infant expire, even minutes after birth, it is considered a newborn death and is included in hospital death rates. It is important not to confuse a newborn death with a fetal death.

c. *Outpatient Death*

Outpatient deaths include patients who expire during outpatient care or are treated on a regular or series basis and expire elsewhere. Outpatient deaths are *not* included in hospital death rates.

In addition to patients undergoing treatment or diagnostic testing as an outpatient (outpatient surgery, exercise EKG, nuclear medicine scan), the following deaths are excluded from inpatient death rates.

(1) ER death
(2) DOA
(3) Home care or hospice death unless the death occurred as an inpatient.
(4) Hospital fetal death (stillborn/abortion)

d. *Hospital Fetal Death (Abortion/Stillborn Infant)*

A hospital fetal death is death *prior* to the complete expulsion or extraction from its mother, in a hospital facility, of a product of human conception, (fetus and placenta), irrespective of the duration of pregnancy and without any signs of life. Fetal deaths are never included in mortality rate except in a separate fetal death rate.

4. Net vs. Gross

Whenever the term *gross* is used statistically, it represents an amount before anything is subtracted or, in the case of death rates, it includes all deaths (inpatient here) with no exclusions. This is analogous to working pay. An employee, for instance, is hired to work a forty-hour work week at a pay rate of five dollars an hour. This employee will have an earned gross pay of $200.00 a week (hourly rate × hours worked, or $5.00 × 40 hours). However, seldom does a worker take home the *gross* amount because the employer generally deducts something from that gross pay before the employee receives the paycheck. (These deductions may include federal and state income tax, social security, retirement fund, hospital insurance, etc.) The amount that the employee takes home (amount on the paycheck) is the employee's *net* pay. The *net* pay is the gross pay minus the deductions. It is important to keep in mind that whenever the term *net rate* is used, something will need to be subtracted. *Gross* minus something = *net*.

B. DEATH RATES

Based on discharge data, a list is prepared of all patients who died during their hospital stay. From these lists or counts the death rate can be determined. Remember that, upon discharge, a patient is classified as being discharged either alive or dead and that the term *discharge* includes death. However, look at the data carefully, because the term *live discharges* is also used, in which case the live discharges must be added to the deaths to determine the total discharges.

Example: On January 15, fifteen patients were discharged. Of these 15, two were deaths and 13 were live discharges.

HINT:

Keep in mind the formula for determining any rate—divide the number of times something happens by the number of times it could *happen. When in doubt about what data to use in a formula, recall this reminder.*

1. Helpful Hints

a. *Death rates should be low*. In previous calculations, high percentages based on census/inpatient service data were the norm, with high percentages being advantageous and expected. The opposite should hold true for death rates. A result of 90% (or even 20%) would clearly indicate a miscalculation and alert the statistician that errors should be sought. In many instances, the death rate will be less than 1%, resulting in a decimal figure (for example, 0.67% or 0.95%). Carefully check the placement of the decimal point. If an actual death rate was 0.95%, a misplaced decimal point could result in an incorrect death rate of 9.5% or, even worse, 95%.

b. *Death rates should be carried out to three (or at least two) decimal places and corrected to two (or one) places.* A tenth of a percent of a large number is less significant than a tenth of a percent of a small number. Since death rates will typically be low, calculations should be carried out further than the other calculations that have been introduced up to this point.

c. *Most death rates use discharge data, not admission data*. Remember: As long as a patient is hospitalized there is a chance that the patient may die and therefore discharge figures are used to calculate death rates. Any exception to this rule will be noted in the appropriate death rate.

d. *Most death rates combine NB and adults and children data.* Death rates can be figured separately (NB separately and A&C separately), but in the majority of cases they are combined. This is in contrast to census data and occupancy percentages.

2. Gross Death Rate

Formula:

$$\frac{\text{Total number of deaths (including NB) for a period}}{\text{Total number of discharges (including deaths) for the period (NB and A\&C)}} \times 100$$

Example: If 100 patients are discharged in a certain month and three of these were deaths, the result is a gross death rate of 3% (3 ÷ 100 = 0.03, which is multiplied by 100).

Explanation: When confused, recall the general rate formula. As you reason out the answer, it becomes clear that any patient who is hospitalized may die during hospitalization. In the example above, three patients expired. However, remember to use *discharge data*, since any patient who is still hospitalized could die before discharge and only upon discharge would it be known whether the patient survived or died. Therefore, death rates are not figured on currently hospitalized patients (census data) but rather on patients who have been discharged (discharge data).

3. Net Death Rate or Institutional Death Rate

Formula:

$$\frac{\text{Total IP deaths (incl. NB) minus those under 48 hours for a period}}{\text{Total discharges minus deaths under 48 hours for the period}} \times 100$$

(Remember that discharges include deaths and that NBs—deaths and discharges—are included in the denominator as well.)

Explanation: The thinking behind this formula includes the belief that if a patient expires in less than 48 hours there was insufficient time to diagnose and treat a life-threatening disorder and that only emergency and stabilizing treatment could be provided during such a short period of time. For this reason, the institutional death rate came into use. To adequately assess deaths based on a more adequate treatment time frame, the net death rate came into use. The feeling was that the net death rate reflected more accurately the hospital's ability to save lives. With today's shorter stays the net death rate is probably out of date.

Hospital deaths are reviewed by a medical staff committee to determine whether appropriate care was administered and to evaluate whether other measures may have helped to save the patient's life, in hopes that lives might be saved in the future. This points to another role of statistical treatment of data. Not only are statistics important for administrative decisions (such as whether to close down a wing of the hospital) but for peer review and better patient care as well.

Not all hospitals use the *net* or *institutional death rate;* and each hospital will determine whether it wants to keep these data. It is important to specify whether a death rate is a *gross* or *net* death rate. The term *net* indicates that certain deaths (deaths occurring less than 48 hours after admission) are *not* included and will be *subtracted* from the death total. Because these deaths are excluded in the numerator, they must also be excluded (subtracted) in the denominator (since they were neither a live discharge nor a death that occurred more than 48 hours after admission).

Example: A total of five patients expired in June, of which two died less than 48 hours following admission and three died more than 48 hours after admission. A total of 450 inpatients were discharged in June.

Gross death rate is total deaths over total discharges (5 divided by 450), then multiplied by 100, which gives a gross death rate of 1.11%.

Net death rate only includes patients who died at least 48 hours after admission, or 3 divided by 450 minus 2 (3 ÷ 448), multiplied by 100, which gives a net death rate of 0.67%.

4. Newborn Death Rate (Infant Death Rate or Infant Mortality Rate)

Formula:

$$\frac{\text{Total number of NB deaths for a period}}{\text{Total number of NB discharges for the period}} \times 100$$

(Include deaths in the discharges.)

Example: A total of two newborns died during the month of December and there were 102 live newborn discharges. To find the NB death rate, the two deaths are placed in the numerator and the total discharges (live and deaths), or 102 + 2 = 104, are placed in the denominator. This gives a newborn death rate of 2 divided by 104 multiplied by 100, for a percentage of 1.92% [(2 ÷ 104) × 100].

SELF-TEST 22

Compute all answers correctly to *one* decimal place.

1. Snowflake Hospital recorded the following data for May:

			Deaths	
	Admissions	***Discharges***	*<48 hrs*	*>48 hrs*
Adults/Children	686	691	6	30
Newborn	58	60	1	4

Calculate:

a. Gross death rate.

b. Net death rate.

c. Newborn mortality rate.

2. The following data are recorded for November:

		Deaths		
Service	***Admissions***	*<48 hrs*	*>48 hrs*	***Discharges***
Medical	250	5	20	261
Surgical	105	2	8	103
Pediatric	33	0	2	35
Obstetrical	36	1	0	34
Psychiatric	47	1	0	45
Newborn	40	1	1	38

Calculate:

a. Gross death rate.

b. Net death rate.

c. Newborn death rate.

d. Net death rate for medical service.

e. Clinical service with the lowest gross death rate.

3. A newborn nursery reports the following data for February:

Bassinet count	15	
Births (admissions)	88	
Discharges	84	
Newborn deaths	2	(1 under 48 hrs; 1 over 48 hrs)
Fetal deaths	5	(2 early; 2 intermediate; 1 late)
IP service days	398	

Calculate: Gross death rate for the newborn nursery in February.

4. Morris County Hospital reports the following for November:

			Deaths	
	Admissions	***Live Discharges***	***<48 hrs***	***>48 hrs***
Adults/Children	386	388	4	12
Newborn	91	95	1	2

Calculate:

a. Gross death rate for November.

b. Net death rate for November.

c. Newborn mortality rate for November.

d. Gross death rate for A&C for November.

5. A hospital newborn nursery reports a total of 234 births during the month of July. During the same month there were a total of four deaths—two newborn and two fetal deaths. One of the newborn deaths occurred under 48 hours after admission; the other occurred over 48 hours. During July a total of 238 newborns were discharged. The bassinet count for the month was 15.

Calculate: Newborn death rate for July.

6. June statistics:

Admissions—adults/children	650
newborn	55
Discharges—including deaths	
adults	602
children	45
newborn	57

		<48 hrs	*>48 hrs*
Deaths—medical	28	4	24
surgical	3	1	2
pediatric	1	0	1
obstetric	1	1	0
newborn	2	1	1
fetal (intermediate and late)	3		

Calculate:

a. Gross death rate for June.

b. Net death rate for June.

c. Newborn death rate for June.

5. Surgical Death Rates

Two surgical death rates are *not* based on discharges and therefore are an exception to the rule that applied to the four previous death rates. These surgical death rates are computed by some but not all hospitals. When referencing surgical data it should be pointed out that there is a difference between a surgical operation and a surgical procedure. A *surgical operation* is one or more surgical procedures performed at one time for one patient using a common approach or for a common purpose. A *surgical procedure* is a single manipulation that can be complete in itself. A closed reduction to align a broken bone is a procedure, as is a forceps delivery of a fetus. A patient undergoing heart bypass surgery not only has an incision made in the chest but also a vein removed from another part of the body (such as the leg). Although two incisions are made, it is one operation. However, a patient undergoing a splenectomy and an open reduction of a broken wrist following an accident is undergoing two surgical operations. The two rates computed are:

a. Postoperative death rate.
b. Anesthesia death rate.

a. Postoperative Death Rate

Formula:

$$\frac{\text{Total surgical deaths within 10 days postoperative for a period}}{\text{Total patients operated upon for the period}} \times 100$$

Explanation: Whether the death rate is of value has been questioned. It is included here because it is still used frequently by some hospitals. However, determining death rates for specific operations can provide more valuable information. Determining the number of patients who expire as the result of a cholescystectomy or hemicolectomy can be more meaningful than stating that the postoperative death rate was 5%.

Also, few surgical patients nowadays are still hospitalized ten days postop because of the trend to ever shorter inpatient stays. Only patients in critical condition and those who develop major complications are likely to exceed ten postoperative days.

NOTE:

> *This formula is an exception to the rule of using discharged patients as the basis for figuring death rates. Here the comparison is made between patients who died within* ten *days after an operation and all patients who were operated on during that same period. Only patients who underwent an operation are included in this formula and the death must have occurred within the postoperative days. Applying the general "rate formula," the patients to whom this* could *happen are those who were operated on. This value is used in the denominator rather than patients discharged. Patients who expire late in the postoperative period (10 days or more) are considered most likely to have died as the result of a medical condition rather than because of complications due to surgery.*

Example: During the month of March, a total of three postoperative deaths were reported within 10 days postop. During March, a total of 375 patients underwent operative procedures. Applying the formula, three deaths are placed in the numerator and 375 patients (the number operated on) in the denominator. Dividing 3 by 375, and then multiplying by 100, results in a postoperative death rate of 0.8% for March.

SELF-TEST 23

Compute the rates correctly to *two* decimal places.

1. The following information is given for July:

Surgical patients admitted	185
Surgical patients operated on	187
Surgical patients discharged	183
Total deaths on surgical unit	6
Total deaths postoperatively	4
Total deaths within 10 days postop	2
Total surgical procedures performed	193
Total anesthetics administered:	188

Calculate: Postoperative death rate for July.

2. Feel Good Hospital during August reported the following surgical statistics:

Admissions	193	
Discharges	189	
Deaths	7	(3 under 48 hours; 4 over 48 hours)
		(5 under 10 days; 2 over 10 days)
Operations performed	210	
Patients operated on	188	

Calculate: Postoperative death rate for August.

b. Anesthesia Death Rate

Formula:

$$\frac{\text{Total deaths caused by anesthetic agents for a period}}{\text{Total number of anesthetics administered for the period}} \times 100$$

NOTE:

Anesthesia deaths occur infrequently and the rate is generally only computed annually. Because it is difficult to prove that a death resulted from an anesthetic agent, these deaths can only be determined by a physician. When keeping statistics on anesthesia deaths, it may be more meaningful to classify them by specific anesthetic agent rather than to all anesthetics.

Example: During the year, 1400 anesthetic agents were administered and it was determined that one death resulted from an anesthetic agent. The yearly anesthesia death rate would be 1 divided by 1400, then multiplied by 100, for a rate of 0.07% [(1 ÷ 1400) × 100]. Be sure to check the placement of the decimal point in anesthesia death rates.

SELF-TEST 24

Compute the answers correctly to *two* decimal places.

1. Chastity Hospital reports the following surgical data for the year:

Admissions	1843	
Discharges	1849	
Deaths	40	(9 under 48 hrs; 31 over 48 hrs)
		(12 under 10 days postop; 28 over 10 days postop)
		(2 reported due to anesthetic agent)
Operations performed	2010	
Patients operated on	1852	
Anesthetics administered	1854	

Calculate:

a. Anesthetic death rate for the year.

b. Postoperative death rate for the year.

c. Gross death rate for surgical patients for the year.

d. Net death rate for surgical patients for the year.

2. In July, Blessing Hospital reported the following surgical data:

Admissions	258	
Discharges	262	
Deaths	9	(3 under 48 hrs; 6 over 48 hrs) (2 under 10 days postop; 7 over 10 days postop) (0 due to anesthetic agent)
Anesthetics administered	298	
Surgical procedures performed	301	
Patients operated on	260	

Calculate:

a. Anesthesia death rate for July.

b. Postoperative death rate for July.

c. Gross death rate for surgical patients for July.

d. Net death rate for surgical patients for July.

C. OBSTETRICAL: TERMS/CLASSIFICATIONS/DEATH RATES

1. Terms

a. Delivery/Delivered

Delivery is the act of giving birth, either of a live child or a dead fetus (and placenta) by manual, instrumental, or surgical means. A female may deliver a single infant or multiple infants. The infants, as stated, could be born either dead or alive. A delivery refers to expelling a product of conception or having it removed from the body. It should be pointed out that multiple births are considered a single delivery and that a woman who gives birth to twins, triplets, or other multiple births is credited as having one delivery.

b. Undelivered

Occasionally a pregnant woman is admitted to the hospital because of complications of the pregnancy and then goes home without having delivered. At the time of discharge, the patient's condition is noted as "undelivered." A woman may also be admitted following delivery because of complications and go home undelivered.

c. Puerperium

The puerperal period is the 42-day period following delivery and is included as part of the pregnancy period. It is the approximate six-week period following childbirth during which the uterus returns to its normal size. A female who has delivered a product of conception and who dies within this period due to a pregnancy-related cause is also considered a maternal or obstetrical death.

d. Infant/Infant Death

A liveborn is considered an infant until one year of age. If the infant dies during its first year of life it is an infant death.

e. Maternal Death/Obstetrical Death

The death of any woman from any cause, either while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy is a maternal death.

Two terms are associated with maternal deaths—*direct* maternal death and *indirect* maternal death.

(1) Direct Maternal Death

Hospital statistics primarily include only "direct maternal" deaths, that is, deaths directly related to pregnancy. These include:

(a) Abortion death—during or following an abortion.
(b) Antepartum death (death prior to delivery) caused by the pregnancy.
(c) Postpartum death (death after delivery) due to pregnancy.
(d) Deaths at the time of delivery due to pregnancy.

Deaths Not Included:

(a) Death of a pregnant woman in a car accident.
(b) Death of a pregnant woman due to suicide.
(c) Death of a pregnant woman not directly related to her pregnant condition. (This would be a hospital death but not a maternal death).

(2) Indirect Maternal Death

A maternal death *not* directly due to obstetric causes but aggravated by the pregnant condition. An example of an indirect maternal death might be a patient with diabetes mellitus who is pregnant and who dies as the result of complications from the diabetes, which was aggravated by the pregnant condition.

f. Abortion

An abortion is the expulsion or extraction of all (complete) or any part (incomplete) of the placenta or membranes, without an identifiable fetus or with a liveborn infant or a stillborn infant weighing less than 500 grams or less than 20 completed weeks of gestation, calculated from the first day of the last normal menstrual period. In the absence of known weights, an estimated length of gestation of less than 20 weeks (139 days) may be used; this is calculated from the first day of a woman's last normal menstrual period. Abortion is a term referring to the birth process culminating before the twentieth completed week of gestation. The term *early fetal death* is preferred to the term *abortion*.

g. Stillborn

A stillborn infant is a fetus, irrespective of its gestational age, which after complete expulsion or extraction shows no evidence of life (no heartbeat, no respirations, no pulsation of the umbilical cord, or no definite movement of voluntary muscles). A stillborn is *not* a hospital inpatient and does not have a medical record. Circumstances of the birth should be documented in the mother's medical record. The term *fetal death* is preferred over the more common term of "stillbirth" or "aborted fetus." Because this is a fetal death, the death is not included in inpatient death rates but rather is included in the fetal death rate.

h. ***Hospital Fetal Death***

A hospital fetal death is death prior to the complete expulsion or extraction from its mother, in a hospital facility, of a product of human conception (fetus and placenta) irrespective of the duration of pregnancy and without any signs of life (as stated in the previous section under "stillbirth.") It is important not to confuse a newborn death with a fetal death.

i. ***Partum***

Partum means childbirth.

a) Antepartum—the period before giving birth.
b) Postpartum—the period after giving birth.

j. ***Neonate/Neonatal***

A neonate is a newborn infant and neonatal refers to that infant. Three neonatal periods have been established which are presented in the subsequent section (Section 2b). The neonatal period extends from birth through the first 27 days, 23 hours, and 59 minutes (or, just under 28 days). During this period the infant is referred to as a newborn infant.

k. ***Perinatal Period/Perinatal Death***

The perinatal period is the period surrounding birth. A perinatal death includes both stillborn infants and neonatal deaths.

l. ***Postnatal/Post Neonatal***

The term postnatal or post neonatal (after the neonatal period) refers to the period following birth of the newborn.

m. ***Pregnancy Termination***

Pregnancy termination is the expulsion or extraction of a dead fetus or other products of conception from the mother, or the birth of a liveborn infant or a stillborn infant.

n. ***Induced Termination of Pregnancy***

Induced termination of pregnancy is the purposeful interruption of an intrauterine pregnancy with the intention of not giving birth to a liveborn infant and which does not result in a live birth. This definition excludes management of prolonged retention of products of conception following fetal death.

2. Classifications

a. Newborn Birth Data Classification

Newborns or neonates are classified by two sets of criteria—one is birth weight (to the nearest gram) and the other is gestational age, dating from the woman's last normal menstrual period. Birth weight is determined immediately after delivery or as soon as feasible. Birth weight is more easily measured than gestational age.

Comparisons of grams to pounds:

1000 grams = 2 lb 3 oz

2500 grams = 5 lb 8 oz

The term *premature birth* applies to a newborn with a birth weight of less than 2500 grams.

In addition, two methods of classification are routinely used in classifying newborns. One method was established by the American College of Obstetricians and Gynecologists (ACOG). The Standards are found in *Standard Terminology for Reproductive Health Statistics in the United States.* The second classification system is that used in ICD-9-CM. (LMP stands for last menstrual period).

(1) ACOG Classification by gestational age.

(a) Preterm Neonate	from birth to last day of 38th week (266 days from onset of LMP)
(b) Term Neonate	from week 39 to last day of 42nd week (267 to 294 days from onset of LMP)
(c) Post Term Neonate	from week 43 on following onset of LMP
(d) Low Birthweight Neonate	less than 2500 grams

(2) ICD-9-CM Classification	(gram weight)	(gestational age)
(a) Extreme Immaturity	<1000 gm	<28 weeks
(b) Other Preterm Infants	1000–2499 gm	29–37 weeks
(c) Post Term Infant		42 or more weeks (294 days)
(d) Exceptionally Large Baby	4500+ gm	

b. Neonatal Periods

(1) Neonatal Period I	hour of birth through 23 hrs and 59 min
(2) Neonatal Period II	beginning of the 24th hr of life through 6 days 23 hrs and 59 min (just under 7 days)
(3) Neonatal Period III	beginning of the 7th day through 27 days 23 hrs and 59 min (just under 28 days)

c. Fetal Death Classification

(1) ACOG Classification by gestational age:

(a) Early Fetal Death	less than 20 weeks gestation
(b) Intermediate Fetal Death	20 wks to less than 28 wks
(c) Late Fetal Death	28 or more weeks gestation

(2) ACOG classification by gram weight:

(a) Early Fetal Death	500 grams or less
(b) Intermediate Fetal Death	501 to 1000 grams
(c) Late Fetal Death	1001 grams or more

(3) ICD-9-CM

(a) Early Fetal Death	before 22 weeks gestation
(b) Late Fetal Death	after 22 weeks gestation

3. Death Rates

a. Maternal

NOTE:

Maternal death rates, like anesthesia death rates, should be low. Therefore, the rate is most commonly computed only on an annual basis, rather than monthly, and should be carried to three decimal places. Raw data may be submitted to external agencies and used to calculate nationwide rates or state, regional, or local rates.

If all maternal deaths are the result of abortion, it is a good idea to attach a note to the death rate stating this fact, to avoid confusing deaths resulting from abortions with deaths in the delivery room.

Formula:

$$\frac{\text{Total maternal deaths for a period}}{\text{Total maternal (obstetrical) discharges for the period (including deaths)}} \times 100$$

Example: The year-end report from the obstetrical unit lists the following figures:

Admissions	1550	
Discharges	1554	
Deliveries	1488	
Abortions	46	
Undelivered	38	
Deaths	3	(2 due to abortions; 1 following C-section)

Applying the formula, 3 deaths make up the numerator and 1554 discharges are included in the denominator. Dividing 3 by 1554, and then multiplying by 100, results in a maternal death rate of 0.19% for the year.

SELF-TEST 25

Compute the answers correctly to *two* decimal places.

1. The obstetrical unit reported five deaths of pregnant females for the year. The causes of death are listed as follows:

   Puerperal septicemia

   Toxemia of pregnancy

   Ruptured ectopic (tubal) pregnancy

   Leukemia aggravated by pregnancy

   Placental hemorrhaging due to a fall down the basement steps

Year-end statistics also included:

Admissions	1222	
Discharges	1225	
Deliveries	1203	
Abortions	57	(31 early; 19 intermediate; 7 late)
Undelivered	38	

Calculate: Maternal death rate for the year.

2. Year-end discharge data for Cherub Hospital reveal:

Admissions	1353
Discharges (live):	
Delivered—live infant	1241
Delivered—aborted	63
Undelivered—antepartum	26
Undelivered—postpartum	19
Deaths (due to pregnancy)	2

Calculate: Maternal death rate for the year.

3. Year-end obstetrical statistics include:

Admissions: 1582

Discharges:	***Live***	***Deaths***
Delivered of live infant	1495	3
Delivered of dead fetus	63	1
Undelivered—antepartum	14	0
Undelivered—postpartum	11	1

Calculate: Maternal death rate for the year, assuming all deaths were the result of conditions of pregnancy.

b. Fetal Death Rate (Stillborn Rate)

Although fetal deaths have already been mentioned, they have not been included in any of the computations carried out to this point. Remember that fetal deaths are *only* included in formulae specifically designated for them and that include the word *fetal* in them—fetal death rate, fetal autopsy rate. "Stillborn" and "aborted fetus" are terms commonly used to describe a fetal death. The criteria have already been mentioned as to what constitutes an early, intermediate, or late fetal death, so they will not be reiterated here. Check for these designations earlier in this chapter. Remember that a fetus classified as a fetal death has not shown any signs of life upon entering the world (upon expulsion from the womb) and cannot be revived through any resuscitative means. Do not confuse newborn deaths with fetal deaths. If there is any sign of life at the time of birth, the birth is considered a live birth, even though death might occur shortly after delivery.

(1) Included in Fetal Death Rates

Fetal death rates include only *intermediate* and *late* fetal deaths. This excludes fetuses of less than 20 weeks gestation or those weighing 500 grams or less.

Early fetal deaths (500 grams or less in weight or less than 20 weeks gestation) are considered insufficiently developed to sustain life outside the womb.

(2) *Fetal Death Rate (Stillborn Rate)*

Formula:

$$\frac{\text{Total number of intermediate and late fetal deaths for a period}}{\begin{array}{c}\text{Total number of } \textit{births} \text{ for the period} \\ \text{(including live births, and intermediate and late fetal deaths)}\end{array}} \times 100$$

NOTE:

This is another formula that does not *use discharges in the denominator. The rationale for this is that every conceptus can be expelled (born) either dead or alive and the outcome is known at the moment of birth. By applying the "rate formula," and asking about the number of times something* could *happen, it becomes apparent that with each birth there is a chance the infant or fetus could be born with or without signs of life. Since only intermediate and late fetal deaths are included in a fetal death rate, they must also be included in the denominator (added to the live births) as well as in the numerator. If the term "births" is not specifically designated, keep in mind that "births" are also recorded as "newborn admissions."*

Example: Newborn figures for April include a total of 505 live births. Live discharges included 515 newborns. Deaths included three newborn deaths, six early fetal deaths, four intermediate fetal deaths, and two late fetal deaths. To find the fetal death rate, add the number of intermediate and late fetal deaths (4 + 2 = 6) and divide by the number of live *births* plus the total intermediate and late fetal deaths (505 + 6 = 511), or 6 divided by 511, and then multiplied by 100, equals 1.17% [(6 ÷ 511) × 100].

SELF-TEST 26

Calculate the answers correctly to *two* decimal places.

1. A newborn unit recorded the following for May:

Admissions	238	
Discharges (live)	235	
Deaths (newborn)	1	(under 48 hours)
Fetal deaths	3	(1 early; 1 intermediate; 1 late)

Calculate:

a. Fetal death rate for May.

b. Newborn death rate for May.

2. A newborn nursery's records for August reveal:

Bassinet count	18	
Admissions	265	
Discharges	260	
Deaths	2	
Fetal deaths	6	(1 of 12-week gestation)
		(1 of 14-week gestation)
		(1 of 20-week gestation)
		(1 of 24-week gestation)
		(1 of 28-week gestation)
		(1 of 30-week gestation)

Calculate:

a. Fetal death rate for August.

b. Newborn death rate for August.

3. October newborn data include:

Bassinet count	20	
IP service days	565	
Admissions	305	
Discharges	311	
Deaths	1	
Fetal deaths	5	(1 weighed 465 gm)
		(1 weighed 528 gm)
		(1 weighed 936 gm)
		(1 weighed 1001 gm)
		(1 weighed 1055 gm)

Calculate:

a. Fetal death rate for October.

b. Newborn death rate for October.

*c. **Vital Statistic Rates***

In addition to the hospital death rates already introduced, there are formulas which have been developed and are used by other entities. Included in this section are the rates from "Standard Terminology for Reproductive Health Statistics in the United States."

(1) Maternal Mortality Rate

The maternal mortality rate is defined as the number of deaths assigned to puerperal causes in a calendar year, divided by the number of live births in that year, the quotient being multiplied by 100,000.

Formula:

$$\frac{\text{Deaths due to maternal conditions}}{\text{Number of live births}} \times 100{,}000$$

Example: If the national yearly deaths due to puerperal causes was 250 and the total number of live births recorded was 3,600,000 in that same year then the maternal death rate for the year is recorded as 6.9 maternal deaths per 100,000 live births. (250 divided by 3,600, 000 times 100,000 equals 6.94).

Discussion: The formula does not give a true representation of maternal deaths because fetal deaths are not represented in the denominator, which inflates the rate slightly. Also, multiple births tend to inflate the denominator but not the numerator, though multiple births are not nearly as common as single births and the effect would be minor for a large population.

(2) *Infant Mortality Rate*

The infant mortality rate is defined as the number of deaths of persons of age zero to one in a calendar year, divided by the number of live births in that year, the quotient being multiplied by 1,000.

Formula:

$$\frac{\text{Infant deaths (neonatal + post neonatal)}}{\text{Number of live births}} \times 1000$$

Example: If 401,581 live births were reported in California along with 4593 infant deaths, then the infant mortality rate would be 11.4 infant deaths per 1000 live births in that year.

(3) *Neonatal Mortality Rate*

The neonatal mortality rate is defined as the number of deaths of neonates (infants under 28 days of age) that occurred in a calendar year divided by the number of live births that year, the quotient being multiplied by 1000.

Formula:

$$\frac{\text{Number of neonatal deaths}}{\text{Number of live births}} \times 1000$$

Example: Reports indicate the following:

Deaths <1 year of age	= 4186
Deaths <28 days of age	= 2743
Live births	= 347,000

The neonatal mortality rate is computed by placing 2743 in the numerator and 347,000 in the denominator and multiplying by 1000. The result is 7.9 neonatal deaths per 1000 live births that year.

Additional: To determine how many of the infant deaths were neonatal, place 2743 in the numerator, 4186 in the denominator, and multiply the quotient by 100. This results in 65.53% of the infant deaths that were neonatal.

It has been shown that the bulk of infant deaths occur in a relatively short period of time following birth and the neonatal death rate interprets the deaths during this period.

(4) *Perinatal Mortality Rate*

The perinatal mortality rate is defined as the number of fetal deaths plus neonatal deaths divided by the number of live births plus fetal deaths, the quotient being multiplied by 1000.

Formula:

$$\frac{\text{Number of neonatal (NB) deaths} + \text{fetal deaths}}{\text{Number of live births} + \text{fetal deaths}} \times 1000$$

NOTE:

When applying this formula it is important to designate the neonatal period, since three separate periods have been established. Most formulas included all three periods. Also, since there are three categories for fetal deaths, most only include the intermediate and late fetal deaths, but again, the deaths included should be specified.

Example: The data indicates

Fetal deaths = 2911
Neonatal deaths = 2743
Live births = 347,000

To compute the perinatal mortality rate, place 2911 + 2743 in the numerator, 2911 + 347,000 in the denominator, determine the quotient (.01616) and multiply by 1000 for a total of 16.2 perinatal deaths per 1000 fetal deaths plus live births per year.

(5) *Post Neonatal Mortality Rate*

The post neonatal mortality rate is defined as the number of post neonatal deaths divided by the number of live births, the quotient being multiplied by 1000.

Formula:

$$\frac{\text{Number of post neonatal deaths}}{\text{Number of life births}} \times 1000$$

Example: 3000 post neonatal deaths were reported for 345,000 live births, Placing 3000 in the numerator and 345,000 in the denominator results in a quotient of .008696; multiplying the quotient by 1000 results in 8.7 post neonatal deaths per 1000 live births.

(6) *Fetal Death Rate*

The fetal death rate is defined as the number of fetal deaths (again it is important to designate which fetal deaths are to be included; most statistics only include fetal deaths over 20 weeks gestation) divided by the number of live births plus the number of fetal deaths, the quotients being multiplied by 1000.

Formula:

$$\frac{\text{Number of fetal deaths}}{\text{Number of fetal deaths} + \text{live births}} \times 1000$$

NOTE:

Sometimes this formula is computed by simply dividing the total number of fetal deaths by the number of live births, so it is important to know which formula is being used.

Example: Fetal deaths for year = 2915
Live births for year = 348,000

When 2915 is placed in the numerator and 348,000 + 2915 in the denominator, the quotient is recorded as .008307, multiplying by 1000 results in a rate of 8.3 fetal deaths per 1000 births (liveborn plus fetal deaths).

In using the second formula, 2915 is divided by 348,000 for a quotient of .008376, which multiplied by 1000 equals 8.736. This indicates that there were 8.4 fetal deaths per 1000 live births.

Since the number of fetal deaths is grossly underreported nationally, the fetal death rate determined by these formulae will also be grossly underestimated.

SELF-TEST 27

State population statistics for the year include:

Population of state	=	2,555,000
Female population (15–44)	=	35,000
Maternal deaths	=	50
Live births	=	380,000
Infant deaths (<1 yr)	=	4,293
Neonatal deaths (<28 wks)	=	2,527
Fetal deaths (<20 wks)	=	3,011
Post neonatal deaths	=	1,766

Determine the following:

a. Maternal mortality rate

b. Infant mortality rate

c. Neonatal mortality rate

d. Percent of all infant deaths that are neonatal deaths

e. Perinatal mortality rate

f. Postneonatal mortality rate

g. Fetal death rate

(1) Without fetal deaths in denominator

(2) Including fetal deaths in denominator

(7) Induced Termination of Pregnancy Rates

The following rates are taken from the *Glossary of Health Care Terms* and are included here for reference purposes only. National statistics again are grossly underreported and thus the final ratios will also be greatly underestimated.

a. Ratio I

$$\frac{\text{Induced pregnancy terminations}}{\text{Live births}} \times 1000$$

b. Ratio II

$$\frac{\text{Induced pregnancy terminations}}{\text{Induced pregnancy terminations + live births + fetal deaths}} \times 1000$$

c. Induced Termination of Pregnancy Rate

$$\frac{\text{Induced pregnancy terminations}}{\text{Female population 15–44}} \times 1000$$

D. SUMMARY

1. Inpatient deaths are those that occur during a patient's hospitalization as an inpatient, prior to discharge.
2. Outpatient deaths are those that occur
   a. in the emergency room before a person is admitted to the hospital.
   b. among outpatients who are series patients and come in routinely for treatment (chemotherapy, radiotherapy, rehabilitation, etc.) or for outpatient surgery.
   c. among home care patients or hospice patients seen routinely in their homes.
3. Deaths that are *not* included in routine death rates are
   a. outpatient deaths
   b. ER deaths
   c. DOAs
   d. fetal deaths
4. A&C deaths and NB deaths are combined and included together in the same death rate. They are not separated, as was done with census (admission) data.
5. A live birth is one that shows signs of life at the time of birth.
6. The term *fetal death* is preferred over the terms "stillborn," "abortion," or "aborted fetus."
7. The numerator in *all* death rates is the total number of deaths pertaining to that rate.
8. Helpful hints:
   a. Include only inpatient deaths—exclude OPs, DOAs, and fetal deaths.
   b. Death rates should be low.
   c. Death rates should be carried to two or three decimal places.
   d. The majority of death rates are computed by dividing the number of deaths by the number that were discharged.
   e. Net death rates exclude deaths that occur less than 48 hours after admission.

f. Anesthesia death rates and maternal death rates should be extremely low and are generally figured only on a yearly basis.
g. Fetal death rates include only intermediate and late fetal deaths.

9. Gross Death Rate. Deaths divided by discharges.
10. Net Death Rate. (Total deaths minus those under 48 hours) divided by (total discharges minus deaths under 48 hours).
11. Newborn Death Rate. NB deaths divided by NB discharges.
12. Postoperative Death Rate. Postop deaths that occurred within ten days postop divided by the number of patients operated on.
13. Anesthesia Death Rate. Anesthesia deaths divided by the number of anesthetics administered.
14. Maternal Death Rate. Maternal (OB) deaths divided by OB discharges.
15. Fetal Death Rate. Intermediate and late fetal deaths divided by the total births (NB admissions) plus intermediate and late fetal deaths.
16. Maternal terms:
    a. Direct death—due to pregnancy.
    b. Indirect death—aggravated by pregnancy.
    c. Puerperium—a period of 42 days following delivery.
    d. Delivered—expelling contents of womb; may be single or multiple; may be live or dead.
    e. Undelivered—pregnancy-related admission, but the mother did not give birth during the admission.
    f. Synonymous terms: aborted; stillborn; fetal death.
    g. Partum—childbirth.
        1) Antepartum—before childbirth.
        2) Postpartum—after childbirth.
    h. Neonates are newborns. Three neonatal periods have been established and they extend from birth up to the beginning of the 28th day of life.
    i. Vital statistic death rates are used for reporting national death statistics related to obstetrical data.

E. CHAPTER 6 TEST

Note: Compute all answers correctly to *two* decimal places.

1. What is another name for stillborn?

2. What is the gestational period for a/an
    a. early fetal death?
    b. intermediate fetal death?
    c. late fetal death?

3. What is the gram weight for a/an
    a. early fetal death?
    b. intermediate fetal death?
    c. late fetal death?

4. Which IP deaths or those occurring during an inpatient hospitalization are *excluded* in each of the following death rates?
   a. Gross death rate

   b. Net death rate

   c. Fetal death rate

   d. Postop death rate

5. Which death rates *include* something other than discharges in the denominator? Indicate what is used in place of discharges.

6. Which death rate is also called an Institutional Death Rate?

7. Do most death rates separate NB from A&C?

8. Snowbird Hospital (May)–

		Deaths	
	Total	**Under 48 hours**	**Over 48 hours**
Deaths			
A&C	36	30	6
NB	5	1	4
Discharges (live)			
A&C	742		
NB	66		

Calculate:

a. Gross death rate.

b. Net death rate.

9. Treetop Hospital–

Unit	***Deaths***	***Discharges***
Medical	25	310
Surgical	8	196
Pediatrics	2	38
OB	4	71
NB	1	80

Calculate: Gross death rate.

10. During the month of July, the following surgical data was recorded:

Admissions	1015	
Deaths	7	(less than 10 days postop = 2; more than 10 days postop = 5)
Discharges	997	
Patients operated on	975	
Surgical procedures	1018	

Calculate: Surgical postoperative death rate.

11. A maternal unit recorded the following data for the year:

Maternal admissions	192
Discharges (live)	185
Deaths	1
Deliveries	181

Calculate: Maternal death rate.

12. OB statistics for the year–

		OB Deaths
Admissions	2581	
OB Discharges:		
Delivered live newborn	2288	1
Delivered aborted (dead) fetus	239	1
Discharged undelivered	41	0

Calculate: Maternal death rate.

13. Newborn statistics–

		< 48 hrs	***> 48 hrs***	***Early***	***Int.***	***Late***
NB births	235					
Discharges	228					
Deaths	4	3	1			
Fetal deaths	7			4	2	1

Calculate: Newborn death rate.

14. Newborn statistics–

		< 48 hrs	***> 48 hrs***	***Early***	***Int.***	***Late***
NB births (live)	300					
Discharges	291					
Deaths	3	2	1			
Fetal deaths	26			18	5	3

Calculate:

a. Newborn death rate.

b. Fetal death rate.

15. Grant County Hospital (September)–

	Adm.	***Disch.***	***Deaths***	***< 48 hrs***	***> 48 hrs***
A&C	511	505	45	5	40
NB	83	80	1	0	1

Calculate:

a. Gross death rate.

b. Net death rate.

c. Newborn death rate.

16. Newborn statistics–

		Weeks Gestation
NB births (live)	86	
Discharges	75	
Deaths	2	
Fetal deaths	10	15, 18, 16, 28, 31, 25, 22, 14, 27, 20

Calculate:

a. Newborn death rate.

b. Fetal death rate.

17. General Surgery for the year–

Admissions	354	
Discharges	347	
Patients operated on	334	
Operations performed	372	
Anesthesias administered	321	
Deaths–Total	8	
Postop	4	(3 less than 10 days postop)
Anesthesia	1	

Calculate:

a. General surgery death rate.

b. Postop death rate for general surgery.

c. Anesthesia death rate for general surgery.

18. Woodland Hospital (July)–

	A&C	<48 hrs	>48 hrs	NB	<48 hrs	>48 hrs	E	I	L
Bed/bassinet count	225			20					
Admissions	1138			134					
Discharges (live)	1133			130					
Deaths	10	6	4	1	1	0			
IPSD	5722			503					
Fetal deaths							4	2	1

(E = early, I = intermediate, L = late)

Calculate:

a. Gross death rate.

b. Net death rate.

c. NB death rate.

d. Fetal death rate.

19. Regional Hospital (March)–

Clinical Unit	Count Bed/	Bass.	Adm.	IPSD	Live Disch.	Deaths	<48 hrs	>48 hrs	<10 days	>10 days
Medical	45		142	1280	135	8	5	3		
Surgical	20		81	518	72	5	2	3	4	1
Pediatric	8		66	188	58	1	0	1		
OB	18		118	495	114	1	0	1		
Neuropsych	10		44	261	38	2	1	1		
NB		15	110	466	105	2	1	1		
Totals	101	15	561	3208	522	19	9	10	4	1

Other Statistics:

Postop		4	2	2	3	1
Anesthesia		1				
Patients operated on	69					
Anesthesias administered	77					
Operations performed	99					
Fetal deaths	9	(5 = early; 3 = intermediate; 1 = late)				

Calculate:

a. Gross death rate.

b. Net death rate.

c. Newborn death rate.

d. Net death rate for medical service.

e. Clinical service with the *lowest* gross death rate.

f. Clinical service with the *highest* gross death rate.

g. Postoperative death rate.

h. Anesthesia death rate.

i. Maternal death rate.

j. Fetal death rate.

CHAPTER

7

Autopsy Rates

CHAPTER OUTLINE

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LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Distinguish clearly between
   a. Autopsy vs. hospital autopsy vs. hospital inpatient autopsy.
   b. Net vs. gross autopsy.
2. Describe the types of deaths that most likely are "coroner's cases."
3. Describe when "coroner's cases" are included in hospital autopsies.
4. Distinguish which autopsies are included in hospital autopsies.
5. Compute the following autopsy rates:
   a. Gross
   b. Net
   c. Hospital
   d. Newborn
   e. Fetal

Autopsies are most commonly performed to determine the cause of death. Autopsies are also valuable learning tools for studying disease processes and to characterize the extent or type of changes wrought by disease and treatment. Hospital autopsies can improve clinical knowledge and can serve as a means of educating physicians.

An autopsy rate is a health care statistic that is often reported. It is the ratio of autopsies to deaths. Any patient who has expired is a candidate for an autopsy.

A. TERMS

1. Autopsy

An autopsy is the inspection and partial dissection of a dead body to learn the cause of death, and the nature and extent of disease; a postmortem examination.

2. Hospital Autopsy

A hospital autopsy is a postmortem examination performed by a hospital pathologist, or by a physician on the medical staff to whom the responsibility has been delegated, on the body of a person who has at some time been a hospital patient. Note that there is no mention as to where the examination is to take place.

a. *Inpatients*

A hospital inpatient autopsy is a postmortem examination performed in a hospital facility by a hospital pathologist or by a physician on the medical staff to whom the responsibility has been delegated, on the body of a patient who died during inpatient hospitalization. If an inpatient is a coroner's case (see below), but the body is autopsied by the hospital pathologist, it is still credited as a hospital autopsy. Only if the body is removed by the coroner and the body is unavailable for autopsy is it excluded.

b. *Outpatients*

Note that according to the definition of a hospital autopsy, although the autopsy is to be performed by a member of the hospital's medical staff, outpatients can be included as well as inpatients as long as care has been provided at some time. In other words, a body found alongside the roadway, never before treated at the hospital, fails to meet this requirement; however, current outpatients or those who have been an inpatient or outpatient and are autopsied, are included in the "hospital autopsy rate."

3. Coroner

The coroner is a duly elected or appointed official whose primary function is to investigate any death in which the cause of death is uncertain or due to other than natural causes. An inquest before a jury may be a part of the inquiry. The investigation is directed at determining the manner, means, and cause of death.

4. Medical Examiner

A medical examiner is a physician (most commonly a pathologist), officially authorized by a governmental unit (city, county) to ascertain causes of death, especially those *not* occurring under natural circumstances.

Not all jurisdictions have both a coroner and a medical examiner. In other than the major urban areas of the country, the medical examiner's job may be performed by the hospital pathologist or other designated physician on the medical staff, at the request of the coroner.

B. CORONER'S CASES

Most deaths occurring in a hospital are deaths due to illness or natural causes. However, certain patients may be admitted following a gunshot wound or attempted suicide. Should these patients expire while under the hospital's care, the deaths become known as "coroner's cases" and must be reported to the coroner's office. Most coroners are elected officials who do not have a medical degree and whose primary responsibility is to gather evidence surrounding the death.

The deaths reportable to the coroner's office include deaths due to:

(1) Criminal or violent means (homicides, for example).
(2) Suicides.
(3) Sudden deaths following apparent health (so as to rule out foul play, such as poisoning).
(4) Suspicious or unusual circumstances.
(5) Accidents, including those which occur on the job (arising from employment).

The deaths most likely to fall under the jurisdiction of the coroner's office include deaths due to blows, burns, crushing, cuts or stab wounds, drowning, electric shock, explosions, firearms, falls, poisoning (carbon monoxide, food, etc), hanging, heat-related deaths, strangulation, suffocation and all types of vehicle accidents (car, bus, train, bicycle, and motorcycle).

In addition, criminal or self-induced abortions also are to be reported to the coroner, including stillbirths if suspicious in nature due to illegal interference. Each state has its own laws regarding deaths reportable to the coroner and it is important that a health care practitioner know the law in the state in which he or she is practicing.

When computing autopsy rates it is important to know which deaths are included. Some autopsy rates include only inpatient deaths and the autopsies performed on these inpatients.

One autopsy rate (hospital autopsy rate) includes autopsies performed on outpatients as well as inpatients as stated in the term "hospital autopsy" above. A patient may expire in the Emergency Room during examination and treatment and an autopsy may be requested. An outpatient who expires during outpatient surgery or while undergoing an exercise stress EKG and whose body is autopsied, is also included in the hospital autopsy rate. However, the hospital autopsy rate is the only rate in which outpatients are included in inpatient hospital statistics.

NOTE:

Throughout the computations in this text, all references to deaths reportable to the coroner will be called coroner's cases and, unless specifically indicated, will be those cases not *autopsied by the designated physician on the hospital staff and claimed by the coroner.*

C. ADDITIONAL AUTOPSY INFORMATION

1. Who Performs an Autopsy

A hospital autopsy, as previously stated, is one that is performed by the hospital's designated physician. If the death is a coroner's case and the coroner is not a medical examiner, the coroner contracts with a physician to perform the autopsy. A physician (generally a pathologist) performs the autopsy, but the circumstances of the death are investigated by the coroner's office. If the physician hired by the coroner is the hospital's pathologist and the patient was a hospital patient, the autopsy is included in hospital autopsy rates. In the data to follow the abbreviations HP (for hospital pathologist) and cor (for coroner's case) will be used for computational purposes.

2. Where the Autopsy Is Performed

Most hospitals have a morgue to which the dead bodies are taken at the time of death and it is here that most hospital autopsies are performed by the hospital pathologist. If onsite facilities are not provided, a designated place is generally specified for carrying out the autopsy.

3. Deaths Autopsied

(a) Inpatients

Any inpatient who expires during hospitalization is a potential autopsy case. Autopsies not only identify and establish the cause of death but also provide information that may prove helpful to future care.

(b) Outpatients

As mentioned, some autopsies are performed on outpatients or patients who have been treated at the hospital either on an inpatient or outpatient basis, such as hospice and home care patients. However, only one autopsy rate, the hospital autopsy rate, includes autopsies on outpatients.

(c) Fetal Deaths

As throughout the entire text, fetal statistics are *never* included or combined with other groups in any statistical formula and therefore are excluded from the hospital autopsy rate. Fetal autopsies are, however, reported separately.

(d) Coroner's Cases

As reported, deaths reportable to the coroner may or may not be included, depending on who performs the autopsy. If the hospital pathologist performs the autopsy at the request of the coroner, the autopsy will be included with the other autopsies, otherwise it is excluded.

4. Report Requirements

Whenever a hospital autopsy is performed, a report must be filed in the patient's medical record and the hospital laboratory. Tissue specimens from the patient must also be placed on file in the hospital, usually the hospital laboratory.

5. Consent

A physician obtains permission from the patient's next of kin to perform an autopsy. The autopsy is performed prior to the release of the body to the funeral home. Consent is not required for a coroner's case.

6. Combining A&C and NB

In autopsy rates—whether a hospital autopsy rate, gross autopsy rate, or net autopsy rate—the data on adults/children and newborns are combined, as is done when death rates are computed.

SELF-TEST 28

For each of the following examples, indicate whether the example is applicable to a *hospital autopsy* by answering yes or no.

1. Patient dies in the hospital. The body is autopsied by the hospital pathologist in the hospital morgue. Yes No
2. Patient dies in the hospital. The body is taken to the local morgue and the hospital pathologist performs the autopsy. Yes No
3. Patient dies in the hospital. The body is released to the medical examiner, who performs the autopsy. Yes No
4. Patient dies at home three weeks following inpatient discharge from the hospital. The body is brought to the hospital and the hospital pathologist performs an autopsy. Yes No
5. Three months after inpatient hospitalization, the patient is brought to the emergency room of the hospital, where he is pronounced DOA. The hospital pathologist performs an autopsy. Yes No
6. Patient is admitted to the hospital having received a stab wound to the abdomen. He expires during hospitalization and his body is released to the medical examiner, who performs the autopsy. Yes No
7. Patient is admitted to the hospital and dies four hours after admission. No sign of violence or suicide is present, but the patient had not been under a physician's care. The coroner removes the body and designates someone other than the hospital pathologist to perform the autopsy. Yes No
8. Patient is brought into the emergency room following a car accident and dies prior to inpatient admission. The coroner authorizes the hospital pathologist to perform the autopsy. Yes No
9. A cancer patient had been receiving cobalt therapy on an outpatient basis. Between scheduled outpatient visits, the patient died at home. The body was brought to the hospital, where the pathologist performed the autopsy. Yes No
10. The hospital pathologist is taking a two-week vacation and has a staff physician cover for him while he is gone. During this time, a home care patient dies and the designated physician does the autopsy. Yes No
11. A late fetal death is autopsied by the hospital pathologist. Yes No

NOTE:

Before starting to compute autopsy rates, consider carefully the data required. Since only those who have died will be autopsied, the denominator (those it could *happen to) will be deaths,* not *discharges. The numerator will be the number of patients autopsied. Both numerator and denominator will generally be small numbers, but the percentage will be larger than death rates.*

D. AUTOPSY RATES

1. Gross Autopsy Rate

Formula:

$$\frac{\text{Total autopsies performed on IP deaths for a period}}{\text{Total IP deaths}} \times 100$$

(Deaths include newborns as well as adults/children.)

Explanation: Remember that the term *gross* means *all*, with no subtractions or deletions of any cases.

NOTE:

Only inpatients are included (not OPs). This rate indicates only the percentage of autopsies on IP deaths, irrespective of whether they were coroner's cases.

Example: During the first three months of the year, 18 inpatient deaths were recorded. Two of these were coroner's cases and fell under his jurisdiction. Of the remaining 16, an autopsy was performed on four patients. Four outpatient deaths were also reported and two of these were autopsied.

Since only inpatients are included in a *gross* autopsy rate, we can eliminate any reference to the outpatient data. Of the inpatients, four were autopsied and 18 inpatient deaths were recorded. Therefore, the gross autopsy rate is 4 divided by 18, then multiplied by 100, which yields a rate of 22.2% [(4 ÷ 18) × 100]. (*Note*: The two coroner's cases were included even though their bodies were not available for autopsy by the hospital pathologist.)

SELF TEST 29

Compute all rates correctly to *two* decimal places.

1. In November, one newborn death, eight adults/children deaths, and three intermediate/late fetal deaths were recorded. Three OP deaths were also recorded. A total of six autopsies were carried out by the hospital pathologist: one newborn, three adults/children, one late fetal death, one OP. Total discharges for the month were 331 adults/children and 67 newborns. Total admissions were 335 adults/children and 65 newborns.

   Calculate:

   a. Gross autopsy rate for November.

   b. * (R6) Gross death rate for November.

NOTE:

For the remaining questions, the autopsies listed as coroner's cases are the unautopsied cases—the cases removed by the coroner for examination. The examination of these coroner's cases was not performed by the hospital pathologist or by a designated physician on the medical staff.

2. Pleasant Valley Hospital's first-quarter statistics included the following:

Inpatient:	*A&C*		*NB*	
Admissions	715		174	
Discharges	721		172	
Deaths (total)	16	(5 under 48 hrs)	2	(1 under 48 hrs)
Fetal deaths				
3 early				
2 intermediate				
1 late				
Autopsies	6		1	
Unautopsied (coroner)	2		1	

Calculate:

a. Gross autopsy rate.

b. * (R6) Gross death rate.

3. Silver City Hospital's last-quarter statistics contained the following information:

Inpatient:	*A&C*	*NB*
Admissions	1035	221
Discharges	1044	228
Deaths		
Under 48 hrs	11	2
Over 48 hrs	24	0
Autopsies (hospital)	18	1
Coroner's cases	5	1

Fetal deaths

Early	4	(no autopsies)
Intermediate	2	(1 autopsy)
Late	1	(coroner's case—not done by hospital pathologist)

Outpatient:

Deaths	6	
Autopsies	5	(the death not included was a coroner's case)

Calculate:

a. Gross autopsy rate.

b. * (R6) Gross death rate.

c. * (R6) Fetal death rate.

2. Net Autopsy Rate

Formula:

$$\frac{\text{Total autopsies performed on IP deaths for a period}}{\text{Total IP deaths } \textit{minus} \text{ unautopsied cases released to legal authorities for the period}} \times 100$$

$$\frac{\text{Total IP autopsies for a given period}}{\text{Total IP deaths } \textit{minus} \text{ unautopsied coroners' cases}} \times 100$$

Explanation: Again, the use of the term *net* refers to the exclusion (subtraction) of certain patients. In this instance, they are the cases released to legal authorities (coroner/medical examiner), and thus are not available for hospital autopsy. Accordingly, they are subtracted from the total deaths. However, it must be noted that if the coroner authorizes the hospital pathologist to carry out the autopsy, it is included in the rate and is not subtracted. Subtract only those cases *unavailable* for autopsy by the hospital pathologist.

NOTE:

No outpatients are included in a net autopsy rate; only inpatients are included. Only the hospital autopsy rate *includes available outpatients for computational purposes.*

Example: Ten inpatient deaths are reported for March. Five of these deaths are autopsied by the hospital pathologist. Two are coroner's cases and the coroner requests that the hospital pathologist autopsy one of them.

Thus a total of six deaths are autopsied by the hospital pathologist (one of which is a coroner's case that is included since it was autopsied by the hospital pathologist). The numerator contains these six cases. In the denominator, one case has to be subtracted from the total of ten deaths (since the coroner claimed one body, it was not available for autopsy), for a value of 9 (10 – 1). Dividing the numerator (6) by the denominator (9), and then multiplying by 100, gives a result of 66.7% [(6 ÷ 9) × 100].

NOTE:

A net autopsy rate will be higher than a gross autopsy rate. For example, the gross rate and the net rate have the same number in the numerator (6) but, by not subtracting the coroner's cases in a gross autopsy rate, there are 10 deaths rather than 9 in the denominator. With a lower number in the denominator the rate will be higher—in this case a net autopsy rate of 66.7% was found, in contrast to a gross autopsy rate of only 60%.

SELF-TEST 30

Rates are to be computed correctly to *two* decimal places.

1. Second-quarter statistics from General Hospital contained the following data:

Inpatients: Month	*Deaths*	*Hospital Autopsy*	*Coroner's Cases*
April	7	4	1
May	6	3	0
June	9	4	2

Outpatients: Month	*Deaths*	*Hospital Autopsy*	*Coroner's Cases*
April	3	2	1
May	4	2	1
June	5	2	2

Calculate:

a. Net autopsy rate for the period.

b. Gross autopsy rate for the period.

2. Happiness Hospital data for the period July through December was as follows:

	Count: Bed count = 300	*Bassinet count = 35*
Inpatient:	*A&C*	*NB*
Admissions	1800	957
Discharges	1822	963
Deaths:		
Under 48 hrs	9	2
Over 48 hrs	23	2
Autopsies:	10	2
Coroner's cases	4	1

Fetal deaths:		
Early	6	(none autopsied)
Intermediate	3	(2 autopsied; 1 taken by coroner)
Late	2	(1 autopsied; 1 taken by coroner)
Outpatient:		
Deaths	8	
Autopsies	5	(two others were released to the coroner)

Calculate:

a. Net autopsy rate for the period.

b. * (R6) Net death rate for the period.

c. Gross autopsy rate for the period.

d. * (R6) Gross death rate for the period.

e. * (R6) Newborn death rate for the period.

f. * (R6) Fetal death rate for the period.

3. Hospital Autopsy Rate (Adjusted)

Formula:

$$\frac{\text{Number of } \textit{hospital} \text{ autopsies for period}}{\text{Number of deaths of hospital patients whose bodies are available for hospital autopsy for that period}} \times 100$$

NOTE:

In previous formulae outpatients were not *included along with inpatients. In calculating the hospital autopsy rate, OPs (outpatients) are included if their bodies were autopsied by the hospital pathologist or by a designated member of the medical staff.*

Example: A hospital had 215 inpatient admissions in August and 205 discharges, of which 12 were deaths. Eight of these deaths were autopsied by the hospital pathologist. Two former patients died at home and were brought to the hospital and autopsied. To find the hospital autopsy rate, add all the hospital autopsies performed to determine the numerator (8 IP + 2 OP = 10 autopsies). The denominator contains all the inpatients who died (and could have been autopsied) during this same period (12) and the number of OP autopsied as well (2)—for a total of 14. The rate is determined by dividing 10 by 14, and then multiplying by 100, giving a hospital autopsy rate of 71.4% [(10 ÷ 14) × 100].

Example: In June, eight adults, one child, and one newborn died. A total of 240 admissions and 245 discharges were recorded in June. There were also two fetal deaths (one intermediate; one late). Autopsies were performed on four adults, the child, and the newborn, as well as the late fetal death. During June, one patient died in the ER and was autopsied, and two home care patients died and were taken to the hospital for autopsy.

To find the hospital autopsy rate, add the autopsies, except for the late fetal death [(4 + 1 + 1 = 6 IP) plus (1 + 2 = 3 OP), for a total of 6 + 3, which equals 9 autopsies]. Then add all the deaths on which autopsies could be performed [(8 + 1 + 1 = 10 IP) plus (1 + 2 = 3 OP), or 10 + 3 = 13]. Divide 9 by 13, and then multiply by 100. The result is a 69.2% hospital autopsy rate.

NOTE:

Remember never *include fetal death autopsies. Fetal deaths are only included in fetal rates—fetal death rates and fetal autopsy rates.*

Computation Note: Autopsies listed as coroner's cases are the unautopsied cases—the cases removed by the coroner for examination. The examination was *not* performed by the hospital pathologist or by a designated physician on the medical staff, unless specifically indicated. These must be subtracted from the denominator since the body was *not* available for autopsy.

SELF-TEST 31

Compute all rates correctly to *two* decimal places.

1. A hospital with 250 beds recorded six deaths for the month of September. During this period there were 315 discharges of adults and children. The bassinet count was 18, and 95 newborns were discharged as well, with no newborn deaths recorded. The outpatient department recorded five outpatient deaths, two of which were reported from the emergency room. Autopsies were performed on three inpatients and three outpatients.

   Calculate:

   a. September hospital autopsy rate.

   b. Gross autopsy rate for September.

   c. * (R6) Gross death rate for September.

2. June statistics reveal the following:

	A&C	*NB*
IP admissions	475	75
IP discharges	472	72
IP deaths	9	1
IP autopsies	5	1
OP deaths	2	
OP autopsies	2	

   Calculate:

   a. June hospital autopsy rate.

   b. Gross autopsy rate for June.

   c. * (R6) Gross death rate for June.

3. Hillside Hospital

   Period: January thru June Bed count: 175 Bassinet count: 15

	A&C					*NB*				
IP Data	***Total***	***<48***	***>48***	***HP***	***Cor***	***Total***	***<48***	***>48***	***HP***	***Cor***
Admissions	9598					801				
IPSD	28,872					2,610				
Discharges	9,641					810				
Deaths	263	68	195			27	10	17		
Autopsies				52	12				5	2

	A&C					NB				
IP Data	***Total***	***<48***	***>48***	***HP***	***Cor***	***Total***	***<48***	***>48***	***HP***	***Cor***
Fetal Deaths										
Early	18			1	4					
Intermediate	10			2	2					
Late	8			1	1					
OP Data										
Deaths	24									
Autopsies				7	2					

Determine:

a. Gross autopsy rate

b. Net autopsy rate

c. Fetal autopsy rate

d. Hospital autopsy rate

Death rate computations: (Chapter 6 review)

e. Gross death rate

f. Net death rate

g. Newborn death rate

h. Fetal death rate

i. Newborn net death rate

Census and occupancy percentage computations (Chapter 4 and 5 review)

j. Average A&C daily inpatient census

k. Average NB daily inpatient census

l. A&C percentage of occupancy

m. NB percentage of occupancy

4. Out of a total of 441 discharges in June, seven were listed as deaths. Of these, three were autopsied by the hospital pathologist. Two additional deaths were coroner's cases and, of these two, the coroner requested that the hospital pathologist perform one of the autopsies, which he did. Three outpatients also died, but only two were autopsied by the pathologist. The third was removed from the hospital by the coroner.

Calculate:

a. June hospital autopsy rate.

b. Gross autopsy rate for June.

c. Net autopsy rate for June.

4. Newborn Autopsy Rate

Formula:

$$\frac{\text{Autopsies performed on NB deaths for a period}}{\text{Total NB deaths for the period}} \times 100$$

Example: Seventy-four births occurred during the month of July, and a total of 72 newborns were discharged. One newborn expired shortly after birth. Five fetal deaths were also reported during July—three were intermediate fetal deaths and two were late fetal deaths. An autopsy was performed on the NB death and three of the fetal deaths (one intermediate and two late).

Applying the formula, and excluding any reference to the fetal deaths or autopsies, leaves only one newborn autopsied (only one newborn died). This results in a 100% newborn autopsy rate for July (1 divided by 1, and then multiplied by 100, equals 100%).

SELF-TEST 32

Compute all rates correctly to *two* decimal places.

1. Newborn figures for October:

Admissions	223	
Discharges	225	
Deaths	2	
Autopsies	1	
Fetal deaths	5	(2 early; 2 intermediate; 1 late)
Fetal autopsies	1	(done only on the late death)

Calculate:

a. Newborn autopsy rate for October.

b. * (R6) Newborn death rate for October.

2. A neonatal unit records two newborn deaths and two term infants who were stillborn. An autopsy is performed on the two newborns and one of the stillborns. A total of 315 newborns were born, and 312 were discharged during the same month.

Calculate: Newborn autopsy rate for the month.

3. Out of 211 discharges, a neonatal unit had one death, which was autopsied by the hospital pathologist. A mother delivered in a taxicab on the way to the hospital, and she and the infant were admitted upon arrival at the hospital, but the

baby died shortly after admission. An autopsy was performed on this infant as well.

Calculate: Newborn autopsy rate for the period.

5. Fetal Autopsy Rate

Formula:

$$\frac{\text{Autopsies performed on intermediate and late fetal deaths for a period}}{\text{Total intermediate and late fetal deaths for period}} \times 100$$

Example: Ten fetal deaths were logged by the obstetric unit, of which four were early fetal deaths, four were intermediate fetal deaths, and two were late fetal deaths. Of these, the two late fetal deaths were autopsied.

Since only intermediate and late fetal deaths are included in the fetal autopsy rate and both autopsies were performed on late fetal deaths, the number 2 is placed in the numerator and the number 6 in the denominator (4 intermediate + 2 late fetal deaths). Dividing 2 by 6, and then multiplying by 100, gives a fetal autopsy rate of 33.3% $[(2 \div 6) \times 100]$.

SELF-TEST 33

Compute all rates correctly to *two* decimal places.

1. Five fetal deaths were recorded in January. Also recorded were 233 live births and 240 live newborn discharges. One newborn death was also recorded. Three fetal deaths were early deaths and two were intermediate fetal deaths, one of which was autopsied, as was the newborn death.

   Calculate:

   a. Fetal autopsy rate for January.

   b. Newborn autopsy rate for January.

   c. * (R6) Fetal death rate for January.

   d. * (R6) Newborn death rate for January.

2. In December, ten fetal deaths were reported. One of these fetal deaths was a stillborn term infant. Of the remaining, one was a late fetal death and two were intermediate fetal deaths; the others were early fetal deaths. One intermediate fetal death was of a suspicious nature and was removed by the coroner. Of the remaining fetal deaths, an autopsy was performed on the stillborn and late fetal death by the hospital pathologist. A total of 351 live births, 348 live newborn discharges, and one newborn death (which was not autopsied) were recorded in December.

   Calculate:

   a. Fetal autopsy rate for December.

   b. * (R6) Fetal death rate for December.

c. Newborn autopsy rate for December.

d. * (R6) Newborn death rate for December.

E. SUMMARY

1. A hospital autopsy is performed by a physician who is designated by the hospital, most commonly the hospital pathologist.
2. Patients included/excluded
   a. Hospital IP deaths, autopsied by a designated medical staff physician, are included in all autopsy rates.
   b. Hospital-related OP deaths, autopsied by a designated medical staff physician, are included only in the hospital autopsy rate.
   c. Fetal death autopsies are only included in a fetal autopsy rate, never in the gross, net, or hospital autopsy rate.
3. Outpatient autopsies are included only in a hospital autopsy rate.
4. A&C and NB are combined and included together in most autopsy rates.
5. Coroner's cases (medical examiner's cases) include those bodies that need to be investigated further to rule out foul play. They include the cases that fall under his/her jurisdiction—most commonly they involve violence or deaths that are suspicious in nature. Cases may include drownings, poisonings, or burns, as well as abortions.
6. If the case is a coroner's case and the autopsy is performed by the hospital pathologist, it is included as a hospital autopsy.
7. The numerator in all autopsy rates is the total number of autopsies performed that are related to the specific autopsy rate.
8. The denominator in autopsy rates is always comprised of deaths, although some deaths may be excluded in certain rates.
9. In general, autopsy rates are computed by dividing the number of autopsies by the number of deaths.
10. Hospital Autopsy Rate: IP and OP autopsies divided by deaths of hospital patients whose bodies are available for hospital autopsy.
11. Newborn Autopsy Rate: NB autopsies divided by NB deaths.
12. Fetal Autopsy Rate: Intermediate and late fetal autopsies divided by the intermediate and late fetal deaths.
13. Gross Autopsy Rate: IP autopsies divided by IP deaths.
14. Net Autopsy Rate: IP autopsies divided by IP deaths minus the unautopsied coroner's cases.

F. CHAPTER 7 TEST

1. Which autopsy rate may include outpatients as well as inpatients?

2. Who is authorized to perform a hospital autopsy?

3. What types of death fall under the jurisdiction of the coroner?

4. Which deaths, even though autopsied, are *excluded* in hospital autopsy rates?

5. Do autopsy rates combine A&C and NB autopsies or are they maintained separately?

6. Is a body that has been autopsied by the medical examiner included in a hospital autopsy rate if the medical examiner is not on the hospital medical staff?

7. What is excluded in a net autopsy rate that is included in a gross autopsy rate?

Note: All computations should be correct to *two* decimal places.

8. Snowmass Hospital (June)

		Autopsies		
	Deaths	**Yes (HP)***	**No**	**Coroner**
Inpatient	39	5	32	2
Outpatient	2	2		

Calculate:

a. Gross autopsy rate.

b. Net autopsy rate.

c. Hospital autopsy rate.

9. Gossamer Hospital (February)

	A&C	**NB**
Beds/bassinets	250	30
Admissions	1210	205
Discharges	1210	200
Deaths	14	2
Autopsies:		
Yes (HP)	5	1
No	7	0
Coroner	2	1
IPSD	6252	701

Calculate:

a. NB autopsy rate.

b. A&C autopsy rate.

c. Gross autopsy rate.

d. Net autopsy rate.

e. * (R5) Percentage of bed occupancy for A&C.

f. * (R5) Percentage of bassinet occupancy for NB.

*HP = Hospital Pathologist

10. Oceanside Hospital

Period: November   Bed count: 85   Bassinet count: 10

	A&C			***NB***			***Fetal***								
IP Data	***Total***	***HP***	***Cor***	***Total***	***HP***	***Cor***	***E****	***HP***	***Cor***	***I****	***HP***	***Cor***	***L****	***HP***	***Cor***
Adm	441			74											
IPSD	2001			258											
Disch	450			78											
Deaths	16			5			6			4			3		
Autop		5	2		2	1		1	1		1	1		1	1
OP Data															
DOA	8	1	4												
ER death	4	2	1												
HC* death	2	0	0												
Other	3	0	1												

Calculate:

a. Gross autopsy rate

b. Net autopsy rate

c. Hospital autopsy rate

d. Fetal autopsy rate

e. Newborn autopsy rate

11. Riverside Hospital

*E = Early; I = Intermediate; L = Late; HC = Home Care

	Admissions		***Discharges***		***Deaths***		***Autopsies A&C***			***Autopsies NB***		
	A&C	***NB***	***A&C***	***NB***	***A&C***	***NB***	***Yes***	***No***	***Cor.***	***Yes***	***No***	***Cor.***
Jan.	801	165	797	162	11	3	3	7	1	1	2	0
Feb.	788	151	775	146	9	1	2	6	1	1	0	0
Mar.	818	161	801	157	15	2	4	9	2	1	0	1

Calculate:

a. Gross autopsy rate for the entire period.

b. Net autopsy rate for the entire period.

c. Newborn autopsy rate for the entire period.

d. January gross autopsy rate.

e. February net autopsy rate.

f. March newborn autopsy rate.

12. Valley View Hospital (August)

Patient Care Units	***Adm.***	***Disch.***	***Deaths***	***Autopsies***		
				Yes (HP)	***No***	***Coroner***
Medical	467	461	27	8	18	1
Surgical	102	98	5	2	2	1
Pediatrics	70	65	1	1	0	0
OB	332	330	1	1	0	0
GYN	65	62	0	0	0	0
Orthopedics	63	65	1	0	1	0
Neurology	26	27	3	2	0	1
NB	277	275	1	0	1	0
Totals	1402	1383	39	14	22	3

Calculate:

a. Newborn autopsy rate.

b. Gross autopsy rate.

c. Net autopsy rate.

d. Net autopsy rate for the medical unit.

e. Gross autopsy rate for the surgical unit.

C H A P T E R

8

Length of Stay/ Discharge Days

CHAPTER OUTLINE

A. Terms
   1. Length of Stay (LOS) (For One Inpatient)
   2. Total Length of Stay (For All Inpatients)
   3. Discharge Days (DD)
   4. Average Length of Stay (ALOS)
B. Calculating Length of Stay
   1. General
   2. A&D Same Day
   3. Admitted One Day and Discharged the Next
   4. Longer Stays
C. Total Length of Stay
   1. Importance of Discharge Days
   2. Totaling
D. Average Length of Stay
   1. Adults and Children (A&C)
   2. Newborn (NB)
E. Day on Leave of Absence
F. Summary
G. Chapter 8 Test

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Define “length of stay.”
2. Define “discharge days.”
3. Identify the days counted and excluded in LOS determinations.
4. Describe when discharge days are acquired.
5. Describe when a “leave of absence” day is acquired.
6. Identify the formulae in which a leave of absence day is counted and when it is excluded.
7. Compute the following for A&C and NB:
   a. Individual lengths of stay.
   b. Total lengths of stay for a designated period.
   c. Average length of stay.

In the chapter on census, reference was made to inpatient service days, which are based on data computed daily—(data that pertains to all patients who receive service in a hospital on a specific day). In this chapter, computation will be based on discharge data, and the term *discharge day(s)* is used to distinguish these days from those based on data computed daily. Service days accumulate on a daily basis and a total is derived each day. Discharge days are compiled at the time of discharge and are not recorded until the patient is discharged from the hospital. As long as a patient is hospitalized, there will be *no* discharge days for that patient, because discharge days are compiled only *after* the patient is discharged from the hospital.

At the time of discharge (or death), a "length of stay" (LOS) is determined for each patient. This represents the number of days the patient was hospitalized and received service in the hospital. Synonymous terms include (inpatient) "days of stay," "duration of hospitalization," or "discharge days." Although the total IPSD and Discharge Days (DD) are somewhat similar in number, it is important to use DD in average length of stay computations.

A. TERMS

1. Length of Stay (LOS) (For One Inpatient):

The number of calendar days from admission to discharge.

2. Total Length of Stay (For All Inpatients):

The sum of the days of stay of any group of inpatients discharged during a specified period of time.

3. Discharge Days (DD):

Same as Length of Stay or Total Length of Stay (see above).

4. Average Length of Stay (ALOS):

The average length of hospitalization of a group of inpatients discharged during the period under consideration.

B. CALCULATING LENGTH OF STAY

Certain rules apply, including the following:

1. General

Each day counts as a discharge day *except* the day of discharge. In general, the patient's day of admission is counted as one day, as are all intervening days between admission and discharge, but *not* the day of discharge.

Example: A patient is admitted on June 3 and discharged on June 10. The patient has a length of stay of seven days, counting June 3, 4, 5, 6, 7, 8, 9 but *not* June 10. Notice that the length of stay can be determined by subtracting the date of admission from the date of discharge when the patient has been admitted and discharged during the same month (subtract 3 from 10 to obtain a length of stay of 7 days).

Example: The length of stay of a patient admitted one month and discharged the following month is computed in a similar fashion. If a patient is admitted on May 28 and discharged on June 4, the May figure is subtracted from the number of days in May

(31) and added to the number of days the patient was hospitalized in June (4), resulting in a length of stay of 7 days (31 – 28 = 3 + 4 = 7). Keep in mind, however, the rule of not counting the day of discharge. The days that are counted are May 28, 29, 30, 31, June 1, 2, 3—for a total of 7 days. The final figure arrived at is identical when you use either method of computation, but it is important to remember the rule regarding which days are actually counted.

2. A&D Same Day

Any patient admitted and discharged on the same day accumulates a length of stay of *one* day. No patient admitted to the hospital ever has 0 (zero) days or negative days credited as a length of stay. Therefore, the patient is credited with a one-day length of stay even if the patient was admitted at 6:00 A.M. and discharged (or perhaps transferred to another hospital) at 8:00 A.M.

Example: A patient admitted at 10:00 A.M. on April 2 and discharged at 6:00 P.M. on April 2 acquires a length of stay of one day.

3. Admitted One Day and Discharged the Next

A patient who is admitted one day and discharged the following day also is credited with a length of stay of *one* day.

Example: A patient admitted at 9:00 P.M. on March 5 and discharged the following day at 2:00 P.M. has a length of stay of one day.

4. Longer Stays

For longer stays, the general rule of counting the day of admission and all subsequent days *except* the day of discharge applies.

Examples:

a. Same Month: A patient is admitted on December 1 and discharged December 13. The length of stay for that admission is 12 days. Officially, the days counted are December 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, but not December 13, and the total is 12 days. Unofficially, subtract 1 from 13, which also gives a total of 12 days.
b. Adjacent Months: A patient admitted on February 28 and discharged on March 2 has a total length of stay of two days. (Count February 28 and March 1, but not March 2). Unofficially, 28 – 28 = 0 + 2 = 2. It is important to be accurate and to double-check the totals.

Another Example: A patient is admitted on March 30 and discharged on May 5. In this instance, one must add the days in April (30) to the March and May figures. The total includes two days in March (30, 31) plus the 30 days in April plus four days in May (1, 2, 3, 4), for a total of 36 days. Alternatively, subtract 30 from 31 (1), add in the 30 days in April, and then add five days in May, which gives the same total as before—36 days.

c. Adjacent Years: A patient is admitted on December 28, 1998 and discharged on January 4, 1999. The total length of stay is 7 days (December 28, 29, 30, 31 plus January 1, 2, 3).

Another Example: In long-term care facilities patients may be residents for longer than a year. A patient admitted on November 11, 1997 and discharged (or who expired) on January 10, 1999 has a length of stay of 426 days. For November 1997 the total is 20 days; add the December total of 31 days; add to that the total days in 1998, 365 days; add the January 1999 total of 9 days; and the result is a total of 425 days (20 + 31 + 365 + 9 = 425).

SELF-TEST 34

Compute the length of stay for the following patients. (In questions 1 through 6, assume that the dates are in the same year and that it is a non-leap year.)

1.	Admitted 5-25	Discharged 5-25	________________
2.	Admitted 5-15	Discharged 5-16	________________
3.	Admitted 5-11	Discharged 5-25	________________
4.	Admitted 5-27	Discharged 6-3	________________
5.	Admitted 5-31	Discharged 6-2	________________
6.	Admitted 5-29	Discharged 7-5	________________
7.	Admitted 12-26-98	Discharged 1-10-99	________________
8.	Admitted 12-22-96	Discharged 3-7-97	________________
9.	Admitted 11-19-95	Discharged 3-17-96	________________
10.	Admitted 10-31-95	Discharged 4-5-97	________________

C. TOTAL LENGTH OF STAY

The total length of stay for all patients during a specified period is commonly referred to as *discharge days*. In computing census data, the total is stated in terms of service days, but here the total length of stay is most commonly referred to as discharge days. Remember that no discharge days are compiled until the patient is discharged, so a patient who has been hospitalized for six months and is still an inpatient has *no* discharge days, even though the patient has received six months of service. Service days are credited daily, discharge days only upon discharge. A patient who is hospitalized for more than a year will have all the discharge days credited on the day of discharge (for instance, 701 days if the patient is hospitalized from 2-3-97 until 1-5-99). Therefore, it should be noted that service days and discharge days—even though often similar in number—are *not* interchangeable.

1. Importance of Discharge Days

Lengths of stay (LOS) and discharge days (DD) are important because they serve as a means of managing utilization of hospital resources. Some payers of hospital services cover costs for a limited number of days of service, depending on the diagnosis.

Discharge days are important in analyzing and comparing patient subgroups in terms of disease, treatment, age, and so on. If the average length of stay for coronary bypass surgery computes to four days and Doctor X's patients are staying an average of six days, an evaluation is in order. If the average length of stay of certain physicians, depending on diagnosis, extends beyond the average, the medical staff may choose to take this under advisement. It may be that a certain physician has patients with a greater severity of illness or more complications are occurring under the physician's care, both of which may be reviewed by the medical staff. Discharge days are used to compute average length of stay (ALOS) and this, in turn, may serve as the basis for comparison among various subgroups.

2. Totaling

Various totals may be requested.

Example: Five patients are discharged on July 4. The individual lengths of stay are 10 days, 5 days, 3 days, 8 days, and 2 days. The total discharge days for patients discharged on July 4 is 28 days.

Example: The following patients were discharged on March 1:

Name	*Age*	*Clinical Service*	*Length of Stay*
Adams, A.	50	Medical	12 days
Baker, B.	23	Surgical	5 days
Carter, C.	68	Medical	22 days
Davis, D.	22	Obstetrical	3 days
Eaton, E.	8	Pediatrics	3 days
Fisher, F.	35	Surgical	7 days
Grant, G.	80	Medical	27 days
Hanson, H.	73	Medical	9 days
Irwin, I.	13	Pediatrics	4 days
Jones, J.	59	Medical	8 days

The total length of stay (discharge days) for all patients on March 1 is 100.

If the requirement is to total the length of stay for each clinical service, the results would be:

Medical	78 days	5 patients (12 + 22 + 27 + 9 + 8)
Surgical	12 days	2 patients (5 + 7)
Obstetrics	3 days	1 patient (3)
Pediatrics	7 days	2 patients (3 + 4)

If the requirement is to find the length of stay based on the ages of patients by decade, the results would be:

0 through 9	3 days	1 patient (3)
10 through 19	4 days	1 patient (4)
20 through 29	8 days	2 patients (5 + 3)
30 through 39	7 days	1 patient (7)
40 through 49	—	0
50 through 59	20 days	2 patients (12 + 8)
60 through 69	22 days	1 patient
70 through 79	9 days	1 patient
80 through 89	27 days	1 patient (27)
90 through 99	—	0

D. AVERAGE LENGTH OF STAY

Since totals alone do not give us much information that is useful, the most common use of discharge days is in determining the average length of stay. An average is usually much more easily interpreted, both for statistical purposes and for comparisons. The average length of stay is used to give a representation of the average duration of hospitalization of a group.

NOTE:

Average length of stay calculations do not *combine A&C and NB data for the same reason that average daily census and percentage of occupancy were computed on two unique populations.*

1. Adults and Children (A&C)

As a rule, when calculating the average length of stay, adults and children are computed separately from newborns. The two groups (A&C and NB) are not combined in the same formula. The formulas are identical in their computation method, but each of the two groups is calculated separately. When a question asks for average length of stay, it is assumed that the average for A&C is to be determined and not the combination of adults and children and newborns.

Formula:

$$\frac{\text{Total length of stay (discharge days)}}{\text{Total discharges}}$$

(*Note:* Include lengths of stay for deceased patients but exclude NBs from this formula.)

Example: If a hospital had a total of 700 discharges during the month of March, with a total of 3500 discharge days (DD), the numbers alone are not very significant. However, by stating that the average length of stay of inpatients during March was five days, we have a much more significant statistic. This is determined by placing the discharge days (3500) in the numerator and dividing by the total number of patients discharged (700), resulting in an average length of stay of five days (3500 divided by 700 = 5 days).

Example: The discharges for the first quarter of the year for obstetrical patients totaled 275. The total discharge days, for the same quarter, of OB patients was 825. To compute the average length of stay of OB patients during the first quarter of the year, divide 825 by 275, which results in an average length of stay of 3 days.

SELF-TEST 35

1. Data for January:

	A&C	*NB*
Bed/bassinet count	50	5
Admissions	140	35
Discharges	143	36
IP service days	1203	138
Discharge days	1001	108

Determine:

a. Average length of stay for adults and children (A&C) in January.

b. Average length of stay for newborns in January.

c. Average length of stay for all hospitalized inpatients (A&C plus NB) in January.

2. November Data:

	A&C	*NB*
Bed/bassinet count	100	8
Admissions	345	89
Discharges	338	102
IP service days	2765	215
Discharge days	2724	225

Determine:

a. Average length of stay (A&C) for November.

b. Average length of stay for newborns in November.

3. The following patients are discharged on June 10:

	Admitted	*Discharged*	*Service*
Abbott, A.	5-16	6-10	Medical
Black, B.	5-31	6-10	Surgical
Canfield, C.	6-06	6-10	Medical
Draper, D.	6-10	6-10	Medical
Eckhart, E.	6-02	6-10	Surgical
Franke, F.	6-08	6-10	Obstetrics
Graber, G.	6-09	6-10	Medical
Huber, H.	5-30	6-10	Surgical
Ibsen, I.	4-30	6-10	Medical
James, J.	6-07	6-10	Obstetrics

Determine:

a. Average length of stay for June 10.

b. Average length of stay for medical patients on June 10.

c. Average length of stay for surgical patients on June 10.

d. Average length of stay for obstetrical patients on June 10.

4. February statistics:
   Bed count: 125
   Bassinet count: 12

Service	*Adm.*	*Dis. (Live)*	*Deaths*	*IPSD*	*DD*
Medical	300	303	6	1500	1516
Surgical	120	124	3	960	972
Obstetrics	72	68	1	195	202
Pediatrics	63	65	1	188	194
Newborn	62	65	1	153	165

Determine:

a. Average length of stay (A&C).

b. Average length of stay of medical patients in February.

c. Average length of stay of surgical patients in February.

d. Average length of stay of obstetrical patients in February.

e. Average length of stay of pediatric patients in February.

f. Average length of stay of newborns in February.

g. * (R5) IP bed occupancy percentage for February.

h. * (R5) Bassinet occupancy percentage for February.

5. Quarterly statistics:

	Jan.–Mar.	*Apr.–June*	*July–Sept.*	*Oct.–Dec.*
Admissions	1800	1715	1913	1888
Discharges	1785	1717	1902	1885
IP service days	9013	8621	9589	9461
Discharge days	8955	8581	9502	9470

Determine:

a. Average length of stay for the year.

b. Quarter with the lowest average length of stay.

c. Quarter with the highest average length of stay.

6. A 40-bed surgical unit records the following data for the year:

Type of Surgery	*Adm.*	*Dis. (Live)*	*Deaths*	*IPSD*	*DD*
EENT	228	225	1	483	490
Neurosurgery	112	115	7	1123	1133
Thoracic	202	205	3	1676	1682
Abdominal	1010	1006	12	8012	7095
GU	276	275	2	1659	1654
Other	128	126	1	557	537

Determine:

a. Average length of stay for patients on the surgical unit for the year.

b. Surgical unit that had the highest average length of stay for the year.

c. Surgical unit with the lowest average length of stay for the year.

d. Average length of stay for patients on each surgical unit.

2. Newborn (NB)

NOTE:

Newborn length of stay data, as mentioned, is not combined with adults and children. It would be unfair to compare the length of stay for a newborn with that of an adult. Newborns, in general, are discharged at the time of the mother's discharge and the majority are the product of a normal term delivery. However, with the increase in neonatal intensive care units, more and more neonates born prematurely, who in past years would have expired, now survive, and their length of hospitalization has increased dramatically. Since newborns are a unique population, their stays are determined separately from adults and children. Mothers' length of stay data, however, are included in A&C statistics.

Formula:

$$\frac{\text{Total newborn length of stay (discharge days)}}{\text{Total newborn discharges}}$$

(Remember that newborns who expired after birth are included in this formula.)

Example: A newborn unit recorded the following data during February: 135 births, 140 discharges, 270 newborn service days, and 280 newborn discharge days. To compute the average newborn length of stay, divide 280 (DD) by 140 (total newborn discharges), which results in an average NB length of stay of 2 days.

SELF-TEST 36

1. A newborn nursery records the following statistics for July:

Bassinet count	15
Admissions	204
NB service days	408
Discharges	201
NB discharge days	420

Determine:

a. Average length of stay for newborns in July.

b. * (R5) Percentage of occupancy for the NB nursery in July.

2. A 10-bed NB nursery reports the following for October 1 through October 10:

	10-1	***10-2***	***10-3***	***10-4***	***10-5***	***10-6***	***10-7***	***10-8***	***10-9***	***10-10***
Births	3	2	4	1	1	2	3	3	1	2
Discharges	2	3	5	2	1	1	2	3	2	0
IPSD	8	6	6	5	6	7	5	4	6	5
Discharge days	7	8	10	6	4	5	4	5	6	0

Determine:

a. Average newborn length of stay for October 1 through October 10.

b. Average newborn length of stay for October 1 through October 5.

c. Average newborn length of stay for October 6 through October 10.

d. * (R5) Average newborn occupancy percentage for the entire period (October 1 through October 10).

e. * (R5) Average NB occupancy percentage for October 1 through October 5.

f. * (R5) Average NB occupancy percentage for October 6 through October 10.

3. A newborn nursery records the following data for January 15:

	NB	***Birthweight***		***Mother***
Admissions:	girl	7 lb	6 oz	Arends, A.
	girl	6 lb	10 oz	Brady, B.
	boy	9 lb	1 oz	Clark, C.
	boy	8 lb	3 oz	Doran, D.
	girl	5 lb	11 oz	Eaton, E.
	girl	8 lb	1 oz	Flack, F.

	NB	*Born*	*Discharged*	*Mother*
Discharges:	girl	1-13	1-15	Good, G.
	boy	1-12	1-15	Hart, H.
	girl	1-14	1-15	Ivey, I.
	girl	1-10	1-15	Juhl, J.
	boy	1-13	1-15	King, K.

Determine:

a. Average length of stay for newborns discharged on January 15.

b. Average length of stay for boys discharged on January 15.

c. Average length of stay for girls discharged on January 15.

d. Average birth weight of newborns born on January 15.

e. Average birth weight of newborn boys born on January 15.

f. Average birth weight of newborn girls born on January 15.

E. DAY ON LEAVE OF ABSENCE

A "leave of absence day" is a day occurring after the admission and prior to the discharge of a hospital inpatient, when the patient is not present at the census-taking hour because he or she is on leave of absence from the hospital.

A leave of absence day no longer exists in most hospitals because stays have become progressively shorter. However, facilities that admit patients for longer stays, such as rehabilitation facilities, mental hospitals, nursing home and long-term substance abuse centers, are most apt to grant a leave of absence. Patients in such facilities may need gradual reorientation to total self-care and their length of time away from the facility may begin with a leave of absence of a day or weekend and then gradually increase prior to final discharge.

A leave of absence is an absence authorized by the patient's physician. Some patients are given passes to leave the facility, generally for a home visit (often to see how well they can manage at home prior to discharge) or to take care of important business. A leave of absence may involve an overnight pass or weekend pass and therefore the patient would not be on the care unit at the census-taking time (CTT). A weekend pass, during which the patient leaves on Friday and returns on Sunday evening or even Monday morning, would exclude the patient from several inpatient census counts. Only leaves that involve at least 24 hours of absence are considered in compiling statistical data.

Leave of absence days differ from discharge and readmission. A leave is a segment of an uninterrupted hospitalization, whereas in the latter instance the patient may be discharged one day and readmitted for the same or a different diagnosis the next day. The latter scenario is not considered a leave of absence day. There is no uniform policy regarding the use of leave of absence days and the final decision is up the patient's attending physician.

The use of leave of absence days affects the compilation of statistical data. The formulae in which the leave of absence day is *included* for statistical purposes is as follows:

1. *Discharge Days*—A patient accumulates a discharge day during the time the patient is on a leave of absence (one discharge day for each day on leave of absence).
2. *Average Length of Stay*—Since this is based on the discharge days, the leave of absence day is also included in compiling the average length of stay.

Leave of absence days are *excluded* in determining or computing the following statistics:

1. *Inpatient Service Days*—No service is being rendered the patient during the patient's absence from the hospital.
2. *Inpatient Census*—The patient is not included in the census at the census-taking hour.
3. *Bed Occupancy Percentage*—Since IPSD are used to determine the percentage of bed occupancy, the patient is not included as a patient who is occupying a bed while he or she is on leave of absence.

F. SUMMARY

1. Length of stay (LOS) or discharge days (DD) refer to the number of days the patient was hospitalized (from admission to discharge).
2. LOS or DD accumulate only upon discharge from the hospital.
3. All days are counted in determining LOS, except the day of discharge, unless the patient was admitted and discharged on the same day, in which case a LOS of one day is recorded.
4. To calculate the LOS, subtract the date of admission from the date of discharge.
5. Total daily discharge days are the sum of all LOS of patients discharged on a specific date.
6. Average LOS is the total length of stays of all patients discharged during a specified period of time divided by the total number of discharges during that specified period.
7. A&C and NB data should be kept separate. Generally the two are *not* combined, especially when calculating the average length of stay.
8. A leave of absence day is granted prior to discharge, and the day is *included* (counted) in computing
   a. discharge days
   b. average length of stay

   However, it is *excluded* in computing

   a. IPSD
   b. IP census
   c. bed occupancy percentage

G. CHAPTER 8 TEST

Note: Answers should be correct to *two* decimal places.

1. When does a patient acquire discharge days?
2. Is it possible for an individual patient to have over 365 discharge days? If so, when?
3. What numbers are totaled to determine discharge days?

4. In figuring the length of stay for a patient who is hospitalized for more than one day–
   a. Is the day of admission counted as a discharge day? Yes No
   b. Is the day of discharge counted as a discharge day? Yes No

5. How does a patient acquire a leave of absence day?

6. a. In which formulae is a leave of absence day included in the computation?

   b. In which formulae is a leave of absence day excluded?

7. Under what circumstances would a patient not have any discharge days at the end of the year?

8. Determine the lengths of stay for each of the following, assuming the dates occur in a non-leap year:

a.	Admitted 8-03	Discharged 8-04	______________
b.	Admitted 8-15	Discharged 8-15	______________
c.	Admitted 12-01	Discharged 2-08	______________
d.	Admitted 8-02	Discharged 8-20	______________
e.	Admitted 3-24	Discharged 4-04	______________
f.	Admitted 5-12	Discharged 11-30	______________
g.	Admitted 2-28	Discharged 3-07	______________
h.	Admitted 3-29	Discharged 4-01	______________
i.	Admitted 6-02-98	Discharged 7-04-99	______________

9. Healthful Hospital (April)

	A&C	**NB**
Bed/Bassinet count	180	15
Admissions	905	88
Discharges	895	86
Deaths	7	1
Autopsies:		
Yes (HP)	3	1
No	3	0
Coroner's case	1	0
IPSD	4820	339
Discharge days	4785	330

Calculate:

a. Average length of stay for A&C.

b. Average length of stay for NB.

c. * (R6) Gross death rate.

d. * (R7) Gross autopsy rate.

e. * (R5) Percentage of occupancy for A&C.

f. * (R5) Percentage of occupancy for NB.

10. Hopeful Hospital–Discharge List for June 3.

Live Discharges	***Service***	***Date of Admission***	***Date of Discharge***	***LOS***
A. Adams	Surgical	5-31	6-3	
B. Brown	Medical	5-19	6-3	
C. Clark	Surgical	5-23	6-3	
D. Davis	Psychiatric	5-03	6-3	
E. Edgar	OB	5-31	6-3	
G. Edgar	NB	5-31	6-3	
H. Horn	OB	5-28	6-3	
J. Jones	Orthopedic	5-24	6-3	
K. King	Urology	5-28	6-3	
L. Long	ENT	6-02	6-3	
M. Mason	Gynecology	6-03	6-3	
N. Norris	Medical	5-29	6-3	
O. Olson	Urology	5-30	6-3	
P. Parks	Gynecology	5-27	6-3	
Deaths				
R. Rill	Medical	5-29	6-3	

Calculate:

a. Length of stay for each of the above discharges.

b. Average length of stay for A&C.

c. Average length of stay for NB.

d. Average LOS for medical patients.

e. Average LOS for surgical patients.

f. Average LOS for urological patients.

11. Hillside Medical Center (October)

Bed count: 100 Bassinet count: 15

Service	***Adm.***	***Live Disch.***	***Deaths***	***IPSD***	***DD***
Medical	166	163	10	859	845
Surgical	101	97	2	754	751
OB	92	93	1	365	369
Gynecology	81	80	1	313	325
Urology	60	57	0	231	240
NB	90	93	1	349	352

Calculate:

a. Average length of stay.

b. Average length of stay for each service:
   (1) medical (4) gynecology
   (2) surgical (5) urology
   (3) obstetrics (6) newborn

c. * (R5) Occupancy percentage for October:
   (1) bed
   (2) bassinet

d. * (R6) Gross death rate for October.

12. Oceanside Hospital
Clinical unit: Medical Service Bed count: 50

Month	Adm.	Disch.	Deaths	IPSD	DD
Jan.	250	248	10	1250	1270
Feb.	223	231	8	1275	1266
Mar.	266	264	7	1266	1295
Apr.	245	251	5	1281	1254
May	248	244	4	1279	1287
June	212	213	4	1260	1310
July	218	217	6	1225	1263
Aug.	227	225	9	1248	1240
Sept.	259	260	7	1290	1233
Oct.	271	266	12	1313	1322
Nov.	275	272	10	1326	1333
Dec.	244	246	9	1288	1301
Totals	2938	2937	91	15,301	15,374

Calculate:

a. Average length of stay for the year.

b. Month with the shortest length of stay.

c. Month with the longest length of stay.

d. * (R5) Bed occupancy percentage for the year.

e. * (R5) Month with the best bed occupancy percentage.

f. * (R5) Month with the poorest bed occupancy percentage.

g. * (R6) Gross death rate for the year.

CHAPTER

9

Miscellaneous Rates

CHAPTER OUTLINE

A. Rates
   1. Cesarean Section Rate
   2. Consultation Rate
   3. Morbidity Rates
      a. Prevalence
      b. Incidence
      c. Complication Rate
      d. Case Fatality Rate
   4. Infection Rates
      a. Hospital Infection Rate (Nosocomial Rate)
      b. Postoperative Infection Rate
   5. Bed Turnover Rate
      a. Direct Bed Turnover Rate
      b. Indirect Bed Turnover Rate
      c. Bassinet Turnover Rate
      d. Usefulness of Turnover Rates

B. Summary

C. Chapter 9 Test

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Distinguish clearly between
   a. Delivery vs. undelivered
   b. Birth vs. delivery
   c. Surgical procedure vs. surgical operation
2. Define
   a. Consultation
   b. Morbidity
   c. Epidemiology
   d. Epidemic
   e. Endemic disease
   f. Prevalence
   g. Incidence
   h. Complication
   i. Nosocomial infection
3. Identify the role of the CDC regarding morbidity
4. Identify which infections are "postoperative infections."

5. Compute the following rates:
   a. C-Section rate
   b. Consultation rate
   c. Hospital infection rate
   d. Postoperative infection rate
   e. Bed/bassinet turnover rate

Other rates that are used by health care facilities are included in this section. The principle behind all these rates (and any others that your health care facility might devise) is based on the basic "rate formula" referred to in previous chapters—the ratio of the number of times something *does* happen compared to the number of patients to whom it *could* happen. Try to originate the formula for each of the rates in this chapter yourself, rather than looking immediately at the stated formula. With the increased availability and use of computers in health care facilities and the ability to collect and store data more efficiently, the probability of computing a wide array of rates and percentages is greatly increased. Facilities can now calculate anything from the rate of readmissions to the percentage of patients seen in consultation. Included in this text are rates that are calculated routinely in many health care facilities.

A. RATES

1. Cesarean Section Rate

Many hospitals determine the percentage of deliveries performed by C-section (Cesarean section) as compared to vaginal deliveries. Many hospitals have decreased the number of surgical deliveries. In some situations, their action could be the result of media coverage of the statistics related to surgical deliveries, since they may cost more than vaginal deliveries and may pose additional risk.

a. Delivery

The term delivery was defined in Chapter 6 when maternal death rates were discussed. It is important to remember that a delivery refers to expelling a product of conception or having it removed from the body. Multiple births constitute *one* delivery, although each fetus delivered live is a newborn and each conceptus (fertilized ovum at any stage of development from fertilization until birth) delivered without signs of life is a fetal death. Consequently, a woman who delivers quintuplets is credited with one delivery, just as a woman who gives birth to a single infant is credited with a single delivery. However, the number of births (newborn admissions) will be increased by five when live quintuplets are born, in contrast to an increase of one newborn when a single infant is born.

b. Not Delivered

This term includes pregnant females who were admitted to a hospital for a condition of pregnancy, but who did not deliver either a liveborn, stillborn, or conceptus during that hospitalization. This category includes threatened abortions and false labor, or treatment of a pregnancy-related condition.

c. Cesarean Section Rate

Formula:

$$\frac{\text{Total number of Cesarean sections performed in a period}}{\text{Total number of } \textit{deliveries} \text{ for the period}} \times 100$$

Example: A total of 220 deliveries are recorded by the obstetrical unit of a hospital. Of these 220 deliveries, 50 were performed by Cesarean section (C-section). In this instance, the Cesarean section rate is 50 divided by 220, and then the quotient is multiplied by 100, giving a rate of 22.7% [(50 ÷ 220) × 100].

Example: The obstetrical service lists 100 admissions for February. Discharges on the obstetrical unit total 103. Deliveries are reported as 77, and 22 were reported to be undelivered. Of the deliveries, 21 are accomplished by Cesarean section. Twins were born to two mothers, and one mother gave birth to triplets. The only information needed is the number of Cesarean sections and the number of deliveries, irrespective of the number of infants delivered. Therefore, 21 C-sections occupy the numerator and 77 deliveries occupy the denominator. Dividing 21 by 77, and then multiplying the quotient by 100, results in a Cesarean section rate of 27.3% [(21 ÷ 77) × 100].

NOTE:

Do not confuse newborn births with deliveries. A woman may give birth to either a live infant or a dead fetus, but either of the births would be considered a delivery. Also, a delivery may include more than one newborn, as was already mentioned.

SELF-TEST 37

Answers should be correct to *two* decimal places.

1. July obstetrical data:

OB admissions	451	
OB discharges	456	(3 of which died)
Deliveries	446	(includes 4 sets of twins)
Undelivered	7	
Cesarean sections	6	

Calculate: Cesarean section rate for July.

2. October obstetrical statistics:

OB admissions	65
OB discharges (live)	60
OB deaths	1
Undelivered	5

Delivered:

		Total	***Number Delivered by C-Section***
Live:	Single infant	50	15
	Twins	3 sets	1 set
	Triplets	1 set	0
Dead:	Stillborn	1	1
	Aborted	1	0

Calculate:

a. Number of newborn births recorded in October.

b. Total number of deliveries recorded in October.

c. Number of newborn deaths recorded in October.

d. C-section rate for October.

3. May OB statistics:

OB admissions	78
OB discharges (live)	72
OB deaths	0
Undelivered	4

Delivered:

		Total	*Delivered by C-Section*	*Deaths*
Live:	Single infant	60	15	1 (at 36 hrs)
	Twins	4 sets	0	0
Dead:	Early fetal	3	0	
	Intermediate fetal	1	0	
	Late fetal	1	1	

Calculate:

a. Number of newborn admissions recorded in May.

b. Number of newborn deaths recorded in May.

c. Total deliveries recorded in May.

d. C-section rate for May.

4. A hospital reports that there were 150 deliveries during October, fifteen of which were performed by C-section. Of the deliveries, 35 mothers were primiparous and five of these mothers were delivered by C-section.

a. *Originate* a formula to find the percentage of women who delivered for the first time.

Calculate:

b. Percentage of mothers who delivered for the first time.

c. A hospital needs to know the percentage of first-time mothers who had a C-section. *Originate* a formula to calculate this percentage.

Calculate:

d. Percentage of all C-sections that were performed on first-time mothers.

e. Percentage of first-time mothers who had a C-section delivery.

2. Consultation Rate

A consultation has been defined as "a deliberation by two or more physicians with respect to the diagnosis or treatment in any particular case." A patient's attending physician sometimes requests a consultant to see his/her patient and offer an opinion, either to confirm a diagnosis or to treat a condition that is not in the attending physician's area of expertise. The consultant evaluates the patient and then must prepare a consultation report that includes the findings and recommendations for treating the patient's condition.

a. Consultation Rate

Formula:

$$\frac{\text{Total number of patients receiving consultation}}{\text{Total number of patients discharged}} \times 100$$

Example: A pediatric unit discharged 100 patients during the past month. Of these, 33 were seen by a consultant. Taking the number of patients receiving consultations (33) and dividing by the total number of pediatric patients discharged (100), and then multiplying the quotient by 100, results in a rate of 33% [(33 ÷ 100) × 100].

SELF-TEST 38

1. During the first quarter of the year, it was reported that 2013 patients (1961 = A&C; 52 = NB) were seen in consultation by at least one consultant during their hospital stay. Of this number, 1008 (988 = A&C; 20 = NB) were seen by two or more consultants during their stay. A total of 3575 adults/children were admitted during this first quarter of the year, and 635 newborns were admitted. Discharges totaled 3568 for adults/children and 621 for newborns during the same period. Deaths recorded were 32 adults/children and two newborns. Inpatient service day totals were 20,331 for adults/children and 4052 for newborns.

   Calculate:

   a. Percentage of patients seen in consultation during their hospital stay during the first quarter of the year.

   b. Percentage of hospitalized patients seen by more than one consultant during their hospital stay during the first quarter of the year.

2. Glad Tidings Hospital reports the following statistics:

Service	*Adm.*	*IPSD*	*Disch.*	*Deaths*	*Patients Seen in Consultation*
Medical	998	15,203	991	18	312
Surgical	604	9,585	607	15	204
OB	378	4,219	372	2	85
NB	345	4,116	346	2	36
Psychiatric	207	3,028	202	3	44

Calculate:

a. Percentage of patients seen in consultation.

b. Clinical service with the lowest percentage of patients seen in consultation.

c. Clinical service with the highest percentage of patients seen in consultation.

3. A pediatric ward records the following statistics for May:

Bed count	12	
Admissions	30	
Discharges	28	
Deaths	1	(under 48 hrs) (patient autopsied)
IP service days	300	
Nosocomial infection	1	
Seen in consultation	8	(6 were seen by two or more consultants)

Calculate:

a. Percentage of pediatric patients seen by a consultant in May.

b. Percentage of pediatric patients seen by two or more consultants in May.

c. * (R5) Pediatric death rate in May.

d. * (R6) Pediatric autopsy rate for May.

e. * (R4) Pediatric bed occupancy percentage for May.

3. Morbidity Rates

As previously mentioned, morbidity refers to disease. Hospitals often equate morbidity with infection rates, or more specifically infections which originate in the hospital and are called nosocomial infections. However, national and world-wide data are gathered and statistics generated regarding the prevalence and incidence of both rare and common diseases.

In the United States, the Center for Disease Control (CDC), with headquarters in Atlanta, Georgia, is the clearing house for disease statistics. Communicable diseases were the first group of diseases to be reported nationally. Today each local health department gathers data on a great variety of communicable diseases, forwards its count to the state health department and a cumulative total is then sent to the CDC. The CDC is the central agency for compiling national data on communicable disease. However, it is believed that the data is underreported in many cases and for many common diseases. (Sample disease-reporting forms are provided in the appendix.)

Data on noninfectious, occupational, and chronic diseases are also gathered from a variety of sources, including hospital records, school nurse records, insurance industry data, registries (tumor, communicable disease, fracture, TB, trauma) and the National Health Survey.

Data similar to that gathered in the United States is available for most of the developed world, and attempts are made to gather data in third world countries by various relief organizations and through the United Nations.

Epidemiology originated as the study of epidemics and epidemic disease. The branch of study developed as the result of great epidemics which occurred in various parts of the world over the centuries. These epidemics included cholera, plague, typhus, and influenza, to name a few. Today epidemiology is the observation of the occurrences of disease in populations.

Epidemiology is concerned with both small and great numbers. The cause of a single, isolated case of a disease is often as hard to find as the cause of a massive outbreak. Because of this, epidemiology is often thought of as investigative medicine.

Epidemiological data has also illustrated changing disease trends. Plotting these trends has shown a decrease in certain cancers and an increase in others. In studying disease it has identified the strong link between smoking and lung cancer, though it cannot be said that all smokers develop carcinoma of the lung.

An epidemic is generally thought to be an outbreak of contagious disease that spreads rapidly. Due to its rapid spread, it infects many individuals in an area. One hundred years ago, infectious disease was the leading cause of death. With the development of vaccines and antibiotics, the death rate from infectious disease has plummeted in developed countries, but remains extremely high in developing countries. Presently, the major killers in the United States are heart disease, cancer, and stroke. Today the term epidemic can include noninfectious diseases and the term epidemic is used to indicate the occurrence or presence of a large number of cases of disease.

Epidemic

An epidemic is a disease that attacks many people in a region at the same time, usually spreading rapidly; it is also defined as a disease of high morbidity which is only occasionally present in the community. (Example—flu epidemic).

Endemic Disease

An epidemic disease is a disease which is commonly found in an area. It is a disease which is present in a community at all times yet can have low morbidity, be constantly present yet be clinically diagnosed in only a few. It can be said that malaria is endemic to the tropics or that histoplasmosis is endemic to the Midwestern farm belt.

a. *Prevalence*

Prevalence refers to something that is widely or commonly occurring or existing. With regard to morbidity, it is defined as the number of existing cases of a disease in a given population. The existing cases of a disease (per period) are divided by the population at that time, and the quotient is then multiplied by a factor of 1,000, 100,000 or 1,000,000 to determine the prevalence of a disease in a given population.

Formula: for Disease Prevalence

$$\text{Prevalence} = \frac{\text{Known cases of a disease (for a period)}}{\text{Population (for the period)}} \times 1000$$

Example: A Total of 400,000 people are alive with a diagnosis of AIDS in the United States in 2000. If the population of the United States is recorded as 280 million on July 1, 2000, the prevalence of AIDS in the U.S. population is:

$$\frac{400{,}000 \times 100{,}000}{280{,}000{,}000} = 142.86 \text{ per } 100{,}000 \text{ population/yr (or)}$$

$$\frac{400{,}000 \times 1{,}000}{280{,}000{,}000} = 1.43 \text{ individuals per 1,000 population/yr}$$

b. *Incidence*

Incidence refers to frequency or extent, as in the phrase that there is a "high incidence of malaria in the tropics." When a population is followed for a period of time, incidence of disease can be calculated as the number of new cases of a disease per unit of time. The newly reported cases of a disease (per period) are divided by the population on July 1 of that year, the quotient being multiplied by a convenient factor of 1,000, 100,000 or 1,000,000 to determine the incidence rate.

Formula for Disease Incidence

$$\text{Incidence} = \frac{\text{Newly reported cases (in a period)}}{\text{Population at the midperiod}} \times 1000$$

Example: Out of a population of 270 million in the United States in the past year, 21,700 new cases of tuberculosis were reported to the various State Health Departments. To determine the disease incidence multiply 21,700 by 100,000 and divide by 270 million. Therefore, the incidence of TB in the U.S. population this past year showed 8.04 new cases of TB per 100,000 population.

c. *Complications and Complication Rates*

A complication is an additional disorder which arose after admission to the hospital and which modifies the course of the patient's illness or the medical care required. Infections, hemorrhages, wound disruptions, adverse drug reactions, and transfusion reactions are all examples of complications. Also of concern are falls, burns, and medication administration errors which are recorded in incident reports.

Formula:

$$\text{Complication rate} = \frac{\text{Number of complications}}{\text{Patients at risk}} \times 100$$

Example: Rosewood Hospital reports indicate that in July a total of 85 patients had an abdominal surgical procedure. Of these three had to be treated for complications resulting from the operation. Therefore, the complication rate was 3.53% (3 divided by 85 multiplied by 100).

Complication data and rates may be compiled on a monthly basis to assess trends and to take appropriate corrective action to reverse the occurrence whenever possible.

d. *Case Fatality Rate*

The case fatality rate is defined as the number of deaths assigned to a given cause in a certain period, divided by the number of cases of the disease reported during the same period, the quotient being multiplied by 100.

Formula:

$$\frac{\text{Number of deaths for a given disease}}{\text{Number of cases of the disease reported}} \times 100$$

Example: In 1999 a total of 32,000 cases of infectious hepatitis (hepatitis A) were reported to the CDC. A total of 510 deaths were reported from infectious hepatitis. The population census revealed 270,000,000 people. The case fatality ratio is determined by dividing the number of deaths (510) by the number of cases reported (32,000) multiplied by 100 to convert the result to a percentage, or 1.6% of the reported cases of infectious hepatitis died from the disease.

The case fatality rate is an indicator of the seriousness of a disease. It is often used as a means of showing the relative effectiveness of various methods of treatment.

4. Infection Rates

Hospitals try diligently to prevent hospital-borne infections from affecting their patients. Sterilized instruments are used, contaminated materials are appropriately discarded, and other measures are instituted to prevent the spread of infection. However, there is always the danger of acquiring a hospital-based infection, also called a nosocomial infection. (An infection that pertains to or originates in a hospital is a nosocomial infection.) Infection control committees are charged with preventing and investigating nosocomial infections. Determining the incidence of infection requires medical judgment and proper control measures need to be instituted. Suspected cases are reviewed by the infection control committee which sets criteria and evaluates each case by the established criteria. All types of infections—such as respiratory, gastrointestinal, skin, urinary tract, surgical wound, septicemias, and those related to insertion of catheters—may be included.

Infection rates may include the entire hospital or be determined for a specific clinical unit (pediatrics, for example). Also, hospitals may choose to compute rates for various types of infection, such as urinary tract infections or respiratory tract infections. Ideally, the percentages will be low for hospital (nosocomial) infection rates. A health care facility should not have rates in the two-digit (more than 10%) range, and the computed rate may even fall below 1% (for instance, 0.5%). It is recommended that rates be rechecked (especially for decimal places) when a higher number than expected results.

a. Hospital Infection Rate (Nosocomial Rate)

Formula:

$$\frac{\text{Total number of infections}}{\text{Total number of discharges (including deaths)}} \times 100$$

Example: A total of 200 newborns were discharged during the past month. Twenty infants developed respiratory infections during their hospital stay. Placing 20 (the number of infants who developed an infection) in the numerator and dividing by the number of discharges (200), and then multiplying the quotient by 100, gives an infection rate of 10% [(20 ÷ 200) × 100].

SELF-TEST 39

1. During the year, Good Time Hospital reported 12 nosocomial infections. During this same period, there were 3015 adults and children admissions and 3021 adults and children discharges. Also included in the report were 457 newborn admissions and 453 newborn discharges. Total deaths reported

were 44 (42 A&C and 2 NB). The inpatient service day total was 55,500 for adults and children and 9426 for newborns.

Calculate: Hospital nosocomial infection rate for the year.

2. During the year, Goodfellow Hospital reported the following:

Service	*Adm.*	*IPSD*	*Disch.*	*Deaths*	*Nosocomial Infections*
Medical	364	10,555	361	14	4
Surgical	206	6,821	200	10	5
OB	62	2,485	64	2	1
NB	40	1,718	42	1	1
Orthopedic	88	3,002	85	7	3

Calculate:

a. Nosocomial infection rate for the year.

b. Percentage of orthopedic patients who developed a nosocomial infection.

c. Clinical service with the highest nosocomial infection rate.

d. Clinical service with the lowest nosocomial infection rate.

3. During the past year the State Health Department reported the following:
State Population: 5,610,000

Disease	*Newly Diagnosed Cases*	*Deaths*
Pertussis	168	1
Salmonellosis	9,820	4
Shigellosis	550	1
STDs:		
Syphilis (all stages)	1,410	6
Chlamydia	9,995	0
Gonorrhea	7,000	0

Determine:

a. Incidence of Chlamydia (per 1,000 population).

b. Incidence of Pertussis (per 1,000 population).

c. Case fatality rate of Salmonellosis.

d. Case fatality rate of Syphillis.

4. A total of 500,000 males were diagnosed with a history of prostate cancer during the past year. Of these, 38% were white males and 62% were black males. The U.S. population was reported at 265 million, of which 130 million were males and 135 million were females. Among the male population, 108 million were white and 22 million were black.

Determine:

a. Prostate cancer prevalence (per 100,000).

b. Prostate cancer prevalence (per 100,000) for white males.

c. Prostate cancer prevalence (per 100,000) for black males.

b. Postoperative Infection Rate

Another specific type of infection is one that occurs postoperatively. The surgical team takes great care to prevent a surgical patient from becoming infected as the result of a surgical operation. Copious amounts of antibiotics are often used for irrigation during an operation to prevent the onset of a postoperative infection. However, infections do occur and facilities often keep records of these infections. With the aid of these records, reported infections are investigated and an attempt is made to prevent recurrences. As with any infection, it is not always possible to determine the exact time when the infection was acquired. It is not always clear, for example, whether the patient entered the facility with an infection or the infection was acquired or transmitted in the hospital.

(1) Terms

(a) SURGICAL PROCEDURE

Any single, separate, systematic manipulation upon or within the body that can be complete in itself, normally performed by a physician, dentist or other licensed practitioner, either with or without instruments, is considered a surgical procedure. Surgical procedures are done to restore disunited or deficient parts, to remove diseased or injured tissues, to extract foreign matter, to assist in obstetrical delivery, or to aid in diagnosis.

(b) SURGICAL OPERATION

One or more surgical procedures performed at one time for one patient using a common approach or for a common purpose is a surgical operation.

Explanation: An operation may include more than one procedure, but the procedures would have to be related, or performed for the same common purpose. A salpingo-oophorectomy is considered to be one operation but also two procedures that can be carried out at the same time through the same surgical approach. A patient who had a tonsillectomy and then a hernia repair would, however, have had two operations with two procedures.

(2) Postoperative Infection Rate

Formula:

$$\frac{\text{Number of infections in clean surgical cases for a period}}{\text{Number of surgical operations for the period}} \times 100$$

NOTE:

Clean surgical cases are those that were not infected at the time of surgery. Wounds with prior contamination and infection would be excluded in this formula. Postoperative infection rates are based on infections in which the infectious agent was most likely introduced at the time of the surgery.

Example: A hospital that recorded 10 postoperative infections during the past month and performed a total of 250 surgical operations would have a postop infection rate of 4%. (Ten infections divided by 250, and then multiplied by 100, computes to 4%.)

SELF-TEST 40

1. Careful Hospital records the following data for the surgical unit for December:

Bed count	35	
Admissions	150	
Discharges	142	
Deaths:		
Total	4	(one died under 48 hrs)
Postoperative	2	(less than 10 days = 2; more than 10 days = 0)
Anesthesia	1	
Autopsies	3	
IP service days	943	
Patients operated on	138	
Surgical operations performed	164	
Anesthesia administered	168	
Patients seen in consultation	41	
Infections:		
Nosocomial	2	
Postoperative	4	

Calculate:

a. Postoperative infection rate for December.

b. * (R6) Postoperative death rate for December.

c. Nosocomial infection rate for surgical patients for December.

d. Percentage of surgical patients seen in consultation in December.

e. * (R5) Surgical unit bed occupancy percentage rate for December.

f. * (R6) Anesthesia death rate for December.

2. Surgical statistics for January:

Bed count	40	
Admissions	176	
Discharges	172	
Deaths:		
Total	5	(under 48 hrs = 2; over 48 hrs = 3)
Postoperative	2	(less than 10 days = 2; more than 10 days = 0)
Anesthesia	1	
Autopsies	4	
IP service days	1025	
Infections:		
Postoperative	3	
Nosocomial	2	
Patients seen in consultation	48	
Patients operated on	166	
Surgical operations performed	185	
Anesthesia administered	170	

Calculate:

a. * (R6) Postoperative death rate for January.

b. Postoperative infection rate for January.

c. January nosocomial infection rate for surgical patients.

d. Consultation rate for surgical patients for January.

e. * (R6) Anesthesia death rate for January.

f. * (R6) Gross death rate for surgical patients for January.

g. * (R6) Net death rate for surgical patients for January.

h. * (R5) Bed occupancy percentage for surgical patients for January.

3. Surgical statistics for the first quarter (January through March):

Bed count	36
Admissions	360
Discharges	348
IP service days	2923
Patients seen in consultation	120

Additional Data:

	Deaths			*Infections*		*Patients Operated on*	*Surg. Oper.*	*Anes. Admin.*
Month	***Anes.***	***Postop.***	***Other***	***Noso.***	***Postop.***			
Jan.	1	1	1	1	1	108	120	110
Feb.	0	1	1	1	1	95	98	97
Mar.	0	2	0	1	2	123	133	125

Calculate:

a. * (R6) Month (of the three-month period) in which the postoperative death rate was the highest.

b. * (R6) Postoperative death rate for the period.

c. * (R6) Anesthesia death rate for the period.

d. Postoperative infection rate for the period.

e. Month (of the three-month period) in which the postoperative infection rate was the highest.

f. * (R5) Bed occupancy percentage for the period.

g. Nosocomial infection rate for the period.

h. * (R4) Average daily inpatient census for the period.

i. * (R6) Gross death rate for the three-month period.

4. Surgical statistics for the week of June 1 through June 7:

Bed count: 40
Beginning census: 34

	6-1	***6-2***	***6-3***	***6-4***	***6-5***	***6-6***	***6-7***
Admissions	5	4	6	3	5	3	1
Discharges	3	5	2	4	6	4	7
Deaths:							
Total	0	0	0	1	0	1	0
Postop.				1			
Anes.						1	
IP service days	37	35	40	38	38	36	30
Infections:							
Postop.	0	0	1	0	0	0	0
Nosocom.	0	0	0	0	1	0	0
Patients operated on	2	7	5	6	3	8	2
Surgical operations	3	8	5	7	3	8	3
Anesthesia administered	2	7	6	6	4	8	3

Calculate:

a. * (R4) Census at midnight on June 7.

b. * (R4) Average daily inpatient census for the week.

c. * (R5) Bed occupancy percentage for the week.

d. * (R6) Gross death rate for the week.

e. Postoperative infection rate for the week.

f. * (R6) Postoperative death rate for the week.

g. * (R6) Anesthesia death rate for the week.

5. Bed Turnover Rate

Another measure of hospital utilization of beds is the bed turnover rate. This rate indicates the number of times each of the hospital's beds changed occupants.

Several formulae are in use for determining this rate and there is no universal agreement on the most accurate representation or formula. However, administrators of acute care hospitals are increasingly interested in bed turnover rates because they are considered a measure of bed utilization, especially in conjunction with percentage of occupancy and length of stay. When occupancy increases and length of stay decreases, or vice versa, the bed turnover rate makes it easier to see the net effect of these changes.

The following two formulae (which are among several that can be used) are used most frequently in the United States. They are referred to as the "direct formula" and the "indirect formula."

a. ***Direct Bed Turnover Rate***

Formula:

$$\frac{\text{Total number of discharges (including deaths) for a period}}{\text{Average bed count during the period}}$$

b. ***Indirect Bed Turnover Rate***

Formula:

$$\frac{\text{Occupancy rate (in decimal format)} \times \text{number of days in a period}}{\text{Average length of stay}}$$

Example: A 200-bed hospital recorded the following during the past year.

Discharges:	7000
Average LOS:	8.5 days
Bed occupancy rate:	82%

Using the "direct formula," the bed turnover rate is 35 times. (7000 discharges divided by 200 beds = 35 turnovers.)

Using the "indirect formula," the bed turnover rate is 35.21. (0.82 occupancy rate × 365 days in a year divided by an average length of stay of 8.5 days = 35.21 turnovers.)

Therefore, during the year, each of the hospital's 200 beds changed occupants about 35 times.

c. ***Bassinet Turnover Rate***

The same procedure can be followed to determine the bassinet turnover rate. Remember that A&C (adults and children) data and NB (newborn) data are generally kept separate with regard to census, percentage of occupancy, length of stay, and turnover rate.

d. ***Usefulness of Turnover Rates***

Turnover rates can be useful in comparing:

1) One hospital with another.
2) Rates within the same hospital in terms of
   a) Utilization rate for different time periods.
   b) Utilization rate for different units.

For example, even though two time periods have the same percentage of occupancy, the turnover rates may differ. The rates may be lower because of a longer length of stay during one of these periods. If a unit has a high turnover rate—even though it has a low occupancy rate, such as might occur in the obstetric unit—this might be an indication of the greater number of patients being accommodated than in a unit (such as the surgical unit) with a higher percentage of occupancy but a longer length of stay. The bed turnover rate is generally regarded as a measure of the degree of bed utilization.

SELF TEST 41

Answers should be correct to *two* decimal places.

1. Shoreline Hospital reported the following during the past non-leap year:

	A&C	*NB*
Bed/bassinet count	250	15
Admissions	9205	1256
Discharges	9180	1245
Deaths	103	5
IPSD	69,608	4846
Discharge days	70,150	4888

Calculate:

a. * (R5) Percentage of bed occupancy for the year.

b. * (R8) Average A&C length of stay.

c. Bed turnover rate using the direct formula.

d. Bed turnover rate using the indirect formula.

e. * (R5) Percentage of bassinet occupancy for the year.

f. * (R8) Average NB length of stay.

g. Bassinet turnover rate using the direct formula.

h. Bassinet turnover rate using the indirect formula.

B. SUMMARY

1. Rates can be devised by dividing the number of times something happens by the number of times it could have happened.
2. A delivery involves giving birth—to either a living child or a dead fetus.
3. Multiple births constitute one delivery.
4. A surgical procedure is a single manipulation that can be complete in itself.
5. A surgical operation is one or more surgical procedures performed at one time using the same approach and for a common purpose.
6. Epidemiology is the study of the occurrence of disease in populations.
7. An epidemic is a disease which attacks many people in a region at the same time, usually spreading rapidly.
8. An endemic disease is a disease which is commonly found in an area.
9. Cesarean Section Rate: C-sections divided by deliveries.
10. Hospital Infection Rate: Infections divided by discharges.
11. Consultation Rate: Consultations divided by discharges.
12. Postoperative Infection Rate: Postoperative infections divided by the number of surgical operations.
13. Direct Turnover Rate: Discharges divided by bed count.

14. Indirect Turnover Rate: Occupancy rate times the days in a period divided by the average length of stay.
15. Prevalence of disease is the known cases of a disease (per period) divided by the population at that time, the quotient being multiplied by a convenient factor.
16. Incidence of disease is the newly reported cases of a disease (per period) divided by the population at the midperiod, the quotient being multiplied by a convenient factor.
17. Complication rate is the ratio of the number of complications to the number of patients at risk.
18. The case fatality rate or ratio is the number of deaths for a given disease divided by the number of cases of the disease.

C. CHAPTER 9 TEST

Note: Answers should be correct to *two* decimal places.

1. Serendipity Hospital (July)

OB Unit

Bed count	18	
Admissions	110	
Discharges (live)	101	
Deaths	1	(over 48 hrs)
Autopsies	1	(by hospital pathologist)
Delivered	89	(2 sets of twins)
Undelivered	12	
C-sections	27	

Calculate:

a. * (R6) Maternal death rate.

b. * (R7) Maternal autopsy rate.

c. C-section rate.

2. Cascade Hospital (August)

Unit	Adm.	Disch.	Deaths	Autopsies Yes (HP)	Autopsies Coroner	Consults	Hospital Infections
Medical	401	390	18	5	1	135	5
Surgical	88	81	2	1	0	61	2
Pediatrics	51	48	0	0	0	18	1
OB	268	269	0	0	0	12	2
GYN	47	45	0	0	0	3	0
Orthopedic	50	48	1	0	0	15	1
NB	241	239	1	0	0	2	2
Totals	1146	1120	22	6	1	246	13

Calculate:

a. Overall consultation rate for August.

b. Unit (service) with the highest consultation rate.

c. Overall hospital infection rate for August.

d. Unit (service) with the highest infection rate.

e. * (R6) Gross death rate.

f. * (R7) Gross autopsy rate.

3. Windhaven Hospital (September)

Type of Surgery	***Adm.***	***Disch.***	***Deaths***	***Patients Operated on***	***Consults***	***Postop. Infections***
GI	36	35	1	34	12	1
GYN	45	44	0	43	3	0
C-section	21	22	0	20	1	0
Orthopedic	47	46	1	47	20	2
ENT	18	18	0	18	1	0
Urology	27	25	0	26	1	0
CV	22	20	2	20	10	1
Other	19	20	1	18	6	1
Totals	235	230	5	226	54	5

Other Statistics:

Surgical procedures	254
Surgical operations	235
Anesthesia administered	247

Calculate:

a. Overall surgical consultation rate.

b. Postoperative infection rate.

c. * (R6) Surgical service with the highest death rate.

4. Rainbow Hospital (June)

		Deliveries		***NB***
OB Unit		***Vaginal***	***C-Section***	***Deaths***
Admissions	283			
Discharges (live)	279			
Deaths	2			
Undelivered	21			
Delivered:				
Single	221	156	65	2
Twins	3 sets	2 sets	1 set	0
Triplets	1 set	1	0	0
Stillborn (all single):				
Early	17	17	0	
Int.	8	8	0	
Late	2	2	0	

Calculate:

a. Total number of live births.

b. Total number of deliveries.

c. Total number of newborn deaths.

d. C-section rate for June.

e. Percentage discharged undelivered.

5. Hillcrest Hospital (July)

				Autopsies					
Service	***Adm.***	***Disch.***	***Deaths***	***Yes (HP)***	***Coroner***	***Deliv.***	***C-Sect.***	***Infec.***	***Consult.***
Med	862	860	33	5	1			5	298
Surg	333	331	16	1	0			1	144
OB	257	255	1	0	0	237	66	2	8
NB	221	218	1	0	0			2	2
Totals	1673	1664	51	6	1	237	66	10	452

Calculate:

a. C-section rate.

b. Infection rate.

c. Consultation rate.

d. * (R6) Gross death rate.

e. * (R7) Net autopsy rate.

f. * (R6) Newborn death rate.

g. * (R6) Maternal death rate.

h. Surgical infection rate.

i. Medical consultation rate.

6. Riverview Hospital–OB Unit (June 10)

	NB/Fetus	***Delivered via***		***NB Weights***		***Deaths***
Mother	***Sex***	***Vag.***	***C-Sect.***	***#1***	***#2***	***NB/Maternal***
J. Jones	M	*		8 lb 4 oz		
M. Myers	M		*	7 lb 9 oz		
S. Smith	F	*		6 lb 8 oz		
B. Brand	F	*		6 lb 11 oz		
D. Davis	M twins	*		5 lb 10 oz	6 lb 3 oz	
G. Grant	Abort M	*		450 gm		
C. Cooper	F	*		7 lb 3 oz		
L. Lyons	Abort F	*		950 gm		
N. Nolan	M		*	9 lb 1 oz		
P. Palmer	M	*		5 lb 1 oz		NB 10:55 A.M.
R. Rogers	F	*		8 lb 2 oz		
T. Turner	M		*	8 lb 9 oz		

Calculate:

a. Total number of newborn admissions.

b. Total number of newborn deaths.

c. Total number of deliveries.

d. C-section rate.

e. * (R6) Fetal death rate.

f. Percentage of live births who are male.

g. Average birth weight of liveborn males.

h. Average birth weight of liveborn females.

7. State Health Department records for the past year indicate:
Population: 3,620,000

Disease	New Cases	Deaths
Diphtheria	22	1
Hepatitis A	7,882	4
Hepatitis B	3,444	3
Mumps	33	0
Rubella	78	0
Rubeola	56	0

Determine:

a. Incidence of diphtheria per 1,000.

b. Incidence of Hepatitis B per 1,000.

c. Case fatality ratio of Hepatitis A.

8. State Cancer Registry Data for colorectal cancer indicates:

	Total	M	F
Population:	1,570,000	780,000	790,000
Newly Diagnosed Cases:	793	415	378
Residents with History of:	12,548	6,983	5,665

Determine:

a. Prevalence of colorectal cancer in males (per 100,000)

b. Incidence of colorectal cancer in females (per 100,000)

Exam—Chapters 4 through 9

Note: Assume that all questions on the exam relate to a non-leap year. Answers should be correct to *two* decimal places.

1. Beginning census A&C = 180 NB = 10

Period	*Months*	*Bed Count*	*Bassinet Count*
A	Jan. through Apr.	200	30
B	May through Aug.	220	30
C	Sept. through Dec.	210	30

Admissions:	*A&C*	*NB*
Period A	4036	648
Period B	4588	661
Period C	4271	653
Discharges:		
Period A	4025	645
Period B	4567	662
Period C	4272	650

			A&C		*NB*	
Deaths:			*<48 hrs*	*>48 hrs*	*<48 hrs*	*>48 hrs*
Period A	125	4	47	78	2	2
Period B	117	2	39	78	2	0
Period C	109	3	34	75	1	2

	A&C			*NB*		
		Coroner			*Coroner*	
Autopsies:	*Path.*	*HP*	*Cor.*	*Path.*	*HP*	*Cor.*
Period A	51	4	8	2	0	1
Period B	42	3	7	1	0	0
Period C	34	6	4	2	0	1

IPSD:	*A&C*	*NB*
Period A	20,227	1944
Period B	23,054	2015
Period C	21,475	1988
DD (Discharge days):		
Period A	20,316	1977
Period B	23,129	2021
Period C	21,533	2004

Calculate:

a. Average daily inpatient census (DIPC) for each period and for the entire year for:
   (1) A&C

   (2) NB

b. Percentage of occupancy for each period and for the entire year for:
   (1) A&C

   (2) NB

c. Yearly death rates:
   (1) Gross death rate

   (2) Net death rate

   (3) Newborn death rate

d. Autopsy rates for the year:
   (1) Newborn autopsy rate

   (2) Gross autopsy rate

   (3) Net autopsy rate

e. Average length of stay (LOS) for:
   (1) A&C

   (2) NB

2. Lakewood Hospital (April)

Bed count = 200
Bassinet count = 35

	A&C	*NB*	*OB (included in A&C)*	*<10 days*	*>10 days*
Admissions	1015	189	110		
Discharges	1002	181	104		
Deaths:					
Total	22	3	1		
Under 48 hrs	7	2			
Over 48 hrs	15	1			
Anesthesia	1				
Postoperative	7			3	4
Maternal	1				

	Deaths	*Autopsies*	
Fetal:		*HP*	*Cor.*
Early	5	0	0
Intermediate	3	0	1
Late	2	1	0

	A&C	NB	OB
Autopsies:			
Pathologist	7	1	
Coroner	2	1	
IPSD	5286	816	
Discharge days	5331	710	
Infections:			
Postoperative	1	0	
Nosocomial	12	1	
Consultations	316	15	
OB: Delivered live:			
Single			185
Twins			2 sets
Triplets			0
Delivered stillborn:			
Single			10
Twins			0
Triplets			0
Undelivered			9
Type of delivery:			
Vaginal			143
C-section			54
Anesthesia administered		331	
Surgical operations		326	
Patients operated on		318	

Calculate:

a. Average daily inpatient census for:
   (1) A&C

   (2) NB

b. Percentage of occupancy for:
   (1) A&C

   (2) NB

c. Death rates:
   (1) Gross death rate

   (2) Net death rate

   (3) Newborn death rate

   (4) Postoperative death rate

   (5) Anesthesia death rate

   (6) Maternal death rate

   (7) Fetal death rate

d. Autopsy rates:
   (1) Newborn autopsy rate

   (2) Fetal autopsy rate

   (3) Gross autopsy rate

   (4) Net autopsy rate

e. C-section rate.

f. Infection rates:
   (1) Hospital infection rate

   (2) Postoperative infection rate

g. Average length of stay for:
   (1) A&C

   (2) NB

3. Indicate whether or not each of the following is a *unit* of measure:
   a. Inpatient Service Day — Yes No
   b. Inpatient Bed Count Day — Yes No
   c. Inpatient Bed Occupancy Percentage — Yes No
   d. Inpatient Bassinet Count Day — Yes No
   e. Inpatient Census — Yes No
   f. Average Daily Inpatient Census — Yes No
4. An ice storm hits the local area. The hospital's 100 beds are filled to capacity and eight additional beds are set up in hallways and lounges and are occupied by patients. What is the bed complement for that day?

5. What is included in the numerator of death rates?

6. What is included in the denominator of autopsy rates?

7. What value occupies the numerator when the percentage of occupancy is being calculated?

8. What number is placed in the numerator when the average length of stay is being calculated?

9. Meadowland Hospital

				Beds			
Beginning Census	***Period***	***Months***	***Bed Total***	***Med.***	***Surg.***	***OB***	***Bassinets NB***
A&C = 123	A	Jan. through Mar.	130	65	40	25	20
NB = 18	B	Apr. through Sept.	145	70	45	30	25
	C	Oct. through Dec.	135	70	35	30	25

	Medical Unit				*Surgical Unit*			
	Adm.	***Disch.***	***IPSD***	***DD***	***Adm.***	***Disch.***	***IPSD***	***DD***
Jan. Feb. Mar.	994	989	5169	4956	495	491	3410	3430
Apr. May June	1161	1158	5889	5814	543	538	3814	3708
July Aug. Sept.	1154	1150	5996	5923	551	558	3779	3881
Oct.	355	356	1889	1797	146	144	978	1010
Nov.	321	319	1883	1666	151	149	1001	1101
Dec.	333	338	1897	1708	138	144	990	1055
Period total	1009	1013	5669	5171	435	437	2969	3166
Total for year	4318	4310	22,723	21,864	2024	2024	13,972	14,185

	Obstetrical Unit				Neonatal Nursery			
	Adm.	***Disch.***	***IPSD***	***DD***	***Adm.***	***Disch.***	***IPSD***	***DD***
Jan. Feb. Mar.	450	448	2189	1740	400	398	1710	1266
Apr. May June	491	492	2610	1781	431	433	2188	1382
July Aug. Sept.	487	485	2597	1846	440	438	2197	1495
Oct.	165	164	801	625	140	138	688	482
Nov.	171	169	792	654	138	140	691	497
Dec.	170	176	823	671	137	135	701	489
Period total	506	509	2416	1950	415	413	2080	1468
Total for year	1934	1934	9812	7317	1686	1682	8175	5611

A&C: ***Date***	***Adm.***	***Disch.***	***IPSD***	***DD***	***Date***	***Adm.***	***Disch.***	***IPSD***	***DD***
Dec. 1	25	22	127	119	Dec. 17	21	24	127	124
2	21	22	120	123	18	17	19	121	99
3	28	26	128	137	19	19	20	123	105
4	23	25	127	130	20	23	22	121	119
5	29	27	130	141	21	19	20	115	104
6	18	21	118	112	22	15	18	112	95
7	22	20	124	105	23	9	29	117	146
8	24	26	127	139	24	8	18	90	90
9	29	25	131	130	25	5	4	84	25
10	25	27	128	141	26	23	6	101	29
11	21	22	124	117	27	21	10	118	51
12	18	16	119	89	28	18	16	114	77
13	20	24	126	129	29	21	24	115	120
14	26	24	130	123	30	16	28	117	138
15	24	23	129	121	31	26	25	116	124
16	27	25	131	132	Total	641	658	3710	3434

Unit	Deaths: Total	<48 hrs	>48 hrs	Post op. <10	Post op. >10	Anes.	Autopsies HP	Autopsies Cor.	Anes. Admin.	Patients Operated on	Surg. Oper.	Surg. Proc.
Medical	58	19	39				18	2				
Surgical:	22	7	15	16	6	1	5	1	1998	1881	1910	2111
Thorac.	(2)											
GI	(6)											
Ortho.	(4)											
GU	(3)											
Other	(7)											
OB	2	0	2				1	0				
NB	8	5	3				2	1				
Fetal:												
Early	35						0	1				
Inter.	18						3	2				
Late	12						2	1				

OB Deliveries	Total: Live	Total: Fetal Deaths	Vaginal: Live	Vaginal: Fetal Deaths	C-Section: Live	C-Section: Fetal Deaths
Single	1659	65	1327	57	332	8
Twins	12 sets		7 sets		5 sets	
Triplets	1 set		1 set			

Unit:	Infections: Nosocomial	Infections: Postop.	Consultations
Medical	83		2007
Surgical (total):	105	110	1589
Thoracic	(18)	(12)	(389)
GI	(22)	(20)	(251)
Ortho.	(26)	(31)	(312)
GU	(20)	(25)	(288)
Other	(19)	(22)	(349)
OB	45	8	326
NB	21		228

Outpatients: Deaths = 138
Autopsies =38 by hospital pathologist; 11 coroner's cases

Calculate:

a. Average daily inpatient census for:
   (1) Medical Unit for November

   (2) Surgical Unit for the year

b. Average daily census for:
   (1) Newborns for January through March

(2) A&C for the year

(3) Newborns for the year

c. Bed/bassinet occupancy percentage for:
(1) Obstetrical Unit for April through September

(2) Bassinet percentage for October through December

(3) Bed percentage for A&C for the year

d. The following death rates for the year:
(1) Net death rate

(2) Postoperative death rate

(3) Anesthesia death rate

(4) Maternal death rate

(5) Newborn death rate

(6) Fetal death rate

(7) Gross death rate

e. The following autopsy rates for the year:
(1) Net autopsy rate

(2) Gross autopsy rate

(3) Hospital autopsy rate

(4) Newborn autopsy rate

(5) Fetal autopsy rate

f. C-section rate for the year.

g. Consultation rate for:
(1) Surgical Unit for the year

(2) Neonatal Unit for the year

h. Infection rates:
(1) Postoperative rate for the year

(2) Hospital rate for the year

i. Average length of stay for:
   (1) Medical Unit patients for the year

   (2) Newborns for the year

   (3) Adults and children for the year

j. Periods (A, B, or C) with the highest percentage of occupancy for the Medical Unit.

k. Bed occupancy percentage for December 25 through December 31.

l. Bed occupancy percentage for December 24.

10. United States population statistics for the year include:

		Total	*Males*	*Females*
Population census:		275,000,000	135,000,000	140,000,000
Births (live)		3,900,000		
Deaths:				
Maternal		510		
Infant	(<1 year)	7,450		
Neonatal	(<28 days)	4,875		
	(< 7 days)	3,850		
Post neonatal		2,575		
Fetal				
	(<20 weeks)	6,980		
	(>20 weeks)	3,620		

Determine the following vital statistic rates:

a. Maternal mortality rate.

b. Infant mortality rate.

c. Neonatal mortality rate.

d. Percent of all infant deaths that are neonatal.

e. Perinatal mortality rate.

f. Post neonatal mortality rate.

g. Fetal death rate:
   (1) Without fetal deaths in denominator.

   (2) Including fetal deaths in denominator.

11. State Cancer Data:

	Total	*Males*	*Females*
Population	2,842,000	1,400,000	1,442,000

	New Cases			*History of*			*Deaths*		
	Total	***Male***	***Female***	***Total***	***Male***	***Female***	***Total***	***M***	***F***
Cancer Diagnosis:									
Stomach	190	168	22	1169	1,005	155	50	45	5
Pancreatic	288	158	130	400	220	180	100	58	42
Lung & broncheal	1,810	1,190	620	3,550	2,410	1,140	362	297	115
Non-Hodgkin's lymphoma	440	266	174	1,775	1,058	717	78	49	31
Leukemia	244	196	48	2,886	2,110	776	66	41	25
Uterine	135	—	135	416	—	416	55	—	55

Determine:

a. Incidence of pancreatic cancer in males per 100,000.

b. Incidence of uterine cancer in females per 100,000.

c. Prevalence of lung and broncheal cancer in females per 1,000.

d. Prevalence of stomach cancer in males per 1,000.

e. Incidence of non-Hodgkin's lymphoma in the total population per 100,000.

f. Prevalence of leukemia in the total population per 1,000.

g. Case fatality rate for uterine cancer.

h. Case fatality rate for stomach cancer in males.

CHAPTER

10

Frequency Distribution

CHAPTER OUTLINE

A. Introduction
   1. Ungrouped Frequency Distribution
   2. Grouped Frequency Distribution
   3. Purpose of a Grouped Frequency Distribution
   4. Arranging Scores

B. Terms Related to a Frequency Distribution
   1. Range
   2. Class
   3. Frequency
   4. Cumulative Frequency

C. Creating a Frequency Distribution
   1. Determine High and Low Scores
   2. Arrange Scores in Descending or Ascending Order (This Step Is Not Necessary but Is Extremely Helpful)
   3. Determine Range
   4. Determine the Number of Class Intervals
   5. Set Class/Score Limits
   6. Rules for Subsequent Computations

D. Summary

E. Chapter 10 Test

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Distinguish clearly between
   a. Ungrouped vs. grouped distribution.
   b. Frequency vs. cumulative frequency.
   c. Class limits vs. class boundaries vs. class size or width.
2. Construct a frequency distribution, either ungrouped or grouped.
3. Determine the following:
   a. Range
   b. Number of classes
   c. Frequency
   d. Cumulative frequency
   e. Class limits
   f. Class boundaries
   g. Class size/class width

A. INTRODUCTION

Data collected on a group of people are initially nothing more than a collection of numbers arranged haphazardly in a disorganized array. Often, when these data are organized and analyzed in a systematic fashion, they become meaningful and interpretations can be made based on the scores that are derived from them.

Suppose that a hospital has in its data bank the cholesterol values—recorded at the time of hospitalization—of all patients admitted with an admitting diagnosis of AMI (acute myocardial infarction) and that a physician would like to examine these data. It is quite likely that he would prefer to have the data displayed in an organized way, usually in the form of a frequency distribution.

1. *Ungrouped Frequency Distribution*

Previously it has been mentioned that an ungrouped distribution is

a. a listing of all scores as they are obtained; or
b. a listing of these same scores arranged from the highest to the lowest, or lowest to highest.

2. *Grouped Frequency Distribution*

With a large number of scores, it becomes necessary to group and tally scores to facilitate analysis of the data and to put these data into a more concise form.

Once scores are ranked, it becomes obvious that in many instances the same score is recorded by more than one individual. When scores are grouped, a frequency distribution becomes a grouped frequency distribution. However, according to some statistics texts, a grouped distribution must include a grouping of two or more *different* scores. For example, when scores of 80, 81, and 82 are combined into the same interval the distribution becomes a grouped frequency distribution.

Grouping data has become routine and simple with the aid of high-speed computers, and is even more easily achieved by using the sorting features in software packages that are available for use on a personal computer (PC).

Although the grouping process generally destroys much of the original detail of the data, it is often the most effective way to handle a large array of data and still obtain a clear "overall" picture of the obtained data and the vital relationship made evident by those data.

For example, people can vary greatly in height. A newborn is measured in inches, whereas a genetic giant may be well over seven feet tall. If every height was recorded in inches and measured to the nearest inch, the number of classes or categories could be great. Say, for example, that the shortest newborn was 10 inches in length and the tallest adult was measured at 90 inches, then the number of individual categories would be 80. Even a height distribution in inches that eliminates children and includes only adults can have a range of 30 or more scores if the shortest adult is 48 inches and the tallest 78 inches. For this reason, *grouped data* are often used.

Whenever the range of scores is large—even when like scores are grouped together—it can be difficult to grasp the representation of the data. It is generally conceded that when the range of scores exceeds, say, 20 to 25, further consolidation of data may be desirable. This can be accomplished by grouping contiguous scores and combining their frequency. The resulting tabular arrangement is referred to as a *grouped frequency distribution*.

3. *Purpose of a Grouped Frequency Distribution*

The two main reasons for classifying data into a grouped frequency distribution are to

a. *Bring Order to Chaos*

Scores are listed according to size, which reduces the disorganization present in the original array of data.

b. *Condense Data to a More Readily Grouped Form*

By bringing like scores together or grouping adjacent scores and recording the total number of times each occurs, a more concise and useful distribution results.

4. *Arranging Scores*

Scores are generally listed from the highest score to the lowest in the distribution. Occasionally the reverse is correct, especially if a low score is better than a high score.

B. TERMS RELATED TO A FREQUENCY DISTRIBUTION

Several terms are used when grouping scores for a grouped frequency distribution. They are:

1. Range
2. Class
   a. Class interval
   b. Class limits
   c. Class boundaries
   d. Class size/class width
3. Frequency
4. Cumulative frequency

For illustrative purposes, the following data will be referred to in describing terms related to a frequency distribution. The figures represent the birthweights (in grams) of infants born to mothers who smoked and to non-smoking mothers.

Non-smokers: 3515, 3420, 3175, 3586, 3232, 3884, 3856, 3941, 3232, 4055, 3459, 3998, 4048, 3769, 3688, 3456, 3815, 3422, 3916, 3361, 3661, 3962, 3557, 3191, 3164

Smokers: 2608, 2509, 3600, 1730, 3175, 3459, 3288, 2920, 3021, 2778, 2466, 3270

Comparison of Birthweights (in grams) of Infants born to Smokers vs. Non-Smokers (f = frequency; cf = cumulative frequency)

	Nonsmokers	*f*	*Smokers*	*f*	*cf*
4050+	//	2			37
3900–4049	////	4			35
3750–3899	////	4			31
3600–3749	//	2	/	1	27
3450–3599	/////	5	/	1	24
3300–3449	///	3			18
3150–3299	/////	5	///	3	15

	Nonsmokers	*f*	*Smokers*	*f*	*cf*
3000–3149			/	1	7
2850–2999			/	1	6
2700–2849			/	1	5
2550–2699			/	1	4
2400–2549			//	2	3
2250–2399					1
2100–2249					1
1950–2099					1
1800–1949					1
1650–1799			/	1	1

1. Range

The range is the interval spanned by the data. It is computed by finding the difference between the largest score in the distribution and the smallest. If the scores span an interval in which the highest score recorded is 108 and the lowest is 18, the range becomes 90 (108 – 18 = 90). In the illustration above, the range is 2325 [high score (4055) minus the low score (1730) = 2325].

2. Class

A class is a category into which a score can be placed. It is a single score in a small distribution and a grouping of scores in a grouped distribution. When summarizing large masses of raw data, it often becomes advantageous to distribute the data into classes or categories and to determine the number of individuals or scores to include in each class. All data is then assigned and distributed within these classes, resulting in what is called a *frequency distribution*.

Example: If height measurements were made to the nearest inch, the heights could be divided into classes, thereby grouping together those within a range. One class could include all heights from 60 to 64 inches; the next class would then include heights from 65 to 69 inches; and so on.

Illustrative Example: Once the birthweights are arranged in order of size (from high to low), then categories or classes need to be assigned into which the scores can be grouped. Assuming that 150 consecutive scores (for example, birthweights of 1650 grams through 1799 grams) are all to be included in the same category, this category then comprises a class.

a. *Class Interval*

A class interval is a range of scores. An entire distribution is subdivided into intervals that contain all the scores within the range.

Example: A class interval with limits of 60 to 64 contains all the scores of 60, 61, 62, 63, and 64. Interval limits of 10 to 12 include the scores of 10, 11, 12. A distribution may also have limits of 80% to 89%, within which scores over 80% but less than 90% would be recorded.

Illustrative Example: All birthweights of 1650 grams through 1799 grams (up to 1800 grams) are included in the lowest interval of the distribution. The next class interval includes scores of 1800 grams up to, but not including, 1950 grams.

b. ***Class Limits (Score Limits)***

The end numbers of the class interval are the class limits. The smaller number is the *lower class limit* and the larger number is the *upper class limit*. Class limits are also referred to as score limits or raw score limits.

Example: Referring to the example of heights, a class interval of 60 to 64 inches has a *lower* class limit of 60 and an *upper* class limit of 64.

Illustrative Example: In the birth weight data, the lowest class interval has a lower class limit of 1650 grams and an upper class limit of 1799 grams.

c. ***Class Boundaries***

When measuring continuous variables with scores recorded to the "nearest whole number," the score is actually somewhere between 0.5 before the number or 0.5 following the number. For example, in recording heights to the nearest inch, an individual who is between 5 feet 5 1/2 inches and 5 feet 6 1/2 inches is recorded as 5 feet 6 inches in height. A class interval of 60 to 64 inches theoretically includes all measurements from 59.50 to 64.50 inches. This is the same principle on which *rounding* of numbers is based. These decimal numbers are the class boundaries. Again, the smaller number is the *lower* class boundary and the larger number the *upper* class boundary.

Class boundaries are also referred to as real or actual class limits, or true class limits.

Illustrative Example: Using the lowest class interval, the class boundaries are 1649.5 to 1799.5, which means that an infant needed to weigh at least 1649.5 grams, but not more than 1799.5 grams, to fall into this class interval.

d. ***Class Size/Class Width***

The size or width of a class interval is the difference between the lower and upper class limit or class boundaries and is referred to as *class width*, *class size*, or *class length*. It is the number of scores grouped together in an interval, not the scores themselves nor the frequency. If test scores of 80, 81, and 82 are combined in one interval, then the class size is three scores. Traditionally, the interval size is the same for the entire distribution. However, in some distributions the class intervals will vary. To determine the size of a class interval of equal width, subtract two successive *lower* class or *upper* class limits.

Example: If heights are being recorded in inches and the interval limits have been set at 40–44, 45–49, 50–54, 55–59, and so on, then the class width is five [obtained by subtracting the lower limit (40) from the next lower limit (45), or subtracting two successive upper limits (49 – 44)].

Illustrative Example: The class width in the distribution is 150 scores—[1800 (lower class limit of the second interval) minus 1650 (lower class limit of the lowest interval), equals 150].

The size of the interval to be used is a matter of arbitrary choice; however, it is dependent upon several factors:

(1) the nature of the data;
(2) how this grouped distribution is to be used; or
(3) the kind of interpretation that one desires to draw from it.

Generally speaking, the more detailed the interpretation one needs, the smaller the class interval size should be and, as interval size increases, the more detail is lost. If high descriptive precision is needed or desired, if fluctuations in frequency over small parts of the range are to be studied, and if the number of scores tabulated is large enough to permit such detailed study, then the interval should be small. If, however, only a very rough picture of the distribution of scores is needed, a very broad interval may be quite satisfactory.

3. Frequency

Frequency refers to the number of times a certain score appears in the distribution. Frequency may be determined by counting the tally marks for each class or category. With the use of computers, frequency can be counted directly without having to first tally the scores.

Illustrative Example: The frequencies are recorded for each class interval for both smokers and non-smokers; the lowest class interval has a frequency of zero for non-smokers and one for smokers.

4. Cumulative Frequency

The cumulative frequency is the sum of the frequencies, starting at the lowest interval and including the frequencies within that interval. This column is prepared by "adding in" successive class frequencies from the bottom to the top. The entry opposite the lowest interval is the frequency in that interval; the entry opposite the second interval is the sum of the frequencies in the first and second intervals; the entry opposite the third interval is the sum of the frequencies in the first, second, and third intervals, and so on. The entry opposite the top interval would equal the total number of scores in the distribution. Cumulating frequencies is most commonly done from bottom to top, but it is also possible to cumulate from the top downward.

Steps to follow in cumulating frequencies:

a. First Row

Enter lowest frequency in cumulative frequency column of the first row (bottom row). In this first row, the frequency and cumulative frequency will have identical scores.

Illustrative Example: The only frequency (1) recorded was in the smokers column. This number is then placed in the adjacent cf (cumulative frequency) column (1).

b. Second Row

Add the frequency for the second row to the first row and record this total in the cumulative frequency column.

Illustrative Example: The frequency from the first row (1) is added to the frequency of the second row (0), resulting in a cumulative frequency of 1 ($1 + 0 = 1$).

c. Subsequent Rows

Continue adding the previous cumulative frequency to the next row's frequency, recording each total in the cumulative frequency column.

Illustrative Example: Refer to the illustrative distribution above and add the frequency in each row to the cumulative frequency in the previous row.

d. Top Row

The top row's cumulative frequency should equal N (the total number of scores in the distribution).

Illustrative Example: A total of 37 birthweights were recorded—25 were born to non-smokers and 12 were born to smokers. This total is called N, or the total number of scores. The cumulative frequency in the final row also is recorded as 37. These two numbers (N and final cf) should always be identical.

If you are cumulating from the top downward, then the final cf will be located in the bottom row of the distribution.

C. CREATING A FREQUENCY DISTRIBUTION

Steps to follow in creating a frequency distribution:

1. Determine High and Low Scores

Determine the highest score and the lowest score in the distribution.

2. Arrange Scores in Descending or Ascending Order (This Step Is Not Necessary but Is Extremely Helpful)

Beginning with the high score, list all scores from the highest to the lowest in the distribution. This convention should be followed unless some compelling reason dictates that the lowest score be placed at the top and the highest score at the bottom.

3. Determine Range

Subtract the lowest score from the highest score.

4. Determine the Number of Class Intervals

As a general rule, for most types of data, it is commonly recommended that the number of class intervals be at least 10 but no more than 20, with 15 classes being the preferred average. Some texts recommend no less than five and others state no less than 12, but the majority recommend a minimum of 10 classes. Most authors choose 20 as the maximum number of classes. Remember, however, that the number of recommended classes is only a rule of thumb and that the number must be based on the data and the interpretations that are to be drawn from this data.

Although grouped data can account for a grouping error, the error is generally regarded to be so small or negligible that it can be ignored, unless an interval size results in a very small number of classes, say, below 10. Although anywhere between 10 and 20 different class intervals for grouping scores is generally satisfactory, more precision can be attained with a minimum of 12 class intervals. As a single number, 15 class intervals seems to be a good compromise for an overall choice. Some data will require more class intervals, and other data can be condensed without being affected by grouping error. For more information regarding class interval size and number of class intervals, the reader is referred to a standard statistics text, which will include more details about these subjects.

5. Set Class/Score Limits

There is no universal rule governing how to set the limits of a class interval. Some common methods are included below, but it should be remembered that these are suggestions and that the limits should be representative of the data being grouped. Some statisticians recommend setting limits by beginning with the lowest interval, and others recommend starting at the top interval.

a. *Suggested Methods*

(1) *Lower Limit a Multiple of Interval Size*

A rather common method of setting the lower limit is to make the lower limit a multiple of the interval size. If the lowest score in a distribution is 19 and the interval size is determined to be three, the lower score limit of the first interval would be 18 and the upper score limit 20.

(2) *Multiple of Highest Score the Middle Score of Interval*

In this method a multiple of the highest score is found and this multiple should be the middle score of the interval. If the highest score is 178 and the interval size is three, the multiple computes to 177. In setting the score limits, the limits would read 176–178.

b. *Departures from Convention*

The practice of beginning a class interval as a multiple of class size or making the middle score of the uppermost interval a multiple of the highest score is a rule of thumb. There are instances when other limits are more applicable and the grouping is made easier. It is much easier to group large numbers of scores in multiples of 5 or 10. Score limits of 35–39 or 30–39 are much easier to work with than limits of 32–36 or 28–37. Therefore, limits are often set for the sake of convenience. Limits should be set by taking into account all the factors that will facilitate constructing the distribution and yet be representative of scores in the distribution. A little thought is required when setting class limits. However, in abandoning the rule, it is also possible that a bias can occur if the scores are not equally representative of the midpoint of the interval, because this midpoint is used in making computations from the grouped data. However, these errors will *not* be addressed in this text and the reader is referred to a more comprehensive statistics text for further analysis.

6. Rules for Subsequent Computations

For the sake of maintaining consistency among the computations that follow, the following rules will apply:

a. Desired number of class intervals: 15, or between 12 and 20.
b. Preferred class sizes: 1, 2, 3, 5, 7, 10, 15 (or any higher multiple of 5).
c. Setting lower limits: Determine the class size. If the class size is an
    1) *Odd* Number—Find a multiple of this number nearest to the lowest score in the distribution. This multiple should be the lowest score in the interval. Other limits will be determined automatically from this.
    (2) *Even* Number—Find a multiple of this number and make the lower limit of each interval a multiple of this number.

Example: For illustrative purposes, a familiar example will be used—the results of the final test scores for 100 students at Studious State University. The recorded scores are as follows:

58	68	73	61	66	96	79	65	86	69	94	84	79
80	65	78	78	62	80	67	74	97	75	88	75	82
77	89	67	73	73	83	82	82	73	87	75	61	97
74	57	81	81	69	68	60	74	94	75	78	88	72
75	88	85	90	93	62	77	95	85	78	63	94	92
71	62	71	95	69	60	76	62	76	84	92	88	59
60	78	74	79	65	76	75	92	84	76	85	63	68
72	83	71	53	85	96	95	93	75				

a. Highest score = 97.
b. Lowest score = 53.
c. Range = 44. The lowest score (53) is subtracted from the highest score (97) for a range of 44 (97 – 53 = 44).
d. Class size = 3. The range (44) is divided by 15 (desired number of class intervals), which computes to a class size of 3.
e. Limits of the lowest class interval are 51 to 53. (The class size of 3 is odd and a multiple of the lowest score of 53 is 51. With a class size of 3 there will be three scores tabulated in the lowest class interval—51, 52, 53—resulting in limits of 51–53.)
f. Setting up the distribution:

Score Limits	*Tally*	*Frequency*	*Cumulative Frequency*
96–98	////	4	100
93–95	///// ///	8	96
90–92	////	4	88
87–89	///// /	6	84
84–86	///// ///	8	78
81–83	///// //	7	70
78–80	///// /////	10	63
75–77	///// ///// ///	13	53
72–74	///// /////	10	40
69–71	///// /	6	30
66–68	///// /	6	24
63–65	/////	5	18
60–62	///// ////	9	13
57–59	///	3	4
54–56		0	1
51–53	/	1	1

g. Number of classes = 16.

Example: If the scores in a distribution ranged from a high of 108 to a low of 18, the range would be 90. To find the number of intervals, the range is divided by 15 to approximate the number of scores that would need to be grouped into each class for a distribution of approximately 15 intervals. Dividing 90 by 15 results in a class size of 6 (90 divided by 15 = 6). However, 6 is not a preferred class size so 5 or 7 would more likely be used. Using 7 as the class size, the lower limit of the lowest class would be 14, a multiple of 7. The limits of this class interval would be 7–13. The resultant limits of the remaining classes are: 14–20; 21–27; 28–34; 35–41; 42–48; 49–55; 56–62; 63–69; 70–76; 77–83; 84–90; 91–97; 98–104; 105–111.

If the upper class had been established first by using a multiple of the highest score as being the middle score in the interval, then the top interval would read 102–108, because 105 is a multiple of 7 and becomes the middle score, with the remainder of the score limits following in succession as determined above.

SELF-TEST 42

1. For the scores below, and using the preferred class interval sizes, determine:
   a. The best class interval size for each range of scores.

   b. The approximate number of class intervals for these scores without setting score limits.

	Score Limits	*a. Interval Size*	*b. Number of Class Intervals*
1)	1 through 45		
2)	72 through 136		
3)	43 through 237		
4)	0.12 through 0.38		

2. Determine approximately how many classes would result if:
   a. A class interval of 5 was used for a range from 1 through 55.

   b. A class interval of 5 was used for a range from 172 through 366.

   c. A class interval of 3 was used for a range from 88 through 124.

   d. A class interval of 10 was used for a range from 12 through 160.

3. Determine the range for the following high and low scores:
   a. 345 and 118

   b. 137 and 15

   c. 0.88 and 0.25

4. Indicate the class boundaries for the following class limits:
   a. 56 through 58

   b. 25% through 75%

   c. 0.28 through 0.30

5. For the following distribution, indicate the frequency for each interval and the cumulative frequency for each interval.

   Scores: 56, 51, 47, 58, 55, 52, 53, 52, 49, 55, 54, 53, 47, 51, 56, 57, 49, 50, 50, 48, 56, 58, 47, 57, 51, 54, 57, 49

Score Limits	*Tally*	*Frequency*	*Cumulative Frequency*
56–58			
53–55			
50–52			
47–49			

6. Set the score limits for the upper and lower intervals for a distribution in which 88 is the lowest score and 166 the highest.

D. SUMMARY

General Rules for Forming a Frequency Distribution:

1. Determine high score and low score.
2. Arrange scores in descending order.
3. Find range.
4. Determine the number of class intervals. Divide the range by 15 to approximate the number of scores to be grouped into each class for 15 intervals.
5. Set and list class interval limits for each interval. These limits should be set in ascending or descending order.
6. Tabulate and tally scores. Each data entry is tallied within each specific class interval.
7. Record frequency.
8. Check for accuracy. Total the numbers in the frequency column and make sure that the total agrees with the total number of original scores, or compute the cumulative frequency as an accuracy check.

E. CHAPTER 10 TEST

1. The age of all patients is recorded at the time of each hospital admission. The hospital administration would like a frequency distribution of the ages of patients who were admitted during the preceding year, excluding newborns. The oldest patient admitted was 102 and the youngest was a week-old infant. A total of 7823 patients were admitted during the preceding year.

   Determine:

   a. Class interval size.

   b. The number of class intervals.

   c. Score limits for each interval if zero is the lower limit of the lowest interval.

2. The ages of all cancer patients are recorded at the time the diagnosis of cancer is made. A total of 255 new cancer cases were reported during the past year. The tumor (cancer) registrar is asked to make a frequency distribution of this data. The youngest patient was three years old and the oldest was 92.

   Determine:

   a. Score limits for each class interval if the size of a class interval is five years and the lower limit of the lowest interval is zero.

   b. The number of class intervals.

3. A weight-reduction program for obese people was initiated for those who were at least 50 pounds over their ideal weight. A total of 86 people enrolled in the program at the beginning of the year and 45 of these 86 people remained in the program throughout the year. Their initial weights and final weights were recorded to the nearest pound, and the difference between these two weights was determined, resulting in the following data:

   −15, −26, −37, −55, −41, −18, −44, −9, −39, −22, 0, +5, −42, −33, −66, −24, −72, −33, −18, −29, −37, −43, −6, −46, −33, +10, −3, −51, −45, +12, −27, −53, −48, −19, −27, −46, −35, −62, 0, −18, −38, −28, −52, −16, −33

   Using an interval size of five, construct a frequency distribution, with the largest weight loss recorded at the top of the distribution and the weight gains at the bottom. Use the following headings:

   Hint: Lowest class interval limits are +10 to +14; +5 to +9; 0 to +4; −1 to −5; and so on.

Weight Loss/Gain (in Pounds)	Tally	Frequency	Cumulative Frequency

4. A total of 320 patients was treated during the past year for STDs (sexually transmitted diseases). Excluding the 32 cases that resulted from congenital transmission or sexual abuse, construct the limits for a frequency distribution of the remaining cases (288) if the oldest patient was 88 and the youngest was 12.

5. Blood glucose levels are recorded for all males over the age of 40 who are admitted with a diagnosis of coronary artery heart disease. A total of 755 diagnosed cases were reported. The lowest blood glucose level recorded was 58 and the highest was 442. Using an interval size of 25, set the score limits for each interval.

6. Forty-eight patients were discharged during the past week. The number of clinical laboratory tests performed on each of these patients during their hospital stay was as follows:

   2, 15, 22, 31, 11, 18, 5, 7, 17, 3, 16, 1, 12, 9, 4, 6, 44, 7, 18, 4, 10, 14, 8, 13, 3, 3, 8, 11, 25, 29, 9, 21, 36, 2, 5, 6, 17, 8, 3, 9, 13, 9, 6, 5, 9, 14, 17, 12

   Construct a frequency distribution for these data, starting with an interval of 0 to 2.

7. A blood sample was taken from 100 smokers between the ages of 45 and 65, and then cholesterol levels were recorded. The cholesterol values were as follows:

199	240	255	181	178	181	287	219	218	256
267	209	199	382	246	234	179	286	273	296
166	171	240	288	198	257	289	224	221	225
239	255	198	175	249	186	243	194	235	274
189	232	192	277	231	211	241	298	230	248
251	238	147	211	196	202	231	240	216	187
223	268	201	239	213	189	185	195	234	290
279	231	203	259	230	164	212	217	238	199
190	199	243	163	134	219	205	186	214	228
235	221	266	244	199	263	301	284	217	223

   a. Determine the range.

   b. Determine the number of class intervals if 20 scores are to be grouped into each interval.

   c. Set the class limits for each interval if the lower limit of the lowest class interval is 130.

   d. Tabulate and tally the scores for each interval, and record the frequency and the cumulative frequency.

8. The blood pressures of patients discharged during the past month with a diagnosis of hypertension were reviewed. Eighty-four cases were found. Only the blood pressures recorded at the time of discharge were to be used in the study. The diastolic pressures (in mm Hg) were as follows:

88	98	78	84	77	81	90	82	75	72	100	92
85	92	77	84	77	82	92	88	74	80	95	90
87	80	83	77	86	80	88	90	79	82	93	88
80	85	96	85	90	84	82	95	88	97	105	80
94	92	88	96	90	88	86	84	90	98	102	88
86	95	97	88	75	82	90	98	84	97	100	84
78	80	82	86	90	85	95	88	86	90	101	88

a. Determine the range.

b. Determine the number of class intervals if the class size is two.

c. Construct a frequency distribution with a class size of two, indicating the score limits, tallying the scores, and using a frequency column and a cumulative frequency column.

9. A study was undertaken to compare cholesterol measurements between 60 vegetarians and 60 non-vegetarians. The study yielded the following data:

a. Vegetarians

180	165	140	170	155	125	175	150	165	200
160	130	170	220	145	165	155	180	160	115
170	165	125	185	160	225	180	140	200	165
130	175	135	150	200	145	165	180	140	170
120	160	165	180	175	170	140	180	170	185
130	215	160	185	130	165	150	230	170	135

b. Non-Vegetarians

105	170	150	190	165	200	125	205	170	195
230	130	240	175	145	180	110	210	185	150
220	190	180	200	245	180	250	210	240	215
165	190	115	220	200	170	160	175	245	125
200	165	195	185	210	145	185	175	210	120
195	180	190	170	230	160	260	200	135	170

Determine:

a. Range (1) Vegetarian
(2) Non-vegetarian
(3) Combination of two groups

b. Construct a separate frequency distribution for the two groups using the same class limits for both groups, with 100 as the midpoint of the lowest class interval.

c. Tabulate and tally the scores and record the frequency and cumulative frequency for each distribution.

C H A P T E R

11

Measures of Central Tendency

CHAPTER OUTLINE

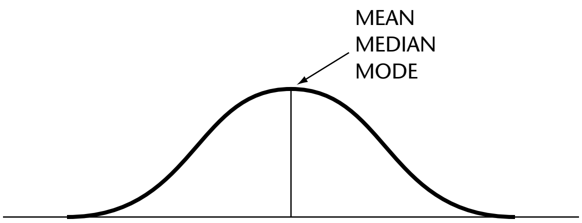
LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Distinguish between the measures of central tendency—mean, median, and mode.
2. Distinguish between a bilaterally symmetrical curve and a skewed curve.
3. Distinguish between a curve skewed to the right vs. a curve skewed to the left.
4. Describe the effect of skewness on the measures of central tendency.
5. Distinguish clearly between a percentile rank and a percentile score.
6. Compare the advantages and weaknesses of percentiles.
7. Determine the score from a frequency distribution for any given percentile.
8. Compute the following:
   a. Mean—arithmetic, weighted, from grouped data
   b. Median
   c. Mode
   d. Percentile from a grouped distribution

Measures of central tendency refer to scores that are most commonly called measures or values that are typical or representative of a set of data. These measures tend to lie near the center of a distribution when the data are arranged according to magnitude, and are therefore commonly referred to as *measures of central tendency*.

Several types of measures are commonly reported, of which the mean, median, and mode are referred to most often. If the frequency distribution is a bilaterally symmetrical, unimodal distribution, then all three measures of central tendency will be equal. Each of these measures has advantages and disadvantages, depending on the data and its intended purpose.



Relationship of measures of central tendency in a normal bell-shaped curve

A. MEAN

1. Arithmetic Mean

The mean (also known as the arithmetic mean) is an arithmetical average. It is computed in the same manner as an average (or averaging) is computed, as mentioned in Chapter 2.

Formula: Sum of All Scores (Σ) Divided by N (Total Number of Scores).

$$\frac{\Sigma \text{ scores}}{N}$$

Example: Seven patients were discharged from the hospital today and the number of days each was hospitalized was reported as 5, 3, 7, 12, 2, 4, 2 days, respectively. The average is the sum of the days (5 + 3 + 7 + 12 + 2 + 4 + 2 = 35) divided by the total number of patients (N = 7), for an average length of stay of 5 days.

SELF-TEST 43: Twenty-five patients were seen in the emergency room yesterday and the number of clinical laboratory and x-ray procedures performed on each patient was recorded as 5, 3, 7, 12, 18, 9, 10, 4, 20, 8, 15, 17, 22, 10, 5, 7, 21, 19, 15, 5, 9, 11, 8, 5, 5. Determine the arithmetic mean correct to the nearest whole number.

2. Weighted Mean

If certain scores (S) are more significant than others, they can be assigned a "weight" (W), depending on their importance.

Formula:

$$\frac{W(\Sigma S1) + W(\Sigma S2) \ldots ; W(\Sigma S_x)}{W1 + W2, \ldots W} = \frac{\Sigma W(S_x)}{\Sigma W_x}$$

Example: A final exam (FE) in a course is weighted three times as much as a quiz (Q), and a regular exam (Ex) is weighted twice as much as a quiz. If three regular exams, five quizzes, and a final exam are administered during a course, then the formula for the weighted mean would be:

$$\frac{3\ \text{FE} + 2\ \text{Ex1} + 2\ \text{Ex2} + 2\ \text{Ex3} + \text{Q1} + \text{Q2} + \text{Q3} + \text{Q4} + \text{Q5}}{3 + 2 + 2 + 2 + 1 + 1 + 1 + 1 + 1}$$

or

$$\frac{3(\text{FE}) + 2(\text{Ex1} + \text{Ex2} + \text{Ex3}) + 1(\text{Q1} + \text{Q2} + \text{Q3} + \text{Q4} + \text{Q5})}{3(1) + 2(3) + 1(5)}$$

SELF-TEST 44: If the percentages for the tests in the previous example are FE = 85, Ex1 = 95, Ex2 = 90, Ex3 = 82, Q1 = 80, Q2 = 88, Q3 = 94, Q4 = 96, Q5 = 73, determine the average grade for the weighted mean correct to two decimal places.

3. Mean Computed from Grouped Data

When data are grouped into a frequency distribution, all the values that fall within a class interval are considered to coincide with the midpoint of the interval. In an interval whose limits are 60 to 62, all the scores within that interval would be considered to be 61 for computation purposes.

Example: A frequency distribution is made of the heights (in centimeters) of 100 males who are participating in a heart study:

Heights (cm)	***Midpoint***	***Frequency***	***Freq. × Midpt.***
175–179	177	2	354
170–174	172	12	2064
165–169	167	25	4175
160–164	162	32	5184
155–159	157	20	3140
150–154	152	9	1368
		100	
		Total:	16,285

The mean is determined by dividing the total of all frequencies multiplied by their respective interval midpoints (16,285) by the total number (N) in the distribution (N = 100 in this distribution). The resultant mean or average height, in centimeters, of 100 male patients in the heart study is 162.85 cm (16,285 divided by 100).

SELF-TEST 45: A frequency distribution is constructed of the ages of patients at the time of death, as follows:

Age	*Midpoint*	*Frequency*	*Freq. × Midpt.*
90–104	97	4	
75–89	82	29	
60–74	67	25	
45–59	52	12	
30–44	37	7	
15–29	22	5	
0–14	7	8	

Determine: Mean age at the time of death for the above patients correct to the nearest whole number.

B. MEDIAN

The median is the middle score of a distribution when the scores are arranged in order of magnitude (from high to low, or low to high). It is the midpoint of a distribution, or the point above which 50% of the scores lie and below which the other 50% lie.

Formula: A. If N Is *Odd*—the Median Is the Middle Score.
B. If N Is *Even*—the Median Is the Average of the Two Middle Scores.

Example: Ten patients are seen for glaucoma screening. The intraocular pressures recorded are 14, 18, 20, 16, 24, 28, 10, 15, 21, 12. The scores arranged from high to low are 28, 24, 21, 20, 18, 16, 15, 14, 12, 10. Since ten is an even number, the median falls between the fifth and sixth scores, resulting in a median of 17 (18 + 16 = 34, divided by 2 = 17).

Example: The number of patients undergoing colonoscopy each day during the past week were recorded as 2, 24, 18, 14, 17, 22, 28. The result of arranging the scores in order of magnitude would be 28, 24, 22, 18, 17, 14, 2. Therefore, the median is 18, because the middle score in a distribution of seven numbers is the value of the fourth score.

SELF-TEST 46: Fourteen new cases of cancer were reported during the previous week. At the time of their diagnosis, the ages of the patients were reported to be 18, 35, 50, 64, 88, 49, 75, 28, 61, 59, 47, 77, 66, 48.

Determine: Median correct to one decimal place.

C. MODE

The mode of a set of numbers is the score that occurs with the greatest frequency, that is, it is the most commonly occurring number (score) in the distribution. It is quite possible to have no mode in a distribution. Even if a mode does exist, it may not be unique. A distribution that has one mode is *unimodal*; a distribution that has two modes is *bimodal*. In a truly normal distribution, the mode score is found at the highpoint of the curve and is located in the center of that curve. It also will equal the median and mean in a normal, unimodal, symmetrical curve.

Example: Twenty cases of measles were reported during the past month. The ages of the patients are 12, 14, 18, 17, 20, 21, 9, 19, 22, 20, 19, 16, 21, 23, 21, 18, 10, 20, 21, 19. Since the mode is the score that occurs most often, the mode is 21 (four cases being reported in this age group).

SELF-TEST 47: Prior to the start of class, resting heart rates were recorded for all females who had signed up for a low-impact aerobics program. The rates for the fifteen females, ages 20 to 25, were 73, 77, 80, 83, 73, 82, 75, 73, 77, 84, 76, 81, 75, 79, 70.

Determine:

a. Mode.

b. Median.

c. Mean, correct to the nearest whole number.

D. CURVES OF A FREQUENCY DISTRIBUTION

1. *Bilaterally Symmetrical Curves*

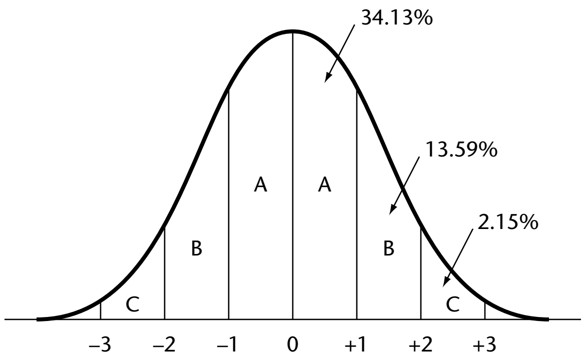
A curve that is bilaterally symmetrical is one that, when folded down the center vertically, is identical on both sides of the fold. In a bilaterally symmetrical curve, all three measures of central tendency (mean, median, mode) will be identical. These three measures will lie at the center of the distribution and thus they are called measures of central tendency.

a. Measures of Variability

Knowing a distribution's measures of central tendency is helpful, but generally it is also important to know whether the data approximates a normal curve, in which case the distribution is said to be similar or homogeneous. A distribution that deviates from the normal curve is dissimilar or heterogeneous. Variability measures have been devised to describe the variation. The most common measures of variation are the range, mean deviation, and standard deviation. The range has been described in the previous chapter. The mean deviation will not be described in this text. The most useful measure is called the standard deviation (represented by "s") and is defined as the square root of the variance of the observations. The variance (s^2) is computed by squaring each deviation from the mean, adding them up, and dividing their sum by one less than n. For further information refer to a statistics text.

b. Bell-Shaped Curve

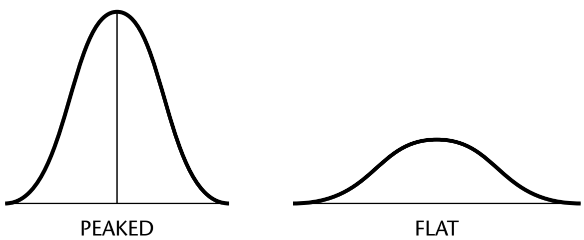
A bell-shaped curve is generally considered the mathematical ideal. It is a curve with a certain proportion and in which a certain percentage of scores lie at certain intervals along the curve. A bell-shaped curve is also referred to as a "normal curve." The bell-shaped curve represents a "normal" distribution. In a normal distribution the data lies within the parameters shown in the diagram below. The baseline numbers indicate the standard deviation and the numbers in sections labeled A, B, and C indicate the percent of scores that fall within each standard deviation. As indicated, 34.13% of scores fall between the mean and +1 standard deviation. In a normal curve approximately 68% of scores fall within one standard deviation (–1 to +1), 95% fall within two standard deviations and 99% lie within three standard deviations.



Normal bell-shaped curve

c. Other Symmetrical Curves

These curves resemble the bell-shaped curve and are symmetrical, but they vary in their ratios of height to width. Some are referred to as "peaked" curves and others as "flat" curves.



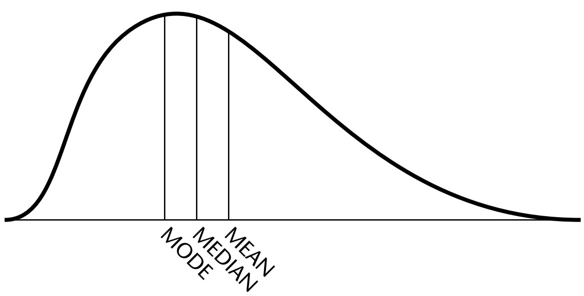
Symmetrical curves

2. Skewed Curves

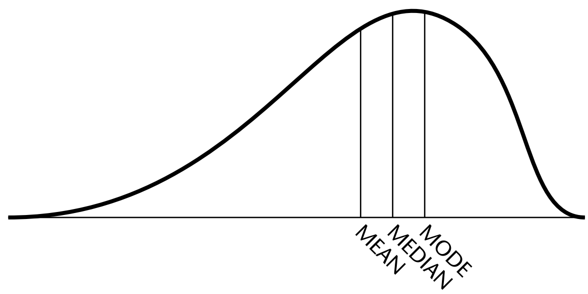
Not all curves are symmetrical in shape. Those that have numbers piled up at the high or low end of the curve are called skewed curves. The direction of skewness refers to the location of the tail rather than to the side on which the piling up of scores occurs.

Skewness also affects the location of the measures of central tendency. Instead of all three measures being representative and identical, the location of each shifts. A curve skewed to the right has its mean shifted to the right (a higher number) and a curve skewed to the left will have its mean shifted to the left.

a. Skewed to the Right (Positive Skewness)



b. Skewed to the Left (Negative Skewness)



Example: The most common example of skewness in hospital statistics occurs when reporting and plotting the lengths of stay of inpatients when one or more of these patients has an exceptionally long stay—possibly a stay of over one year. This would result in a positive skewness (skewed to the right), thus raising the mean for all patients. To illustrate, the following discharges could be reported on a certain date:

Patient	***Admitted***	***Discharged***		***LOS***
Anderson, A.	3-03-89	3-10-89		7
Barker, B.	2-15-89	3-10-89		23
Carlson, C.	3-01-89	3-10-89		9
Daniels, D.	3-07-89	3-10-89		3
Edwards, E.	12-27-88	3-10-89		73
Foster, F.	3-05-89	3-10-89		5
Grant, G.	2-28-89	3-10-89		10
Hughes, H.	3-04-89	3-10-89		6
Ingold, I.	2-26-89	3-10-89		12
Jansen, J.	1-03-88	3-10-89		431
			Total:	579

Mean: 57.9 days (579/10)

Median: 9.5 days (The ten lengths of stay arranged according to magnitude are 431, 73, 23, 12, 10, 9, 7, 6, 5, 3. The middle score is found by computing the average of 10 + 9, or 9.5 days).

c. Effect of Skewness on Measures of Central Tendency

From the illustration above, it is obvious that extreme scores can greatly affect the mean of a distribution. However, it must be pointed out that average lengths of stay are usually computed on more than ten patients. The small number was included here for illustrative purposes only. It was used to show the influence of a nonrepresentative score on the mean of a distribution and the effect that one or more extreme scores can have on measures of central tendency, especially in skewed distributions. The reader should also be made aware that statistics must be taken with a "grain of salt" and that careful judgments must be made when reading or interpreting data.

d. Reporting Measures of Central Tendency from a Skewed Distribution

The term "average" is synonymous with the arithmetic mean but is often incorrectly used to indicate either the mean or median. (The mode is seldom used as a representative measure of central tendency). The mean is not always the best indicator of what the data represents with regard to central tendency. If data are symmetrically distributed, either the mean or the median will be representative of the data. For a series with a large amount of data, the mean is easier to compute, whereas for a small series the median is more easily determined. Median determination is generally very time-consuming, unless a computer is used to more easily sort the data into a sequence by magnitude.

When the series is skewed, the median is the more representative measure of central tendency. As was pointed out in the previous section, even a few cases of extended stays can have a major effect on the computation of the mean. Therefore, the median is normally the average of choice for these types of data. When reporting data from a skewed distribution, it is generally advisable to attach a notation as to why the median was used rather than the mean, or to explain the reason for the higher-than-normal mean.

e. Suggestions for Reporting Averages

If a patient or a group of patients falls at the extremes of a distribution, there are several options to choose from in reporting averages.

(1) Calculate Mean *and Attach a Notation to the Report*

(a) *INCLUDE* THESE *PATIENTS* IN THE CALCULATION

If the distribution is skewed and the mean is computed, a statement of explanation should accompany the report—for instance, that one patient had a length of stay of over one year.

(b) *EXCLUDE* THESE *PATIENTS* IN THE CALCULATION

Do not include the patient who severely skews the distribution, but include a statement of explanation for the exclusion—for example, that one patient had a length of stay of 400 days and was excluded in the computation of the mean.

(C) *CALCULATE BOTH WAYS*

Include and *exclude* these patients. Calculate the mean both by including and excluding the patient in the computation, and attach a note to explain the difference in the two means.

Example: If one patient stayed 431 days (over a year), a report might state that the average (mean) length of stay for all patients was 44.8 days, but that one patient had a length of stay of 431 days. By excluding that patient, the mean length of stay for all patients was 6.7 days.

(2) Calculate Median *and Attach a Notation to the Report*

Explain in the notation that one patient had an extended stay of 431 days and, for that reason, the median was chosen as most representative of the average length of stay of the hospitalized patients.

f. *Additional Points*

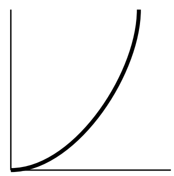
The median is the more representative measure of central tendency when a distribution is skewed. The few extremes in the tail of a distribution do affect the mean more than the median. It should be pointed out that this applies primarily to the acute-care hospital and not to extended-care sections of a hospital, because the lengths of stay of these patients would routinely be longer. When a small number of patients have exceptionally long lengths of stay, the true representative average of the majority of patients is distorted.

The major disadvantage of calculating the median is that it can be time-consuming. Manually arranging numbers in numerical order, especially a large number of them, takes far too long to be practical. However, since computers are now readily available in virtually every health care facility, this task becomes easily achievable through the use of the sorting and calculating capabilities of the computer. Remember that a notation explaining the effect or use of a measure of central tendency should accompany the report.

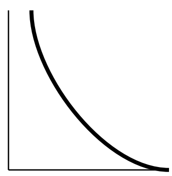
3. Other Curves

Shown below are other types of curves that may be encountered in graphical representations of data. They are included here for reference purposes only.

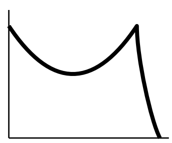
a. J-Shaped



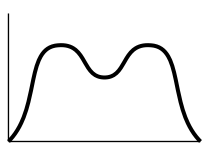
b. Reverse J-Shaped



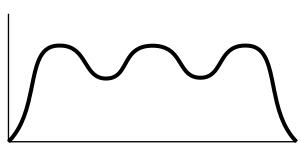
c. U-Shaped



d. Bimodal



e. Multimodal



E. RANKS/QUARTILES/DECILES/CENTILES/PERCENTILES

It is not at all uncommon for an individual to be ranked in relation to other members of a group. Everyone has at one time or another been told they ranked, for example, tenth out of 30 participants who took an exam, or came in tenth out of a field of 30 contestants in a race, and so on. Most people are also familiar with a percentile ranking, such as placing in the top 10% of a class or group (or in the lower 10%).

1. TERMS

a. Rank

Rank indicates relative status in a group. The rank of a score indicates its position in a series when all scores have been arranged in order of magnitude. A rank of 30, for example, indicates that the score is 30th from the top (or from the bottom) when all scores have been arranged in order of magnitude.

The meaningfulness of any designated rank depends upon the number of scores in the series or distribution. To rank 30th in a group of 50 is not the same as ranking 30th in a group of 100 or 30th in a group of 30. For this reason, ranks are more appropriately expressed in more relative terms as percentiles.

b. Quartiles

Data arranged in magnitude can be divided into subparts. The median divides the distribution into two equal parts. By extending this concept, the distribution could be broken into four equal parts. Each of these four parts is called a quartile—the first quartile extends to the 1/4 mark, the second quartile to the 1/2 point (median or middle), and the third quartile extends to the 3/4 point of the distribution.

There are three quartile designations (first, second, and third) which correspond to the 25th, 50th, and 75th percentiles. The second quartile is the 50th percentile, which is also the median or midpoint of the distribution.

c. Deciles

Similarly, the data set can be divided into ten equal parts called deciles. The first decile includes 1/10 or 10% of the data in the distribution; the second decile another tenth (to the 20% mark); and so on. The fifth decile corresponds to the second quartile, or median.

There are ten deciles: 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, 90th, 100th. The 50th decile is the 50th quartile and the median of the distribution.

d. Centiles/Percentiles

Percentiles divide the distribution into 100 equal segments. The first decile is the 10th percentile; the first quartile is the 25th percentile, etc. Percentile rank of a given score in a distribution is the percentage of measures in the whole distribution that are lower than the given score. When a person scores at the 90th percentile, it indicates that the score exceeds 90% of all scores of a set of observations and is exceeded by only 10%. The 50th percentile is the median of the distribution.

e. Percentile Rank

The percentile rank is the percentile for a specific score. For example, someone who scores a 67 on a test may rank at the 90th percentile. However, a score of 15 on another test may also be ranked at the 90th percentile.

f. Percentile Score

The percentile score is the score that one had to attain to reach a specific percentile. For example, to rank at the 90th percentile, an individual may have needed a score of 67.

2. Percentages/Percentiles

a. Importance of Percentiles

A raw score reported as 43 may not be meaningful to the person who achieved it. If, in addition, the person was told that this score placed him/her at the 85th percentile and that out of all those who took the test only 15% got a higher score, the person would have a better understanding as to his/her test performance in relationship to the entire group.

Example: A group of arthritic patients is undergoing daily range-of-motion exercises in the physical therapy department. One test involves standing upright and bending forward, in an attempt to touch the toes. Scores are recorded to the nearest half-inch, and are based on how close the fingers come to touching the floor. If 60% get to within two inches of the floor, any person who attains this level of achievement has a better indication of how he/she did compared to others in the group.

b. Weakness of Percentiles

Percentile scores are not equally divided up and down a percentile scale. If ten score points separate the 70th and 80th percentile, this does *not* mean that ten score points separate each decile level, because scores often tend to be clustered near the middle, with less of a spread within this range. Special statistical treatment is required to figure specific scores from a percentile score.

In percentiles:

(1) The number of scores between each percentile is equal.
(2) The score ranges between percentiles may be unequal.

c. Cumulative Frequency Related to Percentiles

The calculation of a cumulative frequency was discussed in the chapter on frequency distributions. It is computed in the same manner here—by adding each frequency to the previous frequency and accumulating frequencies from one end of the frequency distribution to the other. Each row should be a total of all the frequencies up to that row. Remember that it is most common to cumulate from the bottom to the top, but it is also possible to cumulate from the top downward.

d. Computing Any Given Percentile

(1) Ungrouped frequency distribution

In an ungrouped distribution in which the scores are in rank order a given percentile, decile or quartile is determined by multiplying the percentile percentage (for example 10% for the tenth percentile) by the total number of scores (N) in the distribution. Then by counting up from the bottom the desired number of scores, the percentile score can be ascertained. If there are 40 scores in a distribution and the first decile score is desired, multiplying 40 by .10 results in 4, indicating that the fourth score from the bottom of the distribution represents the first decile score. If the 50th percentile score is desired and N is an even number (as with an N of 40) the score lies between the two middle scores. If N is an odd number, the 50th percentile is the middle score.

(2) *Grouped frequency distribution*

For illustrative purposes, the frequency distribution of the final test scores at Studious State University in the previous chapter will be used (*see* page 179). A total of 100 scores were recorded, thus N = 100. To find the score corresponding to the first decile, the tenth score is desired (10% of 100 is 10). In the grouped distribution it is noted that the tenth score lies in the fourth interval (60–62) in which the frequency is 9. Four scores lie below that interval (the cf just below the fourth interval is 4), so the sixth score (subtracting 4 from 10) out of a frequency of 9 is the representative score. To compute the percentile score:

(a) *Multiply* percentile by N (10% × 100 = 10).
(b) *Subtract* this number (10) from the cumulative frequency next below (4) resulting in a difference of 6.
(c) *Divide* the difference (6) by the frequency within the interval within which the score lies (9), resulting in a quotient of 6/9 or 2/3.
(d) *Multiply* the quotient (2/3) by the interval size (3) with a result of 2 (2/3 × 3 = 2)
(e) *Add* this result (2) to the lower real limit of the interval (59.5) for a sum of 61.5 or 62, correct to the nearest whole number.

Therefore, the score for the tenth percentile is 62.

Example: Using the same grouped frequency distribution, the process above will be repeated for determining the first quartile score.

(1) Multiply: (25% × 100 = 25).
(2) Subtract: (25 – 24 = 1) (24 is the cf just below the interval in which the 25th score lies).
(3) Divide: Difference divided by f (1/6).
(4) Multiply by interval size: (1/6 × 3 = ½ = 0.5).
(5) Add to real lower limit: (68.5 + 0.5 = 69).

Therefore a student who scored a 69 on the final exam scored at the 25th percentile or first quartile, meaning that 25% of those taking the exam got a lower score and 75% received a higher score.

Short cut: Once the basic computation is understood, the process can be streamlined as follows, using the 6th decile for illustrative purposes.
6th Decile = Lower limit + difference/f × interval size

D6 = 77.5 + (7/10 × 3) = 77.5 + 21/10 = 77.5 + 2.1 = 79.6 = 80

Therefore, the sixth decile is represented by a score of 80 on the exam.

SELF-TEST 48: Using the same grouped distribution, determine the following:

a. Eighth decile score

b. Third quartile score

c. Ninth decile score

d. 55th percentile score

F. SUMMARY

1. Averages tend to lie near the center of a distribution and are commonly referred to as measures of central tendency. The mean, median, and mode are called measures of central tendency, but only the arithmetic mean is an average..
   a. Mean
      (1) The arithmetic mean is the arithmetic average of the distribution.
      (2) A weighted mean is used if certain components are more important than others.
      (3) To compute the mean of grouped data, the midpoint of the score limits of each interval is used.
   b. The median is the middle score of a distribution when scores are arranged in order of magnitude.
   c. The mode is the most frequently occurring score.
2. A frequency distribution can be plotted as a curve. Curves may be symmetrical or skewed. The bell-shaped curve is also called a normal curve. Skewed curves are either skewed to the right or left (also referred to as positively or negatively skewed).
3. Skewed distributions affect measures of central tendency. The median is more representative of scores in a skewed distribution than is the mean.
4. A rank indicates relative status within a group.
5. Quartiles, deciles, and percentiles divide a distribution into subparts.
6. The percentile rank and percentile scores are identical.
7. Percentiles and percentages have strengths and weaknesses that should be considered before percentiles and percentages are used.
8. Percentiles can be determined from a grouped or ungrouped frequency distribution.

G. CHAPTER 11 TEST

Note: Where computations are called for, answers should be correct to *two* decimal places.

1. Given the series: 85, 87, 90, 94, 96, 97, 97, 98, 99
   Determine:
   a. Median.
   b. Mean to the nearest whole number.
   c. Mode.
2. An index is to be computed using the following weights: resting diastolic pressure, 3; resting heart rate, 2; serum cholesterol, 1. Readings are taken weekly for six weeks and then averaged for the period. A patient's average readings are as follows: diastolic pressure, 82; heart rate, 62; cholesterol, 164. What is the weighted mean?
3. Which measure of central tendency is largest if a frequency distribution is skewed to the right?
4. Which measure of central tendency is most representative of the scores in the distribution if the distribution is skewed?

5. The lengths of stay are recorded for patients admitted with coded diagnoses for poisoning or injury. They are as follows:

13	11	3	12	2	10	17	24	20	1	35	5	5	3	31
30	39	1	2	6	1	1	10	2	21	11	5	3	1	2
17	6	8	5	1	2	4	4	6	19	2	5	34	2	4
2	6	9	61	40	26	21	14	8	4	13	17	51	15	56
6	2	33	14	3	40	24	3	5	8	18	5	31	8	21
14	5	26	10	6	57	51	2	22	8	6				

Determine:

a. Range

b. Value of N.

c. Mean from ungrouped data.

d. Median from ungrouped data.

e. Mode from ungrouped data.

f. Mean, using a grouped distribution beginning with a lower interval of 1 to 4.

g. Mean using a grouped distribution beginning with a lower interval of 0 to 4.

h. Length of stay score at the
   (1) first quartile.

   (2) third quartile.

   (3) 90th percentile.

   (4) sixth decile.

   (5) second decile.

i. Percentage of scores that fall below a length of stay of 12 days.

j. Percentage of scores that fall between one through four days.

6. State the end (either right or left) at which scores tend to pile up with a

   a. positively skewed distribution.

   b. distribution skewed to the right.

7. Indicate the respective location for the mean, median, and mode for a negatively skewed distribution.

8. The reaction times of an individual to certain stimuli were measured by a psychologist to be 0.53, 0.46, 0.50, 0.49, 0.52, 0.53, 0.44, and 0.55 seconds, respectively. Determine the mean reaction time of the individual to the stimuli.

9. A set of numbers consists of six 6's, seven 7's, eight 8's, nine 9's, and ten 10's. Determine the mean of these numbers.

10. A student in anatomy received the following grades:

Lab	71
Lecture	78
Recitation	89

    a. If the weights accorded these grades are 2, 4, 5, respectively, what is the average grade?

    b. What is the average grade if equal weights are assigned?

11. Three instructors of medical terminology reported mean exam grades of 75, 82, and 84 in their classes. The classes consisted of 32, 25, and 17 students, respectively. Determine the mean grade for all the classes.

CHAPTER

12

Data Presentation

CHAPTER OUTLINE

A. Tables
   1. Basic Table Format
   2. Table Elements
   3. Designing a Table
   4. Examples

B. Plotting a Frequency Distribution
   1. Axes
   2. Vertical Scale
   3. Scale Proportion

C. Graphic Presentation
   1. General Rules
   2. Types of Graphs
   3. Frequency Polygon
   4. Histogram and Frequency Polygon–Additional Information

D. Summary

E. Chapter 12 Test

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Indicate the appropriate types of graphs that can be used for displaying quantitative and qualitative data.
2. Distinguish the type of data presentation that is appropriate for different situations.
3. Construct the following:
   a. Histogram
   b. Frequency polygon
   c. Bar graph/Bar chart
   d. Line graph
   e. Pie graph
   f. Pictograph/Pictogram
   g. Comparison graph–both bar graph and line graph.
4. Distinguish among and interpret various kinds of graphs.

Once data collection is completed and the data analyzed via appropriate statistical techniques, the results need to be communicated for the data to be meaningful. The analysis of the data is generally communicated via a report and/or graphic representation. Sometimes data is collected for one's own use (such as recording the number of lines transcribed by each transcriptionist per day) but often it is shared with another person or group (such as the hospital administrator or outside agency) or the results are reported in a journal or presented at a meeting or conference. The likelihood that statistical data will attract a reader's attention is greatly enhanced if data is displayed in graphic or tabular form. The type of presentation is often dependent on the target audience that the presenter hopes to reach. The type of data presentation, whether a table or graph, is also often dependent on the reader's background, knowledge, and degree of sophistication in reading and interpreting data. Data is displayed or presented in two major forms: (1) tables and (2) graphs.

Tables are used to present large amounts of text-based quantitative data via a matrix of columns and rows with associated headings and labels to identify the data presented in the table. Tables allow an audience to easily compare quantitative values with similar qualitative values. A well-designed table allows the audience to quickly identify similarities, differences, and trends that the data represents.

Tables can range from being simple to complex. A simple format is more effective if the table is to be used for a presentation at a meeting or a conference. A complex table, presented on such an occasion, may result in the audience concentrating on attempting to understand the table rather than on the point the presenter is trying to make. If, however, a presenter needs to present a large amount of data in a minimal amount of space, a more complex, but well-designed table may be more effective. This text will focus on developing simple tables, though the design process is the same whether the table is simple or complex. A table should be self-explanatory. If a table were removed from its accompanying text it should still convey all the information necessary for the reader to clearly understand the data.

Charts and graphs are a more visual form of presentation of data; they are pictorial presentations of the analyzed data. The proper charts and graphs enable an audience to more quickly assimilate and understand the material being presented.

A. TABLES

The following guidelines allow the presenter to create a table that is self-explanatory.

1. Basic Table Format

TABLE 1

Table Header

Series Heading	*Major Category*	*Major Category*
Series Label	Data	Data
Series Label	Data	Data
Series Label	Data	Data
Series Label	Data	Data

2. Table Elements

a. Table Number. Not all tables require a table number. A table number, such as Table 1 or Table 11.1, should be used, if appropriate and required, to aid the reader in accessing the data.
b. Table Header (Title). A table header is one of the most important components of a table. A well-written table header should clearly answer the following questions.

(1) What does the data represent?

Does the data represent annual hospital discharges, annual death rates by disease category, or newly diagnosed cancers for the year?

(2) What is the source of the data?

Was the data collected at Mountain View Hospital, the State Health Department, or was it compiled from regional tumor registries?

(3) When was the data collected? What time period is represented? The time period is most commonly reported by date, such as 1999 or July through December, 1998.

In addition, codes, abbreviations, acronyms or symbols should be avoided in the table header as these might be misinterpreted by the reader, particularly if the audience is unfamiliar with the codes, abbreviations, acronyms, or symbols. Generally it is best to avoid their use even with a professional audience. If their use is unavoidable, it is important to provide an explanatory footnote.

Examples:

(1) Inappropriate table header.

HOSPITAL DISCHARGE DATA

(2) Appropriate table header.

Table 1 **Annual Hospital Discharges** **By Hospital Service and Third Party Payer** **Anytown Hospital, Anytown, IL, 1999**

c. Headings—Categories and Series. Each heading should clearly state what is being displayed. Again, it is best to avoid codes, abbreviations, acronyms or symbols when labeling the data to prevent misinterpretation.
d. Data. The appropriate data elements are entered in the table.

3. Designing a Table

a. Determine table contents. Before creating a table a presenter needs to decide what data should be presented and how it should be presented. When displaying quantitative data it is helpful to include a row or column to indicate totals. Percentages should be stated as whole numbers and the total should equal 100%. Totals provide a simple method of cross-checking the accuracy of the data in a table.

b. Create table header.
c. Label the headings, both the categories and series.
d. Enter and align the data. Proper data alignment makes a table easier and more appealing to read. There are different standards for text and numbers.
   (1) Text. Text can be right-justified, left-justified, or centered, depending on how the table is formatted.
   (2) Numbers. Numbers should be aligned in relation to the decimal place. Whole numbers most often are right-justified, but decimal numbers must be aligned by the decimal point and have the same number of decimal places.

4. Examples

a.

TABLE 1

PERCENTAGE OF OCCUPANCY (by month)
XYZ HOSPITAL, 1997–1998

Month	*1997*	*1998*
January	85%	78%
February	87%	82%
March	82%	85%
April	79%	86%
May	75%	80%
June	70%	77%
July	75%	72%
August	78%	70%
September	80%	75%
October	82%	72%
November	85%	80%
December	73%	80%

b.

TABLE X

Comparison of
PERCENT OF CIGARETTE SMOKERS
18 years of age or older in the United States by decade

	1970	*1980*	*1990*	*2000*
All persons	42.4	37.1	30.1	24.7
All males	51.9	43.1	32.6	27.0
All females	34.0	32.5	28.2	22.8

c.

TABLE Y

PERCENT OF CURRENT CIGARETTE SMOKERS
18 years of age or older in the United States, 2000

	Males			*Females*		
	All	*White*	*Black*	*All*	*White*	*Black*
18–24	27.8	28.4	14.6	21.8	24.9	8.8
25–34	29.5	29.9	25.1	26.4	27.3	26.7
35–44	31.5	31.2	36.3	27.1	27.0	31.9
45–64	27.1	26.3	33.9	24.0	24.0	27.5
65+	14.9	14.1	28.5	11.5	11.7	13.3

d. In the chapter on frequency distributions, data was presented in tabular form with a score column, tally column, frequency column, and cumulative frequency column. A percentage frequency column and percentage cumulative frequency column may also be added. Using the final test scores from Studious State in Chapter 10, (N = 100), the frequency distribution table reads as follows:

FREQUENCY TABLE OF FINAL EXAM SCORES
ELEMENTARY STATISTICS
STUDIOUS STATE UNIVERSITY
SPRING 1999

Score Limits	*f*	*cf*	*%f*	*%cf*
96–98	4	100	4	100
93–95	8	96	8	96
90–92	4	88	4	88
87–89	6	84	6	84
84–86	8	78	8	78
81–83	7	70	7	70
78–80	10	63	10	63
75–77	13	53	13	53
72–74	10	40	10	40
69–71	6	30	6	30
66–68	6	24	6	24
63–65	5	18	5	18
60–62	9	13	9	13
57–59	3	4	3	4
54–56	0	1	0	1
51–53	1	1	1	1

NOTE:

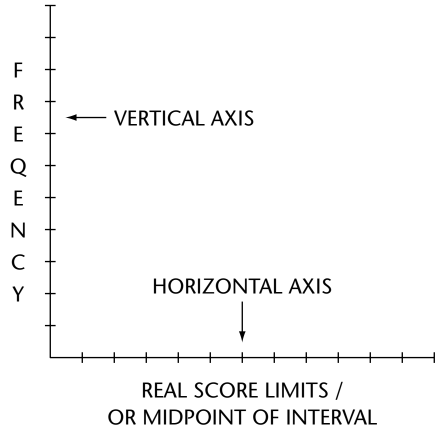
Since there were exactly 100 scores, the percentage frequency and frequency columns are identical, as are the percentage cumulative frequency and cumulative frequency columns. Had N been 80, each frequency would be divided by 80 (N) and multiplied by 100 to determine the frequency percentage, also referred to as relative frequency. The sum of all relative frequencies should be 100%. The cumulative percentage frequency is totaled in the same manner as the cumulative frequency column, summing the percentages from the bottom up. A column indicating the midpoint of each class interval may be included along with a midpoint times frequency column to facilitate computation of a mean from a grouped frequency distribution.

FREQUENCY TABLE
AGE AT INITIAL DIAGNOSIS OF CONGESTIVE HEART FAILURE
XYZ HOSPITAL, 2000

Age Range	*f*	*cf*	*%f*	*%cf*
85+	3	80	3.75	100.00
80–84	7	77	8.75	96.25
75–79	8	70	10.00	87.50
70–74	11	62	13.75	77.50
65–69	15	51	18.75	63.75
60–64	13	36	16.25	45.00
55–59	7	23	8.75	28.75
50–54	5	16	6.25	20.00
45–49	4	11	5.00	13.75
40–44	2	7	2.50	8.75
35–39	2	5	2.50	6.25
30–34	1	3	1.25	3.75
25–29	2	2	2.50	2.50

B. PLOTTING A FREQUENCY DISTRIBUTION

The frequency distribution was introduced in Chapter 10 and individual scores were grouped and consolidated into what is referred to as a "frequency distribution." This same data can be represented in graphic form. Included here are some rules to facilitate the plotting of such a distribution. (The rules are identical to plotting an X, Y chart).



Plotting a frequency distribution

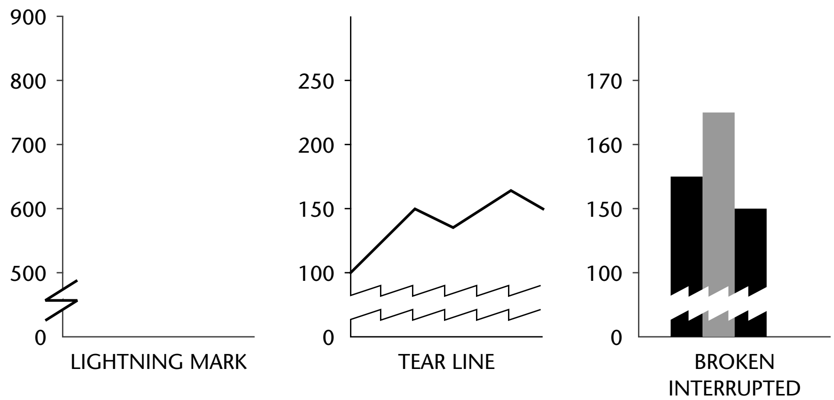
1. Axes

Most graphs have two axes—a *horizontal* axis (x-axis) and a *vertical* axis (Y-axis). As a general rule, when plotting a frequency distribution, one axis represents the score (or class interval) and the other axis the frequency. In the majority of cases,

a. the *horizontal* axis represents the score, score limits, or midpoints of the interval.
b. the *vertical* axis represents the frequency.

2. Vertical Scale

The vertical scale, as mentioned, indicates the frequency of the scores. The scale should begin at zero to avoid misleading the reader. If the data lends itself to a different lower frequency (other than zero), a broken line or other means of interruption should be drawn at the bottom of the vertical axis. This broken line should be employed as well at the bottom of each frequency rectangle to indicate clearly that the "zero frequency" rule was circumvented.



Indicating vertical scale

3. Scale Proportion

The scale of a graph or chart refers to the proportion or distribution of the two axes—the height and width of these axes in relationship to one another. As a general rule, the *height* of the vertical axis should be approximately 3/5 (60%) or 3/4 (75%) the *length* of the horizontal axis.

A graph in which the height exceeds the horizontal length, or otherwise deviates markedly from this proportion, may appear out of proportion with reality. If the graph is being constructed manually, graph paper facilitates plotting and saves construction time. Graphs can be enlarged or reduced on a copying machine to accommodate their intended use, whether within a text or as a visual display.

C. GRAPHIC PRESENTATION

Many types of graphs and charts are employed in presenting statistical data. The choice of graph or chart is dependent upon the nature of the data and the purpose for which the chart or graph is intended. The terms "graph" and "chart" are often used interchangeably, though there are subtle differences in the two types of graphic data presentation techniques. These differences explained in the next chapter; material in this chapter will concentrate on basic graph presentation.

A graph is a pictorial presentation of the relationship between variables. Graphs are designed to help the reader grasp information more quickly and obtain a general picture of the data at a glance. A graph displays data by use of a picture or diagram. Since a graph is a more visual means of presentation than a table, it has a tendency to show relationships more dramatically and catch the eye of the reader. A graph gives a good overview of the essential features of the data. The major advantages of graphics are that they condense data into a form more readily grasped and they facilitate the comprehension of trends that otherwise might be more obscure and uninterpretable. In general, graphs are considered easier to comprehend than tables but often lack the detail which can be presented in a table.

1. General Rules

a. *Use the appropriate graph for the type of data to be presented.* The type of graph to be constructed is dependent on the type of data to be conveyed. Continuous quantitative data (statistical data) are represented by a histogram or frequency polygon, whereas qualitative data is represented by a bar graph or line graph. Line charts show trends over time; pie charts show parts in relation to the whole.
b. *Graphs, like tables, should be self-explanatory.* They should include a descriptive title, labeled axes and a clear indication of the units displayed.
c. *Graphs should be simple and clean in appearance* and should not attempt to overwhelm the reader with so much information that comprehension is difficult.
d. *Color and shading can be used for enhancement.* The use of color or shading can help to convey the meaning of the material being presented. When either color or shading are used to highlight material, it is often necessary to include a key or "legend" to explain the representation.

2. Types of Graphs

As mentioned, the type of graph employed is dependent on the data and its intended purpose. Representative graphs include bar graphs, pie graphs, pictographs, histograms, and frequency polygons.

a. *Statistical Graphs or Graphs of Continuous Data*

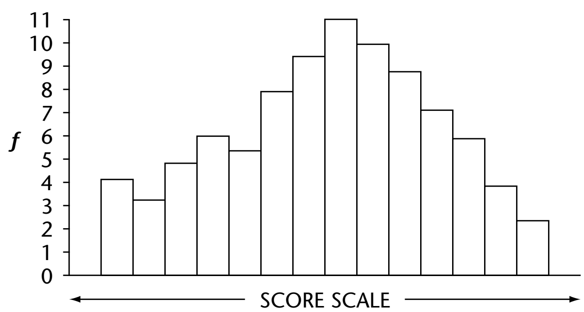
Data plotted in a frequency distribution is continuous data and is displayed via a histogram or frequency polygon. If comparisons are to be made on the same graph, the frequency polygon is the preferred graph. Previously a frequency distribution was plotted of the cholesterol values of a group of vegetarians and non-vegetarians. If a graphical display were to compare the two groups on one graph, the frequency polygon would be the graph of choice.

(1) Histogram

A histogram is probably the most common and simplest of the various graphic forms. A histogram is a pictorial or graphic representation of a frequency distribution or table, in which each frequency is shown by the height of a rectangle erected for each score. The rectangles designate the frequency for each score or class interval in the distribution.

A true histogram presents *quantitative* data (continuous data), never qualitative data. The horizontal axis is composed of the class boundaries or midpoints rather than the score limits. The vertical axis depicts the frequency (designated on the frequency distribution). Rectangles are drawn for each class interval and are laid side-by-side, contiguous to each other, with *no* space between rectangles.

Histogram



b. *Construction of a Histogram*

(1) Lay out the Horizontal and Vertical Axes

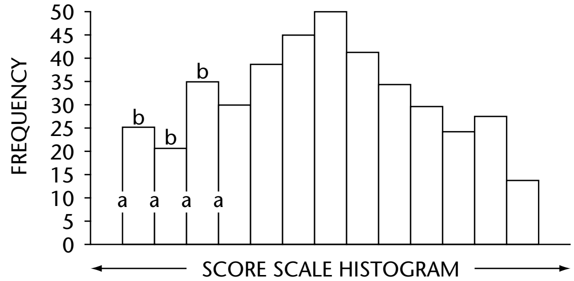
(2) Mark the Axes

Indicate the marks on the vertical axis and the class boundaries along the horizontal axis.

(3) Construct the Rectangles

Rectangles are constructed for each interval of the frequency distribution. Two vertical lines are constructed above each class boundary equal to the height of the class frequency for that interval (see line "a" in diagram below) and a horizontal line or bar ("b" in diagram below) is constructed along the top of each class interval, joining the two vertical lines to form a rectangle.

Continue constructing a rectangle for each additional class interval in the distribution until all intervals are represented and the histogram is complete.

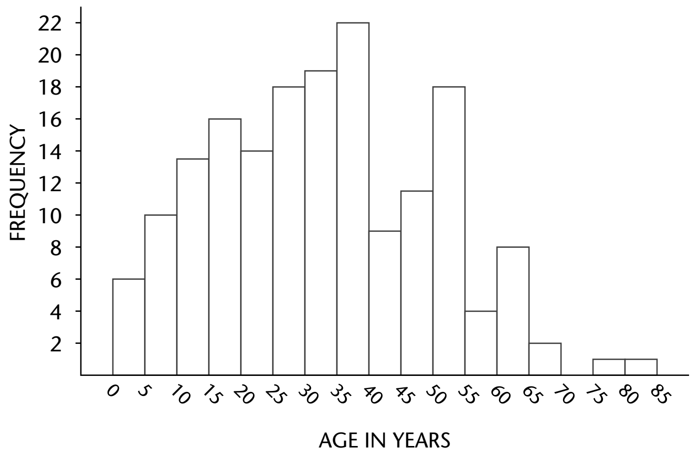


(4) *Label the Axes*

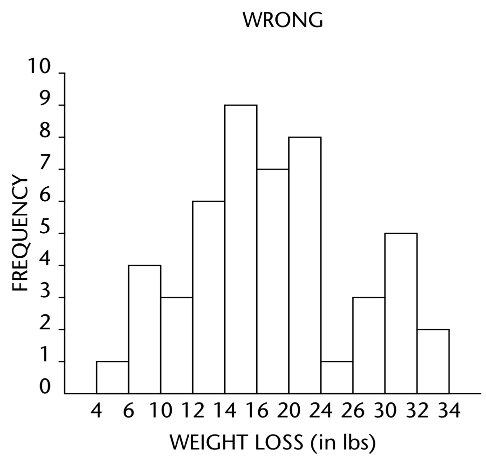
Indicate what the data on each axis represents.

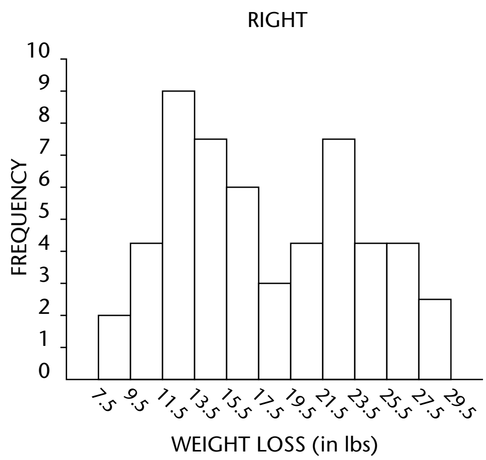
(5) *Title the Histogram*

Traumatic hyphema diagnoses
ABC Clinic
(March 1999)



The area under each rectangle also corresponds to the percentage of total scores. To get a proper representation of data, it is imperative that the size of class intervals be identical. A histogram will be distorted if unequal class interval sizes are used and this distortion must be taken into account when constructing a histogram with unequal class intervals.





c. ***Summary for Constructing a Histogram***

(1) The vertical scale should begin at zero.
(2) Use correct proportion between the scales—the height of the vertical axis should be approximately 3/5 or 3/4 the length of the horizontal axis.
(3) Unequal class intervals should generally be avoided in constructing a histogram. Histograms are most commonly used for class intervals of equal size, because the area of each rectangle is proportional to the class frequency. If class intervals are unequal in size, the heights or widths must be adjusted. How this adjustment is done is not discussed in this text.
(4) Generally, the horizontal axis represents the class boundaries, with the midpoint of the interval in the center. The vertical axis generally represents the frequency.

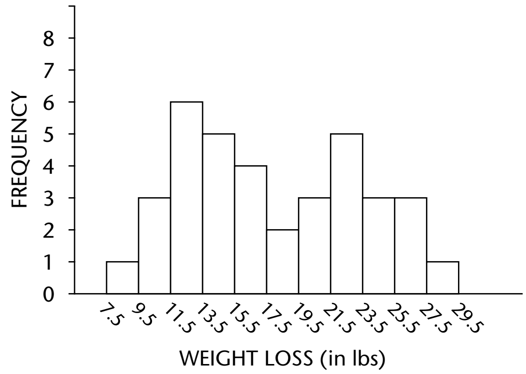
Example: Thirty-six morbidly obese people were put on a controlled liquid diet for a month. Their weights were recorded at the beginning of the month and at the end of the month, and the difference between the initial weight and the final weight was recorded to the nearest pound. The number of pounds lost is as follows: 20, 12, 16, 24, 8, 22, 13, 22, 23, 22, 12, 15, 18, 14, 18, 10, 15, 27, 13, 26, 21, 14, 27, 11, 25, 22, 13, 17, 13, 11, 15, 17, 24, 17, 28, 20.

First a frequency distribution is constructed and then the histogram is graphed. Using a class interval size of two the frequency distribution would read:

Class Boundaries	*Midpoint*	*Frequency*
27.5 to 29.4	28.5	1
25.5 to 27.4	26.5	3
23.5 to 25.4	24.5	3
21.5 to 23.4	22.5	5
19.5 to 21.4	20.5	3
17.5 to 19.4	18.5	2
15.5 to 17.4	16.5	4
13.5 to 15.4	14.5	5
11.5 to 13.4	12.5	6
9.5 to 11.4	10.5	3
7.5 to 9.4	8.5	1

The histogram based on the above data would appear as follows:

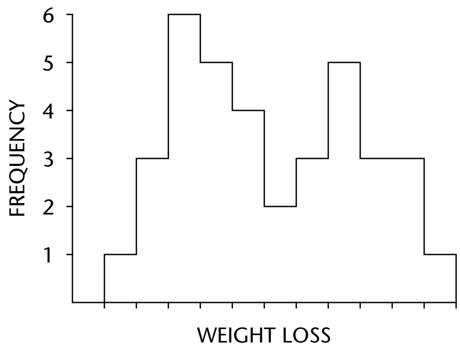
One-month weight loss on liquid diet (by a group of morbidly obese patients)

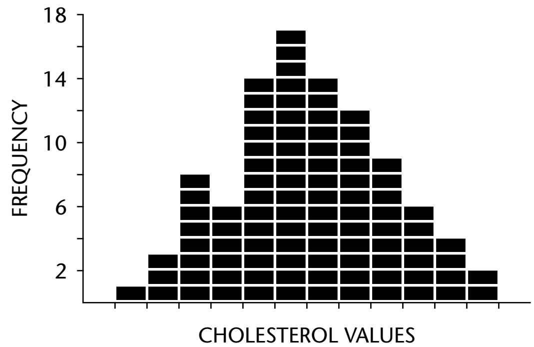


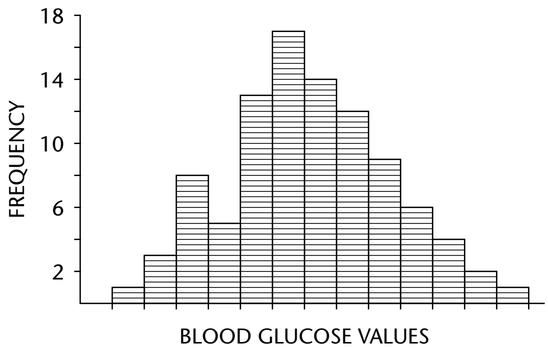
SELF-TEST 49: From the following frequency distribution, construct a histogram:

Systolic Blood Pressure	*Midpoint*	*Frequency*
89.5 to 109.4	99.5	16
109.5 to 129.4	119.5	37
129.5 to 149.4	139.5	29
149.5 to 169.4	159.5	12
169.5 to 189.4	179.5	4
189.5 to 209.4	199.5	2

d. Variations in Histogram Construction







3. *Frequency Polygon*

A frequency polygon is similar to a histogram, in that it uses the same axes (horizontal and vertical) as the histogram and also is a graphic means of displaying continuous data. The plotting or graphic presentation differs, however, because a dot is placed at the frequency level on the vertical scale at the midpoint of the class interval. Instead of drawing rectangles, these points are connected by a straight line that is drawn from one point to the next point. To bring the figure to the baseline, dots are placed at the zero frequency level at the two ends of the distribution, extending the line to the horizontal at the midpoint of the lowest and highest interval.

a. *Advantage of Frequency Polygon*

The major advantage becomes apparent when similar data are compared. Frequency polygons can be superimposed on each other, which allows comparisons between the two data fields to be more readily made.

b. *When to Use*

Frequency polygons should only be used to graph quantitative (numerical) data and not qualitative data.

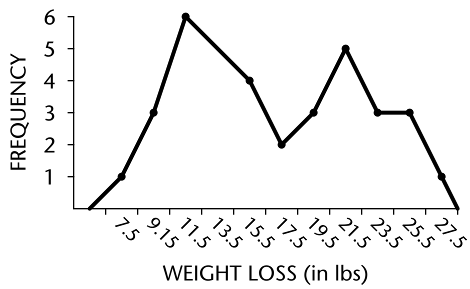
c. *Construction of a Frequency Polygon*

The frequency polygon is based on exactly the same information as is used to construct a histogram, but it displays quantitative data in a different graphic form. The frequency polygon may be considered a "connect-the-dots" diagram, because it joins adjacent frequencies by connecting straight lines.

To close the polygon at each end, a line is drawn to the baseline at the two ends of the distribution at the midpoint of the two intervals with frequencies of zero. At the upper end, the line extends from the frequency level of the upper interval to the horizontal (zero frequency level) where the next outlying interval occurs. This line is also extended to the baseline at the outlying lower level.

Example: Using the data from the frequency distribution referred to under the histogram example (Weight Loss of Morbidly Obese), the frequency polygon would be plotted as follows:

One-month weight loss on liquid diet
(by a group of morbidly obese patients)



Plotting a frequency distribution

4. Histogram and Frequency Polygon—Additional Information

a. Comparisons

(1) Similarities

(a) Same axes—horizontal and vertical—apply.

(b) Midpoints of class intervals are plotted.

(c) Graph the same type of data.

(2) Differences

(a) Points are plotted and connected rather than rectangles drawn to represent frequencies.

(b) A line is drawn to the baseline at the two ends to close a polygon.

b. Supplementary Suggestions for Construction

(1) Limits

Remember that the sides of the rectangles in a histogram are constructed along the class boundaries (real limits) or above the midpoint of the interval, whereas in a frequency polygon the frequency is indicated above the midpoint of the interval.

(2) Title

Any graph or figure should always carry a complete, clear, and concise title. The title should completely identify the data represented. References to a graph should be made in the corresponding textual material, but the graph should *not* be dependent on any accompanying textual description.

(3) Labeling the Axes

Vertical and horizontal axes should be clearly labeled and the scale units indicated.

c. Superimposing Figures

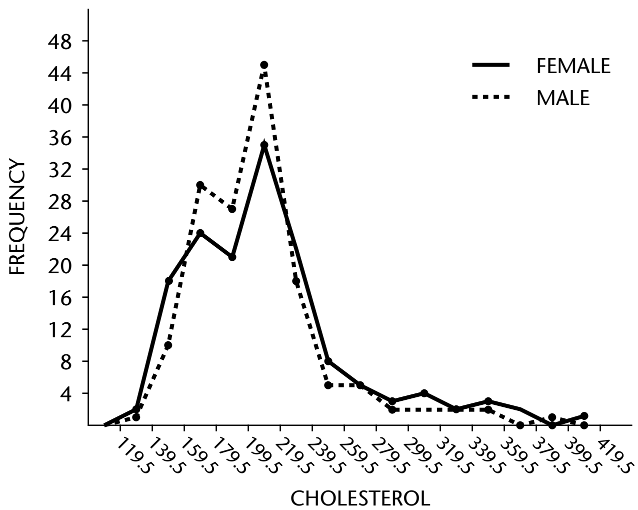
Data comparisons can be displayed by superimposing two frequency polygons on the same chart or graph. If two or more figures are drawn on the same chart, each should be distinguished differently. This could be done through the use of different colors for each figure or a variation in the typeset line drawn (solid, broken, dotted, etc.).

A legend should be prominently placed (in the upper corner or another convenient space) to indicate the meaning of each of these variations to the reader.

Example of a Superimposed Frequency Polygon: A comparison is to be made of the cholesterol levels of a group of 150 males and 150 females between the ages of 20 and 100. Included below is a frequency distribution of the cholesterol values, in which the scores ranged from a high of 415 to a low of 135. The distribution is as follows:

Cholesterol Values	*Midpoint*	*Male Frequency*	*Female Frequency*
399.5 to 419.4	409.5	1	0
379.5 to 399.4	389.5	0	1
359.5 to 379.4	369.5	2	0
339.5 to 359.4	349.5	3	2
319.5 to 339.4	329.5	2	2
299.5 to 319.4	309.5	4	2
279.5 to 299.4	289.5	3	2
259.5 to 279.4	269.5	5	5
239.5 to 259.4	249.5	8	5
219.5 to 239.4	229.5	22	18
199.5 to 219.4	209.5	35	45
179.5 to 199.4	189.5	21	27
159.5 to 179.4	169.5	24	30
139.5 to 159.4	149.5	18	10
119.5 to 139.4	129.5	2	1

Male and female cholesterol levels (ages 20–100)



Frequency polygon

SELF-TEST 50: Construct a frequency polygon for the data (systolic blood pressure) in the Self-Test 49 for the histogram on page 211.

d. *Graphing Other Data*

Qualitative data and discrete quantitative data are best displayed in a bar graph, line graph, or pie graph. The bar graph or bar chart is similar to the histogram. The major difference is in the type of data displayed and the spacing provided between bars to indicate no continuity is intended. The line graph is similar in appearance to the frequency polygon but the line, connecting the dots at the frequency level, does not begin and end at the baseline. The pie graph represents percentages with the data converted to a percentage of the whole.

(1) Bar Graph

A bar graph is particularly useful for displaying data such as sex, ethnicity, occupation, and treatment categories. The bar graph may also compare data which cannot be measured in numbers such as occupation or race. There are no score limits along the horizontal axis. Data such as the number of cigarettes smoked per day, the number of new cancers diagnosed in the past year, and the number of deaths per month for an entire year are examples of data which can be conveniently graphed using a bar graph.

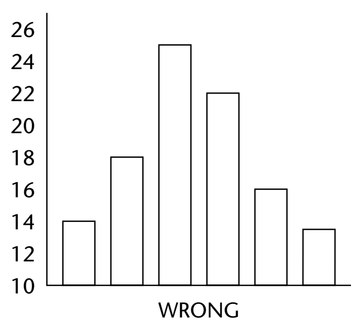
(a) CONSTRUCTION OF A BAR GRAPH

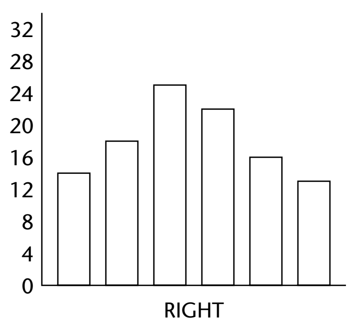
Construction of the axes is similar to that used for the axes of the histogram. The horizontal axis consists of the various categories—such as modalities of treatment. The vertical axis again depicts the frequency or relative frequency. In this graph, however, the order of the categories along the horizontal axis may vary. It may be arranged:

(1) alphabetically;
(2) by frequency within a category; or
(3) by using some other rational basis.

The height of each bar (rectangle) is based on the frequency for that category. Space is left between bars to alert the reader to the fact that no continuity is indicated and to reduce the possibility of implying that there is continuity.

The bars should be of equal width and stand apart from one another, as mentioned. Also, a broken line (or other means of interruption) should be used when the vertical axis does *not* begin at zero, as previously mentioned in the section on “Vertical Scale.”



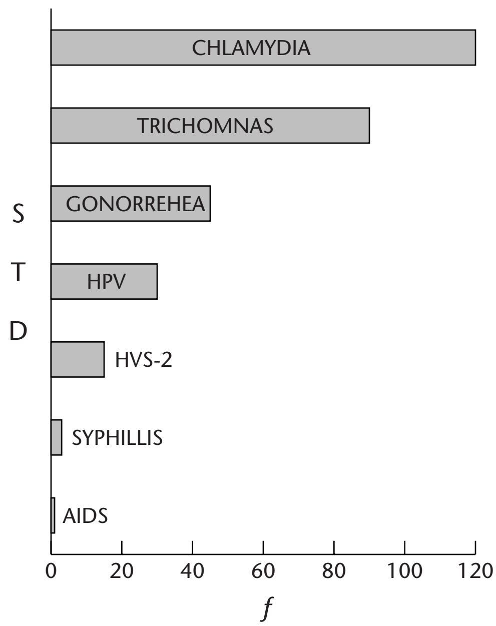


Example: A health department's records indicate the following number of reported and confirmed cases of sexually transmitted diseases during 1998:

Chlamydia	120	HSV-2	15
Trichomonas	90	Syphilis	3
Gonorrhea	45	AIDS	1
HPV	30		

A bar graph of these data would take the following form:

Sexually transmitted diseases
Health Department, 1998



Horizontal bar graph

SELF-TEST 51: A hospital's records over the past decade revealed that the following number of patients have been treated for ectopic pregnancies:

1990	20	1995	31
1991	26	1996	28
1992	24	1997	27
1993	28	1998	32
1994	30	1999	31

Construct a bar graph using these data.

(2) *Line Graph*

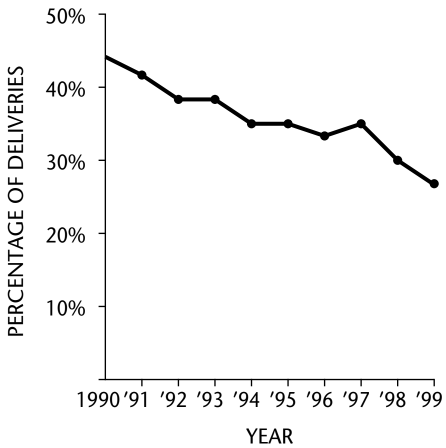
A line graph is to a bar graph what a frequency polygon is to a histogram. In other words, if the rectangle was replaced by a dot at the height of each frequency, and a line was drawn connecting these dots consecutively, the result would be a line graph.

Example: A hospital's records over the past decade showed the following yearly Cesarean section rates:

1990	44%	1995	35%
1991	42%	1996	33%
1992	38%	1997	35%
1993	38%	1998	30%
1994	35%	1999	27%

A line graph of these data would show the decrease as follows:

Cesarean section rates



Line graph

SELF-TEST 52: A hospital's records indicated the number of females who delivered during the past ten years who were under the age of 16 at the time of delivery. Construct a line graph displaying these data:

1990	68	1995	166
1991	84	1996	182
1992	101	1997	203
1993	122	1998	210
1994	147	1999	241

(3) Pie Graph

Another common means of displaying data is a pie chart. A circle is divided into wedges in the same way that a pie is cut into slices for serving. Each wedge of the pie corresponds to the percentage of frequency of the distribution. Pie charts are useful in conveying data that consists of a small number of categories.

(a) CONSTRUCTION OF A PIE GRAPH

(1) Find Percentage of Cases

To find the percentage divide the frequency by N and multiply by 100. If 100 patients were diagnosed with cancer and ten of those were breast cancers, then 10% (10 divided by 100 multiplied by 100 equals 10%) were breast cancers.

(2) Multiply Percentage by 360 Degrees

There are 360 degrees in a full circle and by multiplying 360 by the percentage, the size of each angle can be determined. To divide the circle (or pie) to represent the breast cancer patients, 36 degrees would be marked off from the radius of the circle (.10 times 360 equals 36 degrees). Continue in this manner until the entire pie or circle is divided.

(3) Label and Title the Diagram

As with other graphs, the title should be clearly indicated and the data dated. It is also helpful to include the percentages within each wedge.

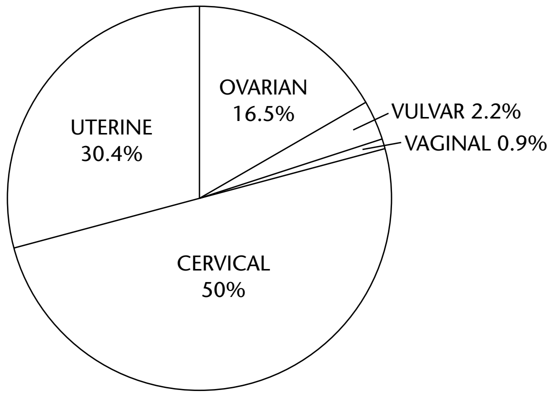
As with other graphs, be sure to clearly title the subject matter, to include dates if needed, and to indicate the percentages within each wedge and what the wedge represents.

Example: A tumor registrar has discovered the following percentages for female cancers:

Cervical	50.0%	×	360°	=	180°
Uterine	30.4%	×	360°	=	109.44°
Ovarian	16.5%	×	360°	=	59.4°
Vulvar	2.2%	×	360°	=	7.92°
Vaginal	0.9%	×	360°	=	3.24°
Totals	100%				360.00°

A pie chart of these data is as follows:

Female cancer percentages



Pie chart

SELF-TEST 53: A hospital reports that, of the patients admitted over the age of 14 during the past year, the following percentages were reported regarding the patient's marital status at the time of admission to the hospital:

Single (never married)	18.8%
Married	55.2%
Widowed	10.5%
Divorced	15.5%

Develop a pie chart using these data.

(4) *Pictograph/Pictogram*

Pictographs make use of pictures in their display of data. A common representative picture is a stick figure that represents a certain number of people. This is often used to present statistical data in a manner that is appealing to the general public. Pictograms often show great originality and ingenuity on the part of the presenter and, because they are eye-catching, can often draw the reader's attention to the data being displayed.

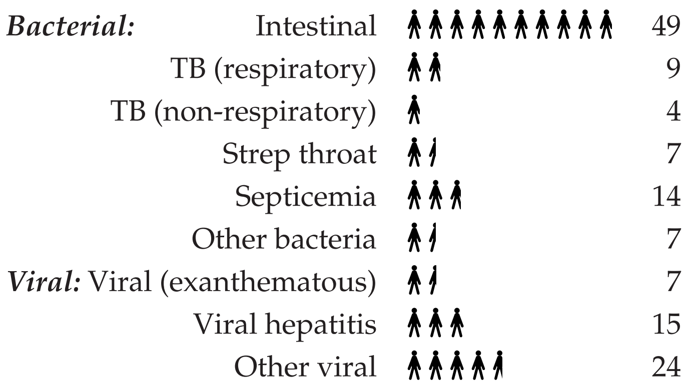
Example: Hospital records indicate that a total of 125 patients were admitted and given inpatient treatment for an infectious disease during the past year. The infections included the following:

Bacterial Infection	***Frequency***
Intestinal	49
TB (respiratory)	9
TB (non-respiratory)	4
Strep throat	7
Septicemia	14
Other bacteria	7

Viral Infection	***Frequency***
Exanthematous	7
Hepatitis	15
Other viral	24

The data are depicted below in pictograph form.

Infections treated on an inpatient basis, 1999
(each figure represents 5 people)



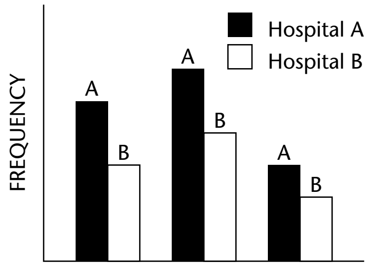
e. *Comparison Graphs*

Occasionally, two or more sets of data are plotted on the same graph using the same axes. This method is most commonly employed when comparisons are to be shown, especially between two related items. For example, one might choose to compare one hospital with another hospital, or one country with another country, and therefore plot both sets of data on the same graph. Comparisons are more easily seen when displayed in this fashion, instead of on two separate graphs, unless one can be laid directly over the other.

(1) Bar Graphs

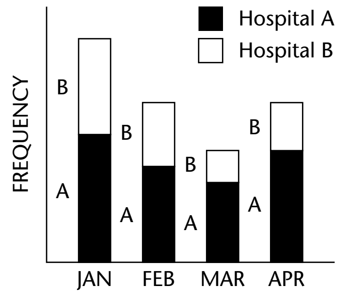
There are several ways by which two or more bar graphs can be compared, including the following:

(a) Side-by-side comparisons.



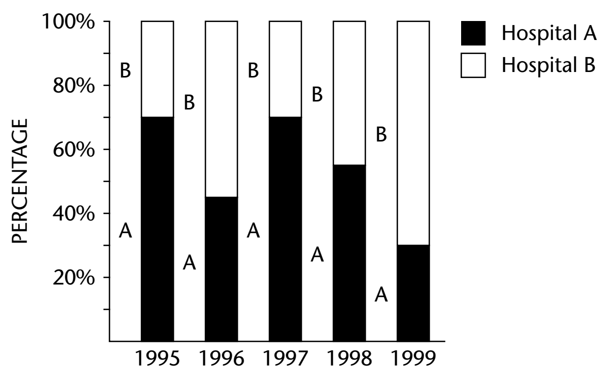
Side by side bar graph

(b) Component part graph (also called stacked bar graph) in which one bar is placed directly on top of another.



Component or stack bar graph

(c) Percentage component part graph. As in the component part graph, the bars are placed directly on top of each other, but each part is a percentage of the whole.



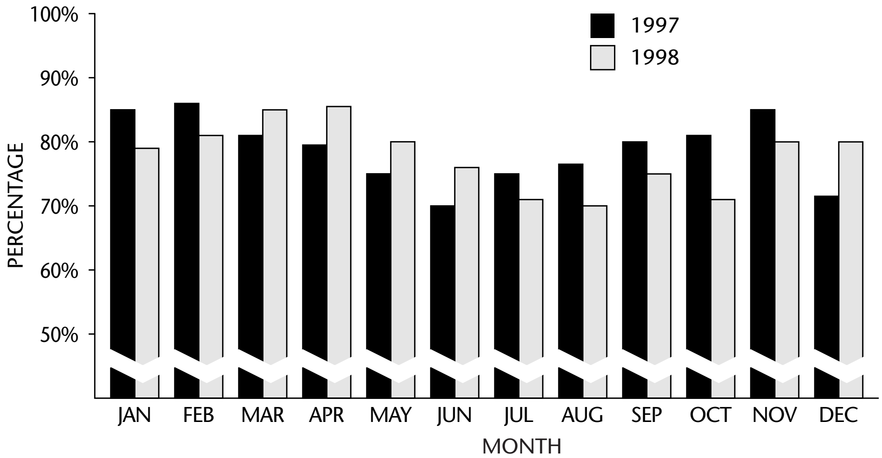
Percentage component/stack bar graph

Example: A hospital wishes to compare (by month) the percentage of occupancy in 1998 with that in 1997. These were recorded as:

Month	*1997*	*1998*	*Month*	*1997*	*1998*
Jan.	85	78	July	75	72
Feb.	87	82	Aug.	78	70
Mar.	82	85	Sept.	80	75
Apr.	79	86	Oct.	82	72
May	75	80	Nov.	85	80
June	70	77	Dec.	73	80

The bar graph comparison would appear as follows:

Comparison of Percentage of Occupancy



Bar graph

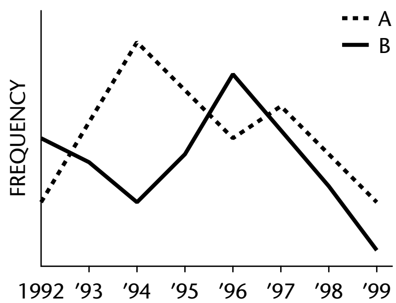
SELF-TEST 54: The local health department reports the following number of confirmed cases of measles and mumps over the past decade:

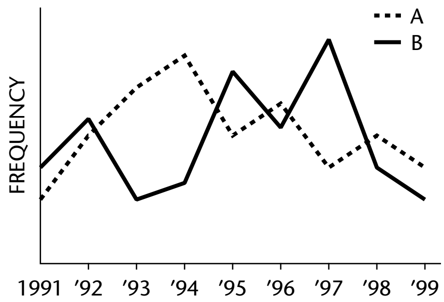
Year	*Measles Frequency*	*Mumps Frequency*
1990	13	9
1991	3	5
1992	1	5
1993	1	3
1994	3	3
1995	3	3
1996	6	8
1997	3	13
1998	3	5
1999	11	4

Construct a comparison bar graph for these data.

(2) *Line Graphs*

The same rules that applied to superimposed frequency polygons hold true for line graphs. Each line should be distinguished differently, as previously mentioned. This could be accomplished by using different colors or a variation in the type of line drawn. Again, a legend should be included to indicate what each line represents.

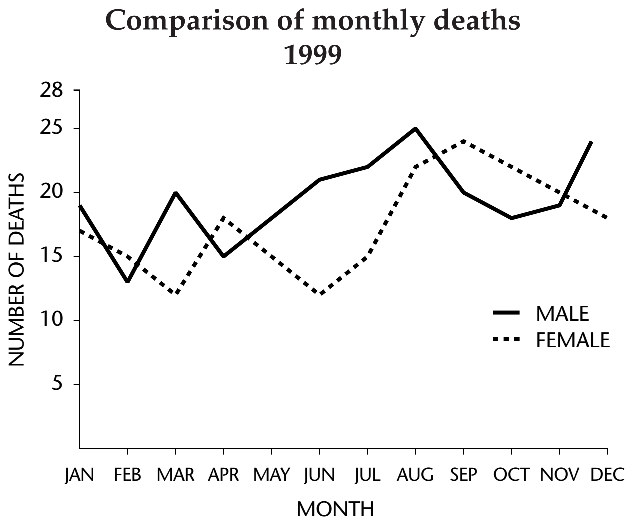




Line graph comparison chart

Example: A line graph comparison is to be made of the deaths recorded during 1999, comparing the number of male and female deaths.

Month	*Male*	*Female*	*Month*	*Male*	*Female*
Jan.	19	17	July	22	15
Feb.	13	15	Aug.	25	22
Mar.	20	12	Sept.	20	24
Apr.	15	18	Oct.	18	22
May	18	15	Nov.	19	20
June	21	12	Dec.	24	18



Line graph

SELF-TEST 55: Construct a comparison line graph of the measles and mumps data from Self-Test 54 (page 222).

D. SUMMARY

The following general rules apply to graphs:

1. Graphs convey information more quickly than tables do.
2. Graphs are generally more impressive than tables.
3. Graphs should relate sufficient information so that the reader does not need to refer to textual material, although additional information regarding the data may be made available in the accompanying text.
4. Graphs should be simple, clear, and uncomplicated so that the message is readily apparent to the viewer.
5. Appropriate and descriptive titles should accompany all graphs. The title should inform the reader about what is being graphed and/or compared, the time period or the dates during which the data was collected, and the source of the data (the group on which the data was collected).
6. The type of data determines the type of graph to be constructed.
7. Quantitative continuous data are represented by a histogram or frequency polygon.
8. Quantitative discrete data are represented by a bar, line, or pie chart.

E. CHAPTER 12 TEST

1. For each of the variables listed below, circle the more appropriate graphical type of presentation.

a.	Number of x-rays performed per person.	Histogram	Bar Graph
b.	Triglyceride level of 100 patients.	Freq. Polygon	Line Graph
c.	Percentage of patients classified by occupation.	Histogram	Pie Chart
d.	Birth rate comparison by years.	Freq. Polygon	Line Graph

2. When plotting a histogram, what is most commonly plotted along the
   a. horizontal axis?
   b. vertical axis?

3. One hundred forty-one cases of CHD (coronary heart disease) have been recently diagnosed. Of these, 83 were males and 58 were females. The ages at the time of initial diagnosis were distributed as follows:

Score Limits	***Midpoint***	***Male Freq.***	***Female Freq.***
80–84	82	5	6
75–79	77	5	4
70–74	72	7	11
65–69	67	17	11
60–64	62	20	12
55–59	57	11	5
50–54	52	6	4
45–49	47	4	2
40–44	42	3	2
35–39	37	2	0
30–34	32	1	1
25–29	27	2	0

Calculate:

a. Mean age at time of diagnosis of CHD from the grouped frequency distribution for
   (1) all patients.
   (2) all male patients.
   (3) all female patients.

b. Construct a frequency polygon of the age differences for the two sexes.

4. Comparative admission statistics for 1995 to 1999 were as follows:

Month	***1995***	***1996***	***1997***	***1998***	***1999***	***Month***	***1995***	***1996***	***1997***	***1998***	***1999***
Jan.	661	531	472	463	460	July	563	542	547	481	455
Feb.	572	470	474	472	480	Aug.	546	551	530	421	406
Mar.	583	526	482	480	466	Sept.	484	493	505	458	463
Apr.	560	493	424	512	501	Oct.	533	538	508	437	424
May	546	562	446	538	498	Nov.	558	472	442	438	427
June	487	558	462	484	460	Dec.	547	503	478	439	410

Construct a comparative line graph of the above data.

5. A hospital recorded the twelve most commonly reported cancers during the past year and the percentage of males and females diagnosed with each type as follows:

Cancer Site	***Male Percentage***	***Female Percentage***
Lung	66%	34%
Colorectal	48%	52%
Breast	1%	99%
Prostate	100%	–
Urinary tract	70%	30%
Uterine	–	100%
Oral	68%	32%
Leukemia	56%	44%
Pancreatic	50%	50%
Skin	53%	47%
Stomach	61%	39%
Ovarian	–	100%

Construct a percentage component part graph of these data.

6. The pathologic diagnosis of 200 females who underwent surgery for a breast lesion are as follows:

Diagnosis	N	%
Benign		
Fibrocystic disease	68	34
Fibroadenoma	36	18
Intraductal papilloma	12	6
Lipoma	4	2
Other benign lesions	26	13
Malignant		
Carcinoma of breast	54	27

   a. Construct a pie graph of this data.

   b. Construct a bar graph of this data.

7. A record is kept of the most common inpatient ENT procedures and the number of cases of each performed over the past six months. These are recorded as follows:

Procedure	Number of Cases
Tonsillectomy with Adenoidectomy	147
Tonsillectomy without Adenoidectomy	42
Septoplasty	16
Sialadenectomy (all types)	16
Mastoidectomy (all types)	15
Myringotomy with insertion of tube(s)	14
Laryngoscopy/Tracheoscopy	12
Myringoplasty	7
Ethmoidectomy	7
Laryngectomy (radical)	7
Epistaxis control	6
Thyroidectomy (all types)	5
Stapedectomy	5
Pharyngoplasty	5
Rhinoplasty (all types)	4
Dacryocystorhinostomy	3

   Construct a pictograph of these data.

8. A comparison was made of the average length of stay (in days) for the years 1985, 1990, 1995, and 2000 between males and females (ages 45–64) for seven diagnoses. The data indicates:

	1985	1990	1995	2000
Males:				
Malignant neoplasm	9.2	9.4	8.2	7.0
Diabetes mellitus	7.9	7.3	6.6	6.5
Disease of the heart	6.5	5.8	5.0	4.8
Cerebrovascular disease	10.2	10.0	6.2	6.8
Pneumonia	8.0	7.9	7.2	6.9
Injuries and poisoning	6.6	7.2	5.8	5.5
Fracture (all sites)	7.5	7.2	6.7	6.3
Females:				
Malignant neoplasm	8.4	8.5	6.7	6.3
Diabetes mellitus	8.3	8.9	6.1	6.0
Disease of the heart	6.7	6.1	5.6	4.7
Cerebrovascular disease	12.2	10.7	7.8	6.7
Pneumonia	8.9	7.9	7.3	6.7
Injuries and poisoning	6.8	6.7	6.0	5.4
Fracture (all sites)	7.3	7.9	6.0	5.2

Construct a comparison graph of:

a. Males and Females for the 7 diagnostic categories for the year 2000.

b. Malignant neoplasm LOS rates for males and females for each of the four periods.

c. Horizontal bar graph of the male LOS rates for all seven diagnostic categories.

d. Female LOS comparisons for all seven diagnostic categories for 1990 and 2000.

C H A P T E R

13

Data Presentation via Computer Technology

Frank Waterstraat, MBA, RRA

CHAPTER OUTLINE

A. Tables
   1. Setting up Tables
      a. Table Header
      b. Category and Series Labels
      c. Table Contents
      d. Data Alignment
B. Data Presentation in Charts and Graphs
   1. Chart
   2. Graph
C. Anatomy of Chart/Graph
D. Charts
   1. Bar Chart
      a. Simple Bar Chart
      b. Bar vs. Column Chart
   2. Additional Bar Charts
      a. Multiple Bar Chart
      b. Stack Bar Chart
      c. Percent Stack Bar Chart
   3. Guidelines for Constructing a Bar Chart
   4. Pie Chart
   5. Line Chart
   6. Guidelines for Constructing a Line Chart'
E. Graphs (Statistical)
   1. Line Graphs
      a. Histogram
      b. Frequency Polygon
F. Summary
G. Chapter 13 Test

LEARNING OBJECTIVES

After studying this chapter, the learner should be able to:

1. Determine the type of table and chart/graph that is appropriate for presenting different types of data.
2. Format a data table.
3. Construct the following using computer software:
   a. Bar Chart
   b. Pie Chart
   c. Line Chart
4. Interpret statistical graphs
   a. Histogram
   b. Frequency Polygon

The presentation of data, using tables and graphs, was introduced in the previous chapter. Pictorial and graphic presentation of data, as well as table construction, has been greatly facilitated through the availability of software packages currently available on most personal computers. No longer are tables, graphs, charts, or diagrams routinely plotted by the pen-and-ink method. Data information can now be fed directly into a PC and a very professional-looking graph, chart, or table can be constructed in a fraction of the time that previously was required when constructing these items by conventional means. The major problem involves selecting the proper chart or graph from the myriad of choices available to the computer user.

A large number of data analysis software packages for the personal computer are available that can help data analysts generate tables, charts, and graphs. Most of these packages are quite useful, particularly for giving data analysts the capability to restructure a table or redraw a graphic with only a few keystrokes. With these packages, adding data, updating data, and finding the best chart or graph is no longer an onerous time-consuming task. A data analyst can quickly and easily draw a number of charts and graphs with different data intervals and presentation formats, then simply select the one that best illustrates the information the analyst wishes to communicate.

On the other hand, data analysts are sometimes tempted to let the software dictate the format of the tables, charts, or graphs. For example, many packages can draw bar charts and pie charts that appear three-dimensional. Does that mean that data analysts should use three-dimensional charts? The data analyst needs to keep the primary purpose of the data analysis and presentation in mind—communicating information to others. The data analyst must decide whether a three-dimensional chart communicates the information better than a two-dimensional chart. The decision cannot be made by a computer. The decision about which kind of chart or graph will be used to communicate data is the role and responsibility of the analyst.

This chapter focuses on the design and presentation principles of tables, charts, and graphs. All the tables and figures in this chapter have been created on a personal computer. Throughout this chapter, different types of chart and graph formats have been applied to illustrate the wide variety of data presentation alternatives that data analysis software offers. The examples in this chapter are for illustration and demonstration purposes only. The reader should not assume that a given type of chart or graph is the best format to present data. In addition, this chapter will not provide detailed instructions on how to use a particular software program to set up tables and generate graphics. There are many excellent books on the market that offer this type of instruction. At the risk of being redundant, computers cannot design data tables and graphic presentations, but they are excellent tools which can assist the data analyst with this challenging task.

When using data analysis software (statistical or spreadsheet) on a personal computer, good table design is the first step in producing informative graphical data presentations. Most data analysis programs require that data be entered into a table before a chart or a graph can be generated.

A. TABLES

1. Setting up Tables

TABLE 13.1: Table Header

Table Number, Who or What?, Where? and When?[1]

Series Heading	***Major Category***		***Major Category***	
	Subcategory	*Subcategory*	*Subcategory*	*Subcategory*
Series Label	Data	Data	Data	Data
Series Label	Data	Data	Data	Data
Series Label	Data	Data	Data	Data
Series Label	Data	Data	Data	Data
Total	Data	Data	Data	Data

[1]Footnote: (if necessary)

The previous chapter outlined the basic format of a table (also see Table 13.1). In review, the basic elements include:

a. Table Header

The table header is probably one of the most important components of a table. The header should clearly answer the questions:

(1) Who or What do the data represent?
(2) Where is the source of the data?
(3) What time period do the data represent?

A table number (Table 1 or Table 1.1) should be used if appropriate or required in the report or document. Also, as it has been pointed out, the table header should avoid the use of codes, abbreviations, acronyms, or symbols. If their use is unavoidable, an explanatory footnote should be included. Some tables will have a footnote notation in the header and details regarding the content of the table are found in the footnote section of the book or paper. For most purposes, the header as illustrated above is appropriate.

b. Category and Series Labels

The table format presented above is a moderately complex table. It has two major category labels, five subcategory labels, and four series labels. Each of these labels should briefly and accurately define the data presented. The labels should clearly state the "units of measure" when quantitative values are used in the table (years, lbs, rate per 100,000). Failure to document the units of measure may result in misinterpretation of the data presented. As with table headers, codes, abbreviations, acronyms, or symbols should not be used, because of the potential for misinterpretation.

c. *Table Contents*

When creating a table, considerable thought should be given to *what* data should be presented in the table and *how* it should be presented. This step should precede the drafting of the header since the header should represent the data. When summarizing quantitative data, totals should also be shown in the data table rows and columns. If percents are used, they should be presented as whole numbers and the total (100%) indicated. Totaling the data in rows and columns provides a simple method of cross-checking the accuracy of the data in the table.

d. *Data Alignment*

TABLE 13.2: Annual Hospital Discharges by Third Party Payer and Hospital Service Anytown Hospital, Anytown, USA 1998

Hospital Service	*Government*		*Private*			*Totals*
	Medicaid	Medicare	PPOs	HMOs	Other	
Medicine	1,098	890	126	987	345	3,446
Obstetric	1,145	234	143	345	765	2,632
Orthopedic	1,234	675	167	765	789	3,630
Pediatric	1,212	10	232	567	234	2,255
Surgery	543	765	324	587	345	2,564
Totals	5,232	2,574	992	3,251	2,478	14,527

Careful attention should be given data alignment, since it makes the table easier and more appealing to read (see Table 13.2). There are different standards for text and numbers.

(1) *Text*

Text justification is usually chosen at the discretion of the analyst. Text can be right justified, left justified, or centered, depending on how the table is formatted. Several different text alignment techniques are used in the table above. Note that some titles are centered in cells, some are centered across cells, while other titles are right justified. When using a computer to design a table, different alignment styles should be tried, since it is easy to revise changes.

(2) *Numbers*

The same design freedom is not available when entering numbers or quantitative data into a table, since numbers should always be aligned in relation to the decimal place. Whole numbers can simply be right justified, whereas decimal numbers must be aligned by the decimal point and all numbers should have the same number of decimal places.

(3) *Example of poor alignment of both text and numbers is shown in Table 13.3.*

TABLE 13.3:

Annual Hospital Discharges
by Third Party Payor and Hospital Service
Anytown Hospital, Anytown, USA 1998

Hospital Service	*Government* Medicaid	Medicare	PPOs	HMOs	*Private Other*	*Totals*
Medicine	1,098	890	126	987	345	3,446
Obstetric	1,145	234	143	345	765	2,632
Orthopedic	1,234	675	167	765	789	3,630
Pediatric	1,212	10	232	567	234	2,255
Surgery	543	765	324	587	345	2,564
Totals	5,232	2,574	992	3,251	2,478	14,527

B. DATA PRESENTATION IN CHARTS AND GRAPHS

As previously mentioned, many types of charts and graphs are employed in data analysis, depending upon the nature of the data presented and the purpose for which the chart or graph is intended. The terms “chart” and “graph” are often misused. There are subtle differences between the two forms of data presentation.

1. Chart

A chart is a method of illustrating data using only one quantitative coordinate. Charts are most appropriate for quantitatively comparing discrete categories or groups of data. The most common charts are column, bar, line, and pie charts. There are also variations of these basic charts which include area, donut, surface, radar, bubble, stock, cylinder, cone, and pyramid charts. Although these charts are less common, they are available in most data analysis software packages.

2. Graph

A graph is a method of relating one qualitative variable to another quantitative data variable. Graphs are used to illustrate patterns or trends of quantitative data over another quantitative variable, usually time. The most common graphs are X:Y graphs, histograms, and polygons. Log-liner line graphs are a special type of mathematical line graph used primarily in scientific presentations.

The basic design characteristics and principles for both charts and graphs are very similar. The different charts and graphs are mostly variations of each other using different scales for different data presentation purposes. This chapter addresses the four most common categories of charts, which include column, bar, line, and pie charts and their associated applications; and the three most common graphs which include histograms and polygons and their applications for presenting health data. Statistical graphs are more technically complex. These shall be reviewed for information purposes only.

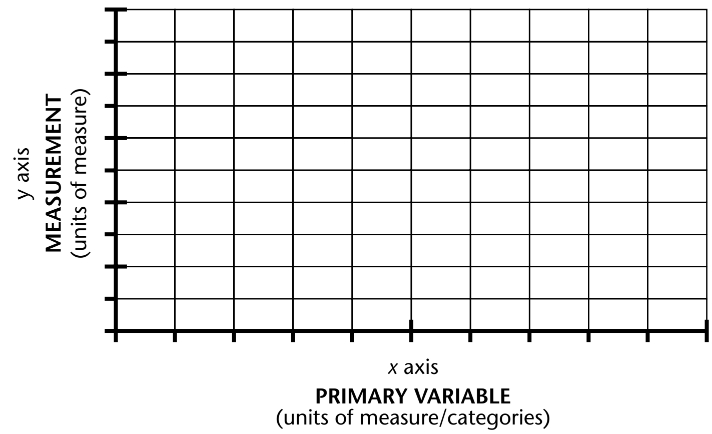


Figure 13.1

C. ANATOMY OF A CHART/GRAPH

Most charts and graphs use rectangular coordinates that have two lines, called *axes*, that intersect at a right angle (see Figure 13.1). The lines are referred to as the x-axis (horizontal line) and the y-axis (vertical line). The x-axis (horizontal line) usually has the categories (chart) or values (graph) representing the primary variable of interest (independent variable). The y-axis (vertical line) has the values that are used to measure the primary variable, such as frequency, number of cases, cost, or other quantitative measure. Each axis is labeled with both the name of the variable and the units in which it is measured. The axis lines are marked to illustrate the data and scale of measurement used.

D. CHARTS

1. Bar Chart

Bar charts are one of the most common data presentation tools. A bar graph can be used to compare the frequencies of categorical data such as types of discharges, occupations, gender, or race. Bar charts compare categories or groups using some quantitative measurement. The quantitative measurement values are usually plotted on the y-axis, while the categories or groups are placed on the x-axis. The x-axis usually does not have a quantitative scale. If quantitative values are used, they are presented in categories (i.e., over 65 years old, 25–34, 35–44, etc.). Bars can be presented either horizontally (bar or horizontal bar) or vertically (column). The height of each bar is proportional to the quantitative data presented on the y-axis. Understanding the basic bar chart characteristics is fundamental to understanding all chart formats.

a. *Simple Bar Chart*

The simplest bar chart displays data from a one-variable table. Each data category is represented by a bar on the x-axis. The categories may be arranged in alphabetical order or in increasing or decreasing bar height. The length of the bar is associated with its quantitative unit of measure plotted on the y-axis.

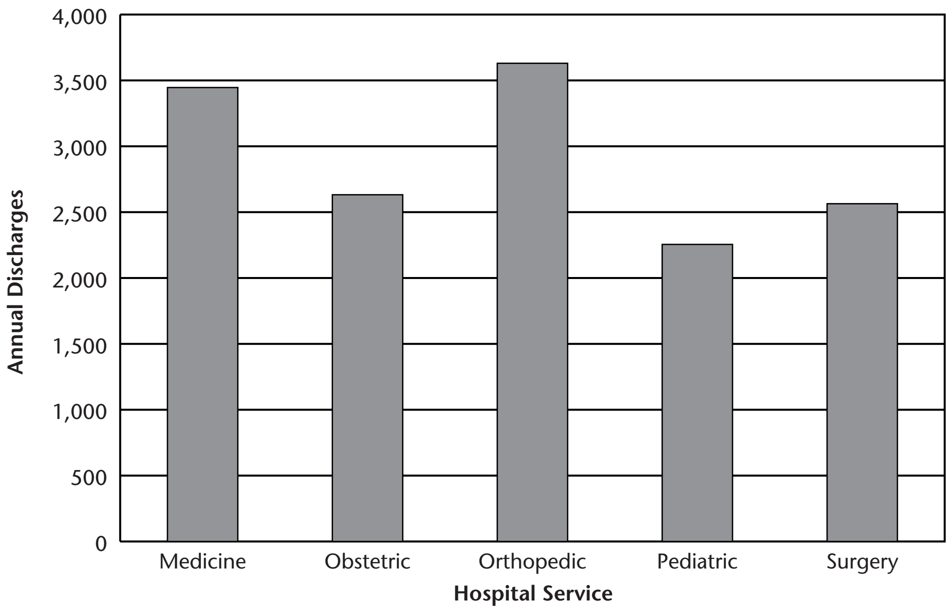
Example: Table 13.4 is a simple one-variable table representing the number of discharges by service at Anytown Hospital.

TABLE 13.4:
Hospital Discharges by Service
Anytown Hospital
Anytown, USA 1999

Service	*Discharges*
Medicine	3,446
Obstetric	2,632
Orthopedic	3,630
Pediatric	2,255
Surgery	2,564
Totals	**14,527**

Shown below is a simple 3D graph of the data from Table 13.4. The column services are represented by the bars plotted on the x-axis. The comparative quantitative measurement data is the number of discharges plotted on the y-axis. The height of each bar is determined by the number of discharges for the respective category. The graphic presentation of the data in Table 13.4 makes it very easy to compare and identify the hospital service with the highest and lowest discharges.

Hospital discharges by service, Anytown Hospital, Anytown, USA

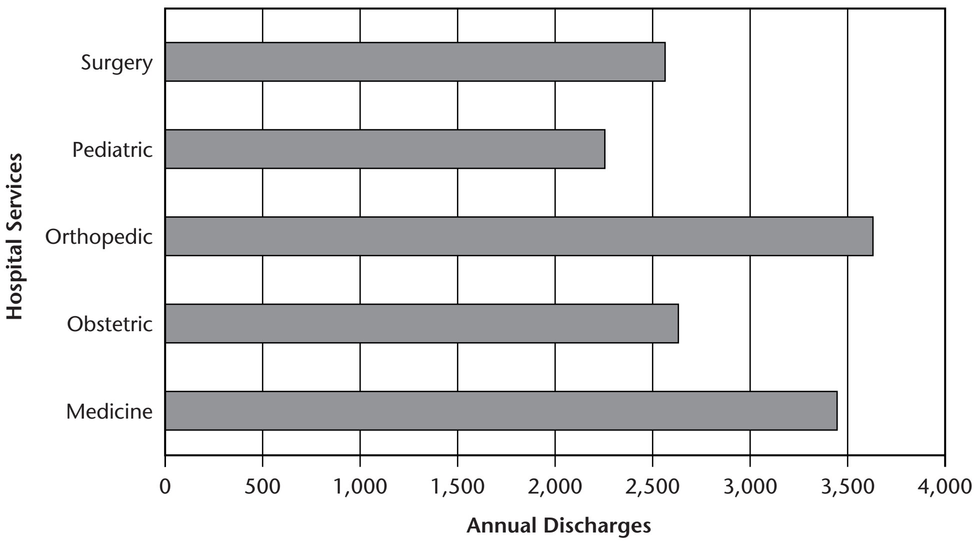


b. ***Bar vs. Column Charts***

Although this category of charts is referred to as Bar Charts, some data analysis programs differentiate bar charts into two categories: column charts and bar charts. Column charts have vertical bars (shown above), while bar charts have horizontal bars (see below). Some programs refer to bar charts as "horizontal bar charts." Whether they are called bar, horizontal bar, or column charts is for the most part irrelevant. Most data analysis software programs use icons rather than names to identify chart options. The decision as to which type of chart (column or bar) to use is at the discretion of the person creating the chart.

Example: Using the above data from Table 13.4, a horizontal bar chart is created below. Since the bars extend horizontally, the figure above would be designated a column chart since the bars extend vertically (or in columns) in comparison to the horizontal bars below. Both charts were created from the data in Table 13.4.

Hospital discharges by service, Anytown Hospital, Anytown, USA, 1999



Frequently, column charts are used to illustrate that something is increasing or decreasing. The high/low characteristic of the column chart provides a simple illustration of an increasing or decreasing trend. On the other hand, if the data labels are critical and the labels are too long to fit on a horizontal x-axis, a horizontal bar chart makes the labels easier to read. It is important to note that when a horizontal bar chart is applied, the categorical data are still on the x-axis. In a horizontal bar chart the x-axis is simply rotated to the vertical position and the y-axis is moved to the horizontal position. The axes are moved, not the data.

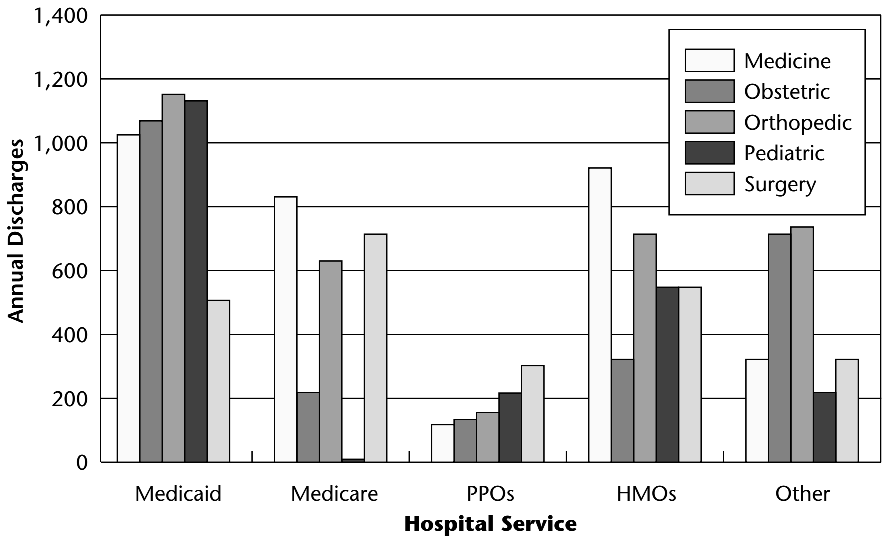
2. Additional Bar Charts

a. Multiple Bar Charts

Multiple bar charts are used to compare categories of data comprised of data subcategories or series data. The design concept is similar to simple bar charts except each category has series data in it that are being compared in the chart as well. The individual series data within a given category are presented with adjoining bars to illustrate that they represent a category. The individual series bars must be presented distinctively and a legend is required (in addition to x-axis category labels) to identify each of the series bars. It is best to limit the number of bars within a category to a maximum of three when there are five or more categories. If there are fewer categories, then more series data can be presented. Thoughtful design is essential to preparation of effective multiple bar charts.

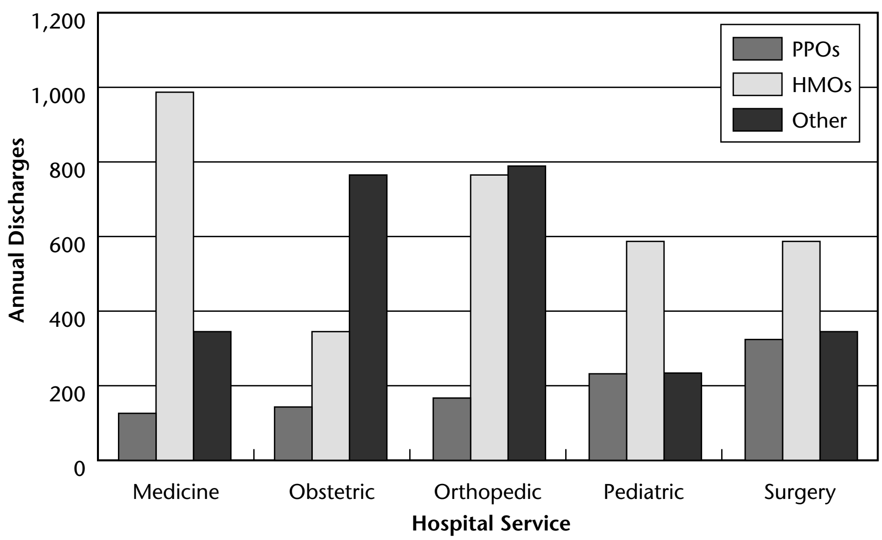
Example: The data in Table 13.2 is represented in a multiple bar chart in the figure below (Figure 13.4). This chart is difficult to interpret because of multiple categories with multiple series data. The chart illustrates the distribution of hospital discharges by third party payer.

FIGURE 13.4: Annual Hospital discharges by hospital service and third party payer, Anytown Hospital, Anytown, USA, 1999



Example: Figure 13.5. In contrast to the previous chart, this chart limits the series data to three data variables, allowing the chart to be more readable. The focus of the presentation (in this chart) is on a comparison of the series data in each category.

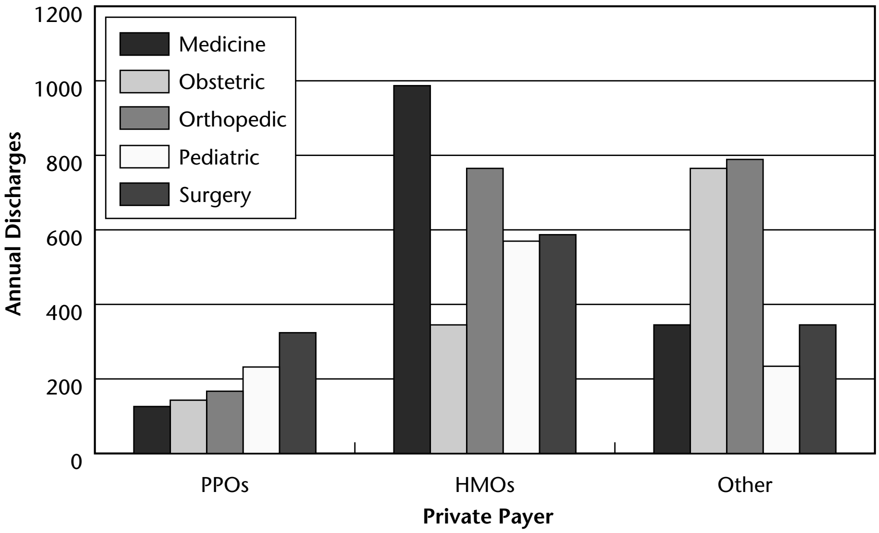
FIGURE 13.5: Annual Hospital discharges by hospital service and private payer, Anytown Hospital, Anytown, USA, 1999



By rotating the category and series data axes on the chart, which is easily done with a computer, a different view of the data is easily obtained.

Example: Figure 13.6 illustrates a chart in which the category and series data axes are rotated. The Private Payer categories are on the x-axis and the hospital services become the series data documented in the bars and legend. The focus in this chart is on comparing the discharge services within each payment category.

FIGURE 13.6: Annual Hospital discharges by hospital service and private payer, Anytown Hospital, Anytown, USA, 1999



As Figures 13.4 and 13.5 illustrate, accurate and effective data presentation requires "critical thinking" and decision making as to the best format for presenting the data. The data analysis software cannot determine which axis is the better axis on which to place hospital service data when analyzing payment categories. The software also does not let the operator know whether the created chart is too cluttered or confusing. Therefore, it is important to have a clear understanding of the purpose of the data to present it effectively. A computer is a tool that can create many different charts, but the person creating a chart must select the appropriate chart that best illustrates the information to be presented by the statistical data.

b. ***Stack Bar Chart***

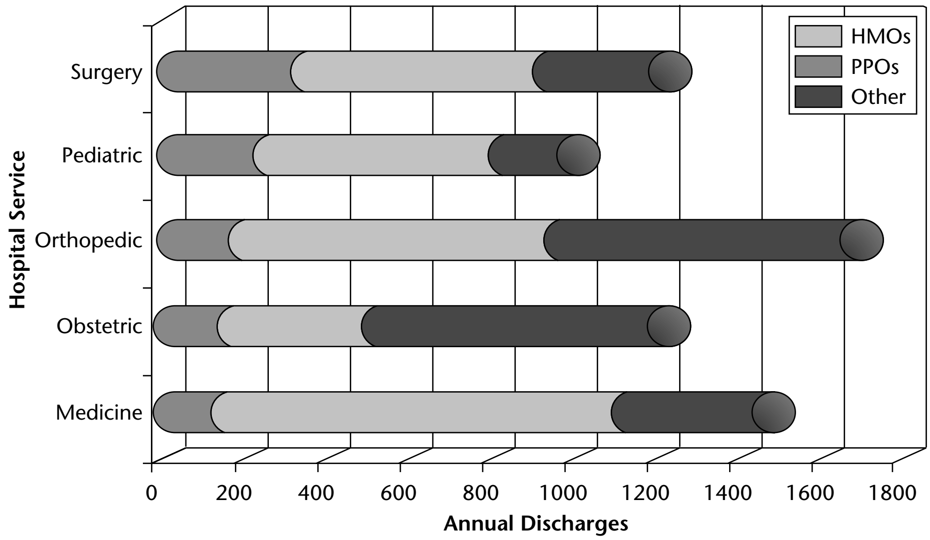
A stack bar chart is used to compare categories comprised of series data. The visual emphasis is on a comparison of the total quantitative values of each data category along the x-axis. The stack bar format allows the viewer to see the series variables that contribute to the total value of the category.

Example: Figure 13.7 is an example of a stack bar chart with the emphasis on comparing total discharges by hospital service. Note that the individual Private Payment series data are difficult to compare because all the series data do not rest on a flat baseline. The basic design characteristics and principles of the stack bar chart are the same as the multiple bar chart. The only difference lies in the chart presentation format that emphasizes comparison of the categorical data on the x-axis.

c. ***Percent Stack Bar Chart***

The percent stack bar chart is useful for comparing the relative contribution of the series data in each of the categorical variables. The chart is used to standardize the

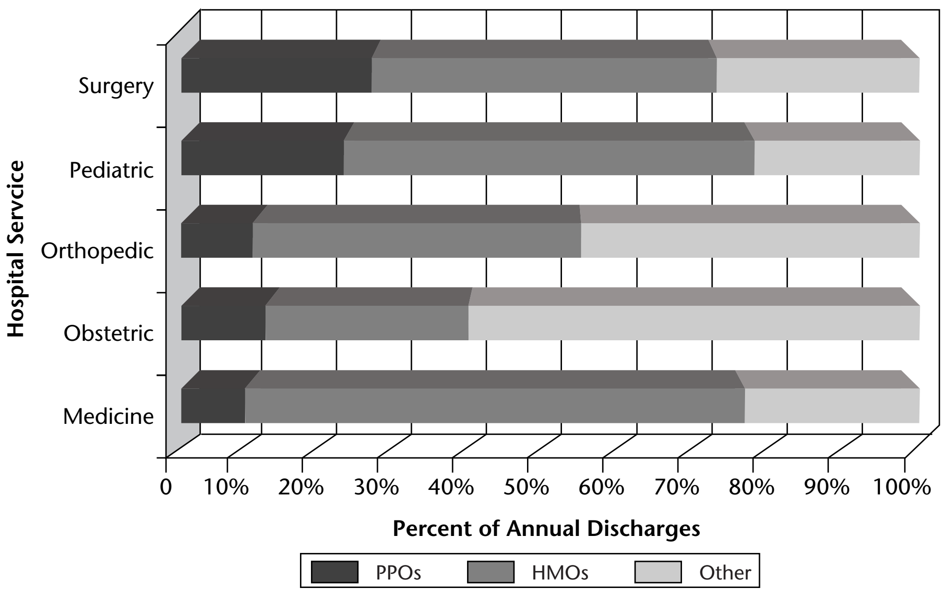
FIGURE 13.7: Annual hospital discharges by hospital service and private payer, Anytown Hospital, Anytown, USA, 1999



series data when the total category values are unequal. The percent stack bar chart is a variation of a stack bar chart except that it provides for a percentage comparison of the component series variables. Because each of the bars is standardized, based on 100 percent, all the categorical bars are the same height. The component series data are presented as percents of the total rather than as actual quantitative values. The percent stack bar chart is used when the main categorical variables have significantly different values and to compare the contribution of the series variables.

Example: Figure 13.8 illustrates a percent stack bar chart. Note that this chart is *not* useful for comparing the main categories' variables (in this case discharges by

FIGURE 13.8: Annual hospital discharges by hospital service and private payer, Anytown Hospital, Anytown, USA, 1999



hospital service), because all the categorical bars are the same height. It is easier to compare the relative contribution of the series data, because it is standardized in percent.

3. Guidelines for Constructing a Bar Chart

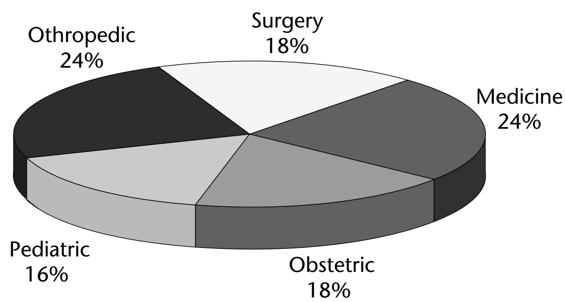
a. Arrange the data in categories that reflect a natural order. (Alphabetical; increasing or decreasing in value).
b. Use either column or bar charts, whichever best illustrates the data.
c. Limit the number of category and series variables presented when multiple bar charts are used. This allows for easier comparative analysis.
d. Use colors or geometric designs (black and white) to clearly differentiate the series bars from each other.

4. Pie Chart

A pie chart is a simple, easily understood chart. The size of the pie "slices" in a pie chart represent the proportional or percentage contribution of each variable to the whole data category analyzed. Pie charts are useful for presenting the data elements for a single variable (for example, parts of a budget, ethnic distribution within a population). Pie charts are best used to illustrate single variable tables.

Example: Figure 13.9 illustrates the percentage distribution of discharges by hospital service.

FIGURE 13.9: Percent distribution of 1999 discharges by hospital service, Anytown, Hospital, Anytown, USA



NOTE:

Use of multiple pie charts for comparing series variables is not effective. It is difficult to compare individual series variables between several pie charts. When comparing series data between multiple categories, a multiple bar chart or a percent stack bar chart is more appropriate.

5. Line Chart

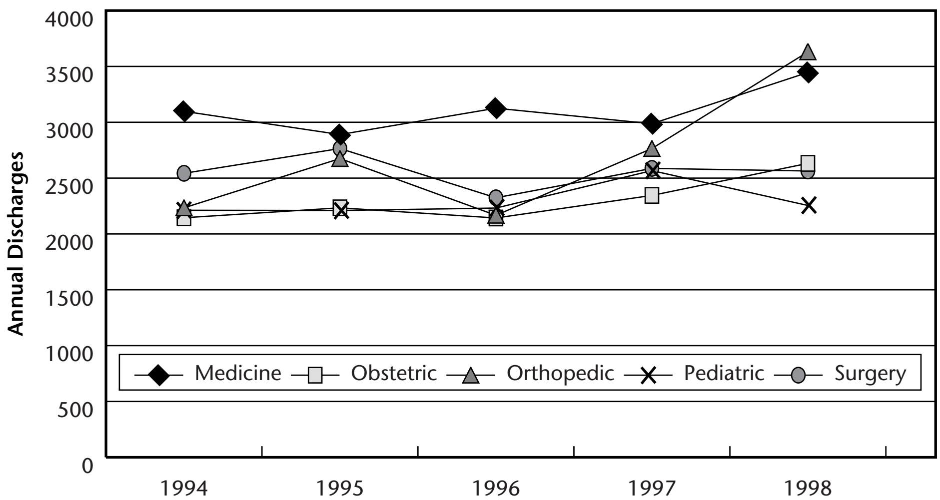
A line graph illustrates patterns or trends of quantitative data over some variable, usually time. When analyzing health data, this type of graph is commonly used to show time-related series data and to compare several series to each other. A line chart is the method of choice for plotting data over time.

Example: Table 13.5 summarizes annual discharges by hospital service over a period of five years at Anytown Hospital. Figure 13.10 plots the data from Table 13.5 in a line graph format.

TABLE 13.5: Annual Hospital Discharges 1995–1998 by Hospital Service Anytown Hospital, Anytown, USA 1999

Hospital Service	***Year***				
	1994	***1995***	***1996***	***1997***	***1998***
Medicine	3,098	2,890	3,126	2,987	3,446
Obstetric	2,145	2,234	2,143	2,345	2,632
Orthopedic	2,234	2,675	2,167	2,765	3,630
Pediatric	2,212	2,210	2,232	2,567	2,255
Surgery	2,543	2,765	2,324	2,587	2,564
Totals	**12,232**	**12,774**	**11,992**	**13,251**	**14,257**

FIGURE 13.10: Annual hospital discharges for 1995–1998 by hospital service, Anytown Hospital, Anytown, USA, 1999



NOTE:

In a line graph, a set distance along each axis represents the same quantitative value anywhere on that axis. This rule applies to both the x-axis and y-axis. The scale on the x-axis depends on the time intervals to be presented for a comparative analysis of the data. Usually, the time data is presented in standard categorical units (hourly, daily, weekly, monthly, or annually). Whatever units are used, they should be appropriate for the data being presented. Several series of data can be shown on the same line graph. In Figure 13.10 each line represents annual hospital discharges for a given service. Appropriate headers and labels are just as critical on graphs as on tables and charts. The same title and label guidelines used for tables should also be applied to charts and graphs.

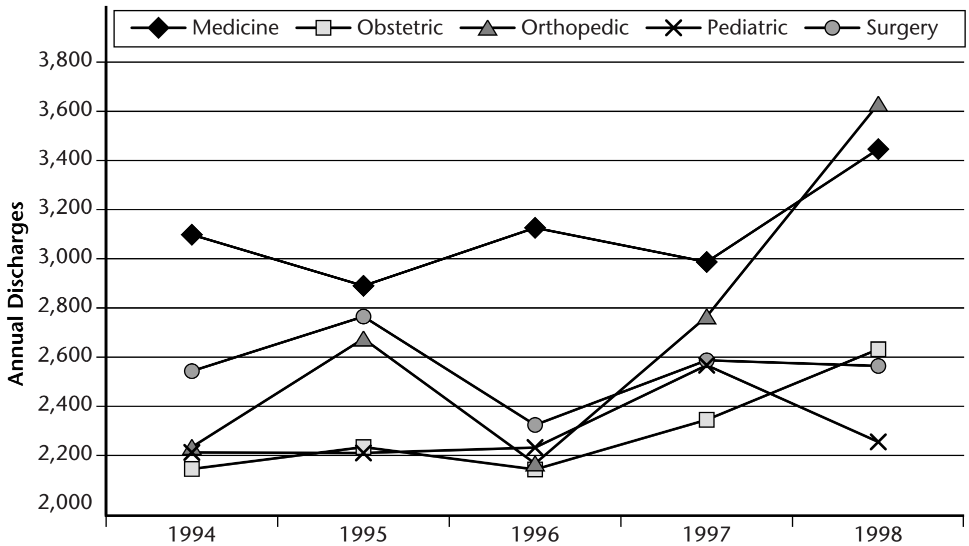
6. Guidelines for Constructing a Line Chart

Mark Twain said that *Statistics don't lie . . . Statisticians do!* A graph or chart incorrectly constructed can be misleading.

Example: The data in Figure 13.11 is identical to the data used in the previous example (Figure 13.10), but the data reflects greater variation between the data. Try to determine the reason for the apparently greater variation in the data before continuing with this section.

The problem lies on the y-axis scale. Notice that in Figure 13.10 the y-axis scale starts at "0," whereas in Figure 13.11 the y-axis scale begins at "2000." Accurate data is misleading when the chart or graph is inaccurately constructed.

FIGURE 13.11: Annual hospital discharges for 1995–1998 by hospital service, Anytown Hospital, Anytown, USA, 1999



Most spreadsheet and graphic presentation programs have default settings so that the focus is on the data rather than the characteristics of drawing a line graph. Nevertheless, there are guidelines for customizing a line graph or reviewing other line graphs to ensure appropriate data presentation.

The y-axis scale should:

a. Have titles that explain who or what, where and when.
b. Have axis labels describing the variables and units of measure.
c. Always start at 0.
d. Be shorter than the x-axis, so that the graph is horizontal (the horizontal length should be greater than the vertical length), and the two axes should be in good proportion—an x:y ratio of about 5:3 is often recommended. The default setting for most spreadsheet programs apply these principles. Editing this feature may result in a distorted view of the data.
e. Have a range of values in standard units of 10's, 100's, 1000's, etc., with the last unit being slightly larger than the largest data unit presented on the graph. Referring to Figure 13.10, the largest y-value is 3,630 in 1998. This scale value was rounded up to 4,000 for determining the range of values that were shown on the y-axis.
f. Have data intervals that adequately illustrate the important details of the data.

E. GRAPHS (STATISTICAL)

1. Line Graphs

A graph is a means of showing quantitative data visually, using a system of coordinates. It is a kind of statistical snapshot that helps the viewer see patterns, trends, aberrations, and differences in the data. Also, a graph is an ideal way of presenting the relationship between detailed quantitative data. The axes are similar to charts, with the x-axis being the horizontal axis and the y-axis the vertical axis. The horizontal axis usually shows the values of the independent (or x) variable, which is the method of classification, for example, units of time. The vertical axis is used to show the dependent (or y) variable, which is usually a frequency measure, such as the number of cases or rate of disease. Each axis is labeled accordingly, with the name of the variable and the units in which it is measured. Marks are placed along each line to indicate the units of measurement. X:Y line graphs are especially useful in showing the relationship between two quantitative variables as compared to a line chart, which illustrates the relationship between one quantitative variable and categorical or grouped data.

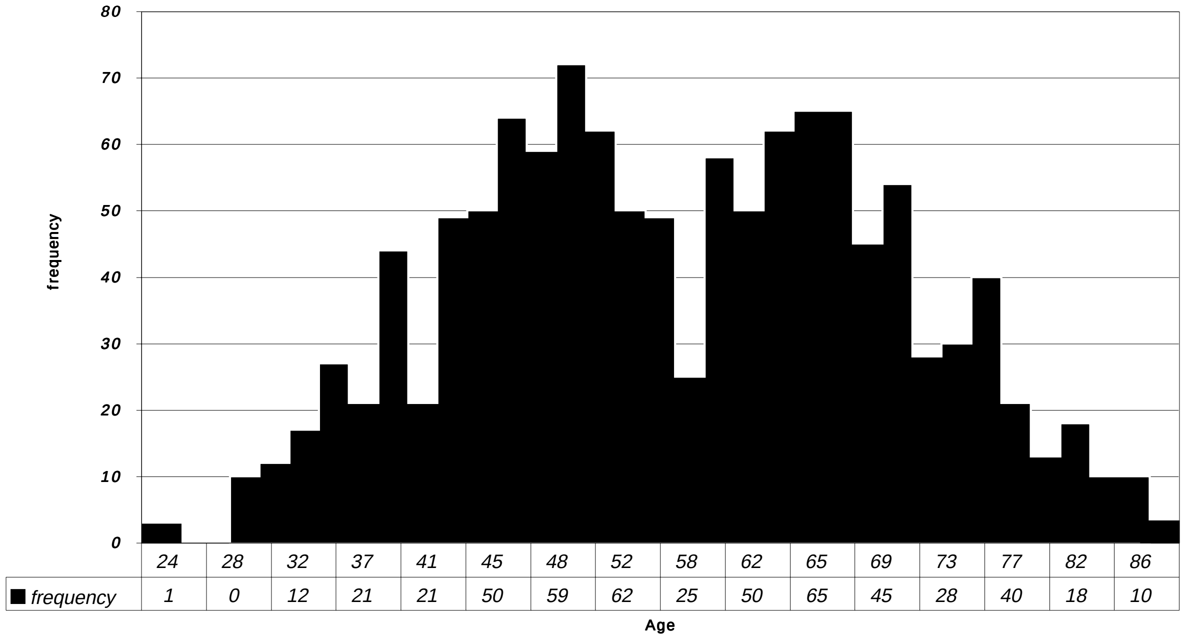
a. *Histogram*

A histogram is a pictorial representation of frequency data. A histogram consists of an x-axis which has data class limits and a y-axis that has frequency data that depicts the relative frequency of the number of cases in each data range. A histogram is similar in appearance to a bar graph except all bars are adjoining, reflecting continuous quantitative data. A histogram is created by grouping the data into two or more data ranges with limits. A plot is generated by creating rectangles with the data ranges along the x-axis and the relative frequencies of the number of cases in each data range determining the height.

Defining the data range limits is more of an art than a science. Smaller data ranges provide a more detailed curve. Larger data ranges smooth out the data and promote an accurate representation, despite slight imperfections in the data sample. Additionally, the width of the data ranges need not be constant. A wide data range may be desirable where the data varies only slightly, but a smaller range may be used when the distribution makes more drastic changes.

Example: Figure 13.12 illustrates a computer-generated histogram.

FIGURE 13.12: Histogram of breast cancer patients' by age (n = 1208), Anytown, IL 1999



NOTE:

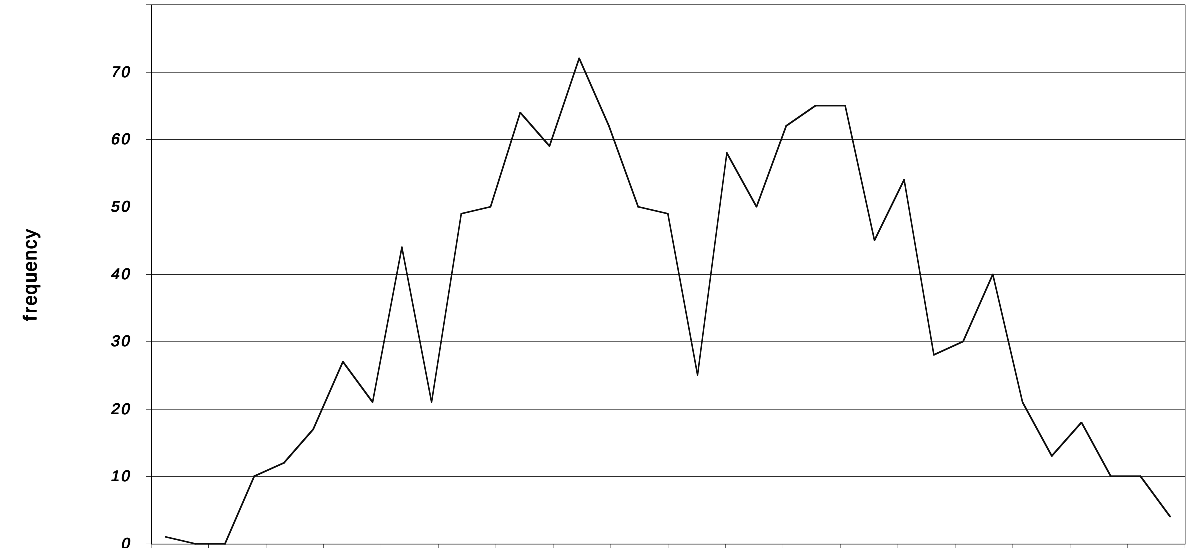
Unlike a bar chart, the data represented by the height and width of the bar is data-dependent. An accurate histogram cannot be drawn with a standard charting program, because bar width is not taken into consideration. Given the height and area requirements of the bars in a histogram, the data must be statistically analyzed and graphed accordingly. Most statistical programs (SPSS, Minitab, MathStat, etc.) offer a statistical tool to accurately construct a histogram. These programs are used primarily for advanced statistical analysis, which is beyond the scope of this book. Health data analysts will find that bar charts are appropriate for most health data presentation applications.

b. *Frequency Polygon*

Another commonly used statistical graph is a frequency polygon. A frequency polygon uses the same data axes as a histogram. A frequency polygon is a line graph that connects the midpoints of each data range interval of the histogram. Like line charts, the lines of frequency polygons are effective for comparing multiple sets of frequency data. Multiple frequency polygons can be superimposed, much like a line chart, to compare two or more frequency distributions. Since a frequency polygon is a form of histogram, like a histogram, most statistical software programs offer a feature to accurately construct a frequency polygon. Again, the application of these types of programs is beyond the scope of this book.

Example: Figure 13.13 illustrates a computer-generated frequency polygon.

FIGURE 13.13: Frequency polygon of breast cancer patients' by age (n = 1208) Anytown, IL 1999



Age	24	28	32	35	39	43	47	50	54	58	60	64	67	71	75	79	82	86
—— frequency	1	0	12	27	44	49	64	72	50	25	58	62	65	54	30	21	18	10

F. SUMMARY

The following characteristics apply to computer-generated graphs:

1. Data should be reviewed for completeness and accuracy before analysis.
2. Understand your data before attempting an analysis.
3. Table and graph titles should answer the questions: who, what, where, and when?
4. A graph should be selected based on the type of data and point to be made.
   a. Bar graphs and column charts are best used to compare categorical data.
   b. Line graphs are best used for illustrating and comparing trends.
   c. Pie charts are used to illustrate percentage distributions.
5. The maximum number of data elements illustrated in a graph should be five. Data elements with multiple subcategories should have less than five.
6. Colors and patterns are useful to emphasize a point, not to make a graph look "pretty."

G. CHAPTER 13 TEST

1. Anytown Hospital's records over the past decade showed the following yearly Cesarean section rates. Set up a table and a chart that will clearly compare Anytown's rates to the Community Hospital rates.

Year	Anytown Hospital	Community Hospital
1994	44%	35%
1995	42%	33%
1996	38%	35%
1997	38%	30%
1998	35%	27%

2. High School A implemented a teen parenting class and High School B did not. The data below indicates the number of students who delivered during the past five years who were under the age of 18 at the time of delivery. Construct a table and chart which clearly displays the trend of teenage pregnancies for students with parenting instruction and without parenting instruction.

Year	***High School A***	***High School B***
1994	168	166
1995	184	182
1996	101	203
1997	122	210
1998	147	241

3. A tumor registrar has collected the following data on female cancers in 1998. The Cancer Committee chairman has asked for a table and a chart that clearly demonstrates the percentage distribution of these cancers:

Cancer Type	***Cases***
Cervical	508
Uterine	302
Ovarian	175
Vulvar	28
Vaginal	19

4. Anytown's Health Department records indicate that these patients were admitted and given inpatient treatment for an infectious disease during the past year. The infections included the following. Construct a table and a chart which clearly presents the greatest incidence of these cases and the contributing hospital.

Bacterial Infection	***Hospital A***	***Hospital B***	***Hospital C***
Intestinal	49	75	60
TB (respiratory)	9	30	19
TB (non-respiratory)	4	28	14
Strep throat	7	17	10
Septicemia	14	20	15
Other bacteria	7	17	20

5. A hospital administrator wishes to compare (by month) the percentage of occupancy in 1998 with that in 1997. Design a chart that will clearly illustrate these trend data.

Month	***Jan***	***Feb***	***Mar***	***Apr***	***May***	***June***	***July***	***Aug***	***Sept***	***Oct***	***Nov***	***Dec***
1997	85	87	82	79	75	70	75	78	80	82	85	73
1998	78	82	85	86	80	77	72	70	75	72	80	80

6. The state cancer registry program has collected the following data. They have asked you to design a series of charts to answer the following questions.

New Cancer cases per 100,000 population Anystate, USA

	1980	*1985*	*1990*	*1995*	*2000*
White males					
Colorectal	58.7	63.4	59.0	53.0	48.1
Pancreatic	11.1	10.7	10.1	9.8	9.2
Lung & Brochial	82.2	82.0	80.9	74.5	71.2
Non-Hodgkin's lymphoma	12.6	15.9	19.6	20.6	20.8
Prostate	78.8	87.1	133.0	140.0	129.0
Black males					
Colorectal	63.5	60.8	59.7	59.8	53.5
Pancreatic	17.6	19.7	15.4	17.4	15.1
Lung & Bronchial	131.0	131.3	118.6	113.3	115.7
Non-Hodgkin's lymphoma	9.3	10.0	14.2	17.9	18.6
Prostate	126.7	133.6	173.3	245.7	210.1
White females					
Colorectal	44.7	45.9	40.2	37.0	36.4
Pancreatic	7.3	8.1	7.7	7.6	7.2
Lung & Bronchial	28.2	35.9	52.5	44.5	44.0
Non-Hodgkin's lymphoma	9.2	11.4	12.9	13.5	12.4
Breast	87.8	107.2	114.4	114.8	115.7
Black females					
Colorectal	49.6	45.9	49.5	46.9	43.3
Pancreatic	13.0	11.3	10.3	12.0	12.5
Lung & Bronchial	33.8	40.2	46.9	49.3	42.7
Non-Hodgkin's lymphoma	6.0	7.1	9.3	7.2	9.5
Breast	74.3	92.5	97.7	101.9	101.3

6a. Which type of cancer is growing the fastest in the black male population?
6b. Which type of cancer is growing the fastest in the white male population?
6c. In which population is the cancer incidence the highest?
7a. What is the percentage distribution of new cancer cases in white females in 2000?
7b. What is the percentage distribution of new cancer cases in black females in 2000?
7c. Compare the distributions new cancer cases for black and white females in 2000.
8a. What type of cancer has the greatest number of new cases reported for all males in 2000?
8b. Which race accounts for the most new cases for each type of cancer in females?
8c. Which type of cancer has the most new cases reported for all races and genders?
8d. What is the percentage distribution of new cancer cases reported for all races and genders for each type of cancer?

These represent just a few of the questions that can be answered by these data. Do you have questions regarding cancer in our population that you would like to answer with these data?

UNIT II

Exam—Chapters 10 through 13

Note: Compute all required computations correct to *two* decimal places.

1. Thirty-five deaths (17 males and 18 females) have been reported during the past year. The ages of the patients at the time of death are as follows:

Males:	68	82	33	44	73	59	57	51	2	62	47
	46	48	70	80	37	59					
Females:	45	82	52	68	76	59	59	55	36	65	66
	52	84	63	46	24	80	NB				

Calculate:

a. Mean age at the time of death of
   (1) all patients.

   (2) all male patients.

   (3) all female patients.

   (4) all female patients if the newborn is excluded.

   (5) all patients if the newborn is excluded.

b. Median age of all 35 patients at the time of death.

c. Mode of the distribution.

Construct:

d. A frequency distribution of all the ages using the following score limits, with a separate column for males and females:

Score Limits	*Midpoint*	*Frequency*			*Cumulative Frequency*		
		M	*F*	*Total*	*M*	*F*	*Total*
80–89							
70–79							
60–69							
50–59							
40–49							
30–39							
20–29							
10–19							
0–9							

Indicate:

e. The size of a class interval.

Calculate:

f. Mean from the grouped frequency distribution.

Construct:

g. A comparison chart, comparing the ages of death of males and females, for the grouped frequency distribution.

2. Construct a comparison bar graph of the following data:

Year	*Deaths*: *Under 48 hours*	*Deaths*: *Over 48 hours*
1995	72	253
1996	68	278
1997	64	268
1998	58	254
1999	52	246

3. Construct a percentage component part graph of autopsy rates, comparing the percentage of deaths that were unautopsied versus those that were autopsied or were coroner's cases.

Year	*Deaths*	*Unautopsied*	%	*Autopsies*	%	*Coroner*	%
1995	312	247	79	58	19	7	2
1996	344	281	82	52	15	11	3
1997	338	273	81	55	16	10	3
1998	310	264	85	41	13	5	2
1999	323	272	84	47	15	4	1

4. Construct a frequency distribution of the lengths of stay (in days) of patients at least one year old who underwent neurosurgery, using a class interval size of 2 with the lowest score limits, 1–2.

LOS:	13	4	7	2	2	5	4	7	6	11
	33	5	5	3	7	4	1	3	6	1
	20	3	3	4	5	3	4	7	6	6
	21	2	2	1	3	4	3	2	1	
	14	1	9	2	2	2	4	3	6	
	16	4	6	7	2	2	7	1	3	
	14	1	3	1	5	3	4	3	3	
	13	5	2	4	4	2	2	6	5	

Determine:

a. Range

b. Mean:
   (1) Ungrouped distribution
   (2) Grouped distribution
   (3) Ungrouped distribution if the high score is eliminated

c. Median:
   (1) Ungrouped distribution
   (2) Grouped distribution

d. Mode

e. Determine the score for:
(1) Fourth decile

(2) Eighth decile

f. Construct a histogram of the data in the grouped frequency distribution

g. Type of skewed curve represented by the distribution

5. Semiannual surgical records reveal the following number of surgical procedures performed on inpatients, and their respective percentages.

Procedure by Medical Specialty	*Number of Procedures*	*Percentage*
Cardiovasular surgery	62	18
Thoracic/Pulmonary surgery	36	10
ENT surgery	12	3
General surgery	111	32
Neurosurgery	5	1.5
Orthopedic surgery	57	16
Urologic surgery	27	8
Gynecologic surgery	40	11.5
	N = 350	100%

Construct a pie graph to represent these data.

6. A total of 180 patients (85 males and 95 females) 18 years of age and older, underwent outpatient surgery during the past month. The age of each patient was recorded as follows:
Males: 80, 78, 74, 73, 70, 70, 69, 67, 66, 65, 65, 63, 63, 62, 62, 61, 61, 59, 59, 59, 58, 58, 58, 57, 57, 57, 56, 56, 56, 55, 55, 55, 54, 54, 53, 53, 53, 53, 51, 50, 50, 50, 50, 49, 49, 48, 48, 48, 48, 48, 47, 47, 47, 46, 46, 45, 45, 44, 44, 42, 42, 41, 41, 40, 40, 40, 39, 38, 37, 37, 36, 36, 35, 33, 32, 31, 29, 29, 28, 27, 26, 24, 21, 21, 19.

Females: 91, 86, 79, 76, 74, 73, 73, 71, 71, 69, 68, 68, 67, 65, 65, 65, 64, 64, 63, 63, 62, 61, 61, 60, 60, 60, 60, 59, 59, 58, 58, 58, 57, 57, 57, 56, 56, 56, 55, 54, 54, 53, 52, 52, 52, 52, 52, 51, 51, 51, 50, 50, 50, 50, 49, 49, 48, 48, 47, 47, 47, 47, 46, 46, 46, 46, 45, 45, 45, 44, 44, 44, 44, 43, 43, 43, 42, 42, 40, 40, 40, 39, 38, 37, 36, 34, 34, 32, 31, 29, 27, 27, 26, 24, 21.

Construct a frequency distribution of the above data, with separate columns for males and females, using 18–22 as the score limits of the lowest interval.

Determine:

a. Range of all 180 scores.

b. Interval size.

c. Median from the ungrouped data:
   (1) All patients

   (2) Male patients

   (3) Female patients

d. Mean using ungrouped data:
   (1) All patients

   (2) Male patients

   (3) Female patients

e. Mean using grouped data:
   (1) All patients

   (2) Male patients

   (3) Female patients

f. Decile score using grouped data:
   (1) Seventh decile for entire distribution

   (2) Fourth decile for male patients

   (3) Eighth decile for female patients.

7. The average length of stay (number of days) for the years 1965, 1990, and 1995, by age groups, were recorded as follows:

Age	*1965*	*1990*	*1995*
<5 years	7.8	6.2	5.2
5–14 years	4.3	5.2	5.0
15–44 years	7.6	5.4	4.4
45–64 years	10.7	6.7	5.6
65–74 years	11.9	8.0	6.5
75+ years	12.4	8.9	7.7
All ages combined	8.9	6.7	5.6

Construct a comparison graph to represent the data.

8. The average length of stay (number of days) for the years 1965, 1990, and 1995, by geographic region, were recorded as follows:

		1965	*1990*	*1995*
Region:	Northeast	10.1	7.3	6.9
	Midwest	8.7	6.2	5.0
	South	8.2	6.7	5.6
	West	8.9	6.3	5.4

Construct a comparison graph of this data.

9. The number of cases of cancer per 100,000 population for the years 1980, 1985, 1990, 1995, and 2000 were recorded as follows:

	1980	*1985*	*1990*	*1995*	*2000*
White males:					
Colorectal	58.7	63.4	59.0	53.0	48.1
Pancreatic	11.1	10.7	10.1	9.8	9.2
Lung & bronchial	82.2	82.0	80.9	74.5	71.2
Non-Hodgkin's lymphoma	12.6	15.9	19.6	20.6	20.8
Prostate	78.8	87.1	133.0	140.0	129.8
Black males:					
Colorectal	63.5	60.8	59.7	59.8	53.5
Pancreatic	17.6	19.7	15.4	17.4	15.1
Lung & bronchial	131.0	131.3	118.6	113.3	115.7
Non-Hodgkin's lymphoma	9.3	10.0	14.2	17.9	18.6
Prostate	126.7	133.6	173.3	245.7	210.1
White females:					
Colorectal	44.7	45.9	40.2	37.0	36.4
Pancreatic	7.3	8.1	7.7	7.6	7.2
Lung & bronchial	28.2	35.9	42.5	44.5	44.0
Non-Hodgkin's lymphoma	9.2	11.4	12.9	13.5	12.4
Breast	87.8	107.2	114.4	114.8	115.7
Black females:					
Colorectal	49.6	45.9	49.5	46.9	43.3
Pancreatic	13.0	11.3	10.3	12.0	12.5
Lung & bronchial	33.8	40.2	46.9	49.3	42.7
Non-Hodgkin's lymphoma	6.0	7.1	9.3	7.2	9.5
Breast	74.3	92.5	97.7	101.9	101.3

Construct a comparison graph of an aspect of this data. (The instructor may want to indicate the data to be compared as any number of comparison charts can be constructed.)

A P P E N D I X

I

Definitions

There are a variety of terms used in health care facilities that are related to or relevant to statistics. The majority of these terms have been used throughout this manual and are included here for easy reference. The major source for definitions was *The Glossary of Healthcare Terms*.

A. PATIENT TERMS

Hospital Patient: An individual who receives, in person, hospital-based or hospital-coordinated medical services for which the hospital is responsible.

Hospital Inpatient: A hospital patient who is provided with room, board, and continuous general nursing service in an area of the hospital where patients generally stay at least overnight.

Hospital Newborn Inpatient: A hospital patient who was born in the hospital at the beginning of his current inpatient hospitalization.

Hospital Boarder: An individual who receives lodging in the hospital but who is not a hospital inpatient.

Pediatric Patient: A patient who is usually under the age of 14. No general agreement exists on the age at which a patient is no longer a child (pediatric patient) and is considered an adult. The dividing line is most often drawn at the 14th birthday, so patients 13 years old or younger are considered pediatric patients. The American Hospital Association (AHA) defines "pediatric service" as the diagnosis and treatment of patients usually under the age of 14.

Hospital Outpatient: A hospital patient who receives service in one or more of the facilities of the hospital at a time when he is currently neither an inpatient nor a home care patient.

B. INPATIENT TERMS

Inpatient Hospitalization: A single hospital stay as an inpatient without interruption, except for possible intervening leaves of absence.

Inpatient Admission: The formal acceptance by a hospital of a patient who is to be provided with room, board, and continuous nursing service in an area of the hospital where patients generally stay overnight.

Inpatient Discharge: The termination of a period of inpatient hospitalization through the formal release of the inpatient by the hospital (end of a hospitalization). A discharge includes any of the following:

1. Released by order of the physician.
2. Left against medical advice (abbreviated AMA).
3. Transferred to another facility—hospital, nursing home, etc.
4. Death of the patient.

(The term discharge includes deaths; however, if the term “live discharges” is used, deaths must be added to these discharges to determine the total discharges.)

Day on Leave of Absence: A day occurring after the admission and prior to the discharge of a hospital inpatient, during which the patient is not present at the census-taking hour because he is on leave of absence from the hospital.

Transfers: Intrahospital—a change in the medical care unit of an inpatient during hospitalization. Discharge Transfer—the relocation of an inpatient to another health care institution at the time of discharge.

C. CENSUS-RELATED TERMS

Census: Count; an official count of people.

Inpatient Census: The number of patients present at any one time.

Daily Inpatient Census (DIPC): The number of patients present at the census-taking time each day *plus* any inpatients who were admitted and discharged (A&D) after the census-taking time the previous day.

Inpatient Service Day (IPSD): A unit of measure denoting the services received by one inpatient during one 24-hour period.

Total Inpatient Service Days: The sum of all the inpatient service days for each of the days during the period under consideration.

Average Daily Inpatient Census (Average Daily Census): Average number of inpatients present each day for a given period of time.

D. BED/BASSINET COUNT TERMS

Inpatient Bed Count/Bed Complement: The number of available hospital inpatient beds, both occupied and vacant, on any given day.

Newborn Bassinet Count: The number of available hospital newborn bassinets, both occupied and vacant, on a given day.

Inpatient Bed Count Day: A unit of measure denoting the presence of one inpatient bed, set up and staffed for use, and either occupied or vacant, during one 24-hour period.

Inpatient Bassinet Count Day: A unit of measure denoting the presence of one inpatient bassinet, set up and staffed for use, and either occupied or vacant, during one 24-hour period.

Inpatient Bed Count Days (Total): The sum of inpatient bed count days for each of the days during the period under consideration.

E. OCCUPANCY TERMS

Inpatient Bed Occupancy Ratio: The proportion of inpatient beds occupied, defined as the ratio of service days to inpatient bed count days during the period under consideration.

F. DEATH-RELATED TERMS

Anesthesia Death: Death caused by an anesthetic agent.

Postoperative Death: Surgical death within ten days after an operation.

Maternal Death: Death of any woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, either directly related to pregnancy or aggravated by the pregnancy.

Direct Maternal Death: Death directly related to pregnancy.

Indirect Material Death: Maternal death not directly due to obstetric causes but aggravated by the pregnant condition.

Hospital Fetal Death: Death prior to the complete expulsion or extraction from its mother, in a hospital facility, of a product of human conception, fetus and placenta, irrespective of the duration of pregnancy. The death is indicated by the fact that, after such expulsion or extraction, the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.

Early Fetal Death: Fetal deaths under 20 weeks of gestation (and weighing 500 grams or less); also referred to as "abortion."

Intermediate Fetal Death: Fetal deaths in which the fetus has completed 20 weeks of gestation but less than 28 weeks of gestation (and weighing 501 to 1000 grams).

Late Fetal Death: Fetal deaths in which the fetus has completed 28 weeks of gestation (and is 1001 grams or more in weight); also referred to as "stillbirth."

Stillborn Infant: A fetus, irrespective of its gestational age, that after complete expulsion or extraction . . . shows no evidence of life (as delineated above).

Perinatal Death: An all-inclusive term referring to both stillborn infants and neonatal deaths.

Neonatal Death: Death of a liveborn infant within the first 27 days, 23 hours, and 59 minutes from the moment of birth. (This is also the period during which an infant is considered a newborn.)

Infant Death: Death of a liveborn infant at any time from the moment of birth to the end of the first year of life (364 days, 23 hours, and 59 minutes from the moment of birth).

G. AUTOPSY TERMS

Autopsy: Inspection and partial dissection of a dead body to learn the cause of death, and the nature and extent of disease; postmortem examination.

Hospital Inpatient Autopsy: Postmortem examination performed in a hospital facility, by a hospital pathologist or by a physician on the medical staff to whom the responsibility has been delegated, on the body of a patient who died during inpatient hospitalization.

Hospital Autopsy: Postmortem examination performed by a hospital pathologist or by a physician on the medical staff to whom the responsibility has been delegated, wherever performed, and regardless of the hospitalization status of the patient at the time of his death.

Available for Hospital Autopsy: The body of a current or former hospital patient that has been transported to the appropriate facility for autopsy. This also includes that the

1. necessary authorization is given by the patient's relatives;
2. hospital pathologist has agreed to perform the autopsy;
3. autopsy report will be filed in the patient's hospital medical record and in the hospital laboratory;
4. tissue specimens will be maintained in the hospital laboratory.

H. LENGTH OF STAY/DISCHARGE DAY TERMS

Length of Stay (for one patient): The number of calendar days from admission to discharge.

Total Length of Stay (for all patients): The sum of the days of stay of any group of inpatients discharged during a specified period of time.

I. OB/MATERNAL TERMS (excluding those related to death)

Obstetrics: All patients having diseases and conditions of pregnancy, labor, and the puerperium, whether normal or pathological.

Puerperium: The period of 42 days following delivery; this period is included as part of the pregnancy period.

Delivery: Expelling of a product of conception or having it removed from the body. Multiple births are considered a single delivery. A delivery may include either a live infant or a dead fetus.

Delivered in the Hospital: Includes mothers for whom the pregnancy has terminated in the hospital, regardless of whether the infant is liveborn or is a fetal death.

Admitted After Delivery: Includes mothers for whom the pregnancy terminated before reaching the hospital, regardless of whether the infant is liveborn or is a fetal death. These patients are often included under the category "not delivered."

Abortion/Aborted: Includes mothers for whom the pregnancy has terminated in less than the time specified by the health agency for a viable infant. It includes the expulsion or extraction of all or any part of the placenta or membranes without an identifiable fetus or with a liveborn infant or a stillborn weighing less than 500 grams or occurring before the 20th completed week of gestation.

Pregnancy Termination: Expulsion or extraction of a dead fetus or other products of conception from the mother, or the birth of a liveborn infant or a stillborn infant.

Induced Termination of Pregnancy: The purposeful interruption of an intrauterine pregnancy, with the intention being other than to produce a liveborn infant, and which does not result in a live birth.

Not Delivered: Includes pregnant women admitted for a condition of pregnancy but not delivered of a liveborn or stillborn infant in the hospital. (The women may have been admitted because of threatened abortion or false labor.)

J. NEWBORN TERMS (excluding terms related to newborn deaths)

Hospital Live Birth: The complete expulsion or extraction from the mother, in a hospital facility, of a product of human conception, irrespective of the duration of pregnancy, which, after such expulsion or extraction, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached. Heartbeats are to be distinguished from transient cardiac contractions; respirations are to be distinguished from fleeting respiratory efforts or gasps.

Premature Birth: Newborn with a birthweight of less than 2500 grams (5 lb 3 oz).

Neonatal Periods:

Period I: From hour of birth through 23 hours and 59 minutes.
Period II: From beginning of 24th hour through 6 days, 23 hours, and 59 minutes.
Period III: From beginning of 7th day through 27 days, 23 hours, 59 minutes.

K. MISCELLANEOUS TERMS

Medical Services: The activities related to the medical care performed by physicians, nurses, and other professional and technical personnel under the direction of a physician.

Medical Staff Unit: One of the departments, divisions, or specialties into which the organized medical staff of a hospital is divided in order to fulfill medical staff responsibilities.

Medical Care Unit: An assemblage of inpatient beds (or newborn bassinets) and related facilities and assigned personnel in which medical services are provided to a defined and limited class of patients according to their particular medical care needs.

Special Care Unit: A medical care unit in which there is appropriate equipment and a concentration of physicians, nurses, and others who have special skills and experience to provide optimal medical care for critically ill patients, or continuous care of patients in special diagnostic categories.

Surgical Procedure: Any single, separate, systematic manipulation upon or within the body that can be complete in itself, normally performed by a physician, dentist, or other licensed practitioner, either with or without instruments, to restore disunited or deficient parts, to remove diseased or injured tissues, to extract foreign matter, to assist in obstetrical delivery, or to aid in diagnosis.

Surgical Operation: One or more surgical procedures performed at one time for one patient using a common approach or for a common purpose.

Medical Consultation: The response by one member of the medical staff to a request for consultation by another member of the medical staff, characterized by review of the patient's history, examination of the patient, and completion of a consultation report that gives recommendations and/or opinions.

Swing Beds: Hospital-based acute care beds that may be used flexibly to serve as long term care beds.

APPENDIX

II

Formulae

Listed below are the basic formulae used for hospital statistics. They have been included in the various chapters of the text and are repeated here for easy reference.

A. CENSUS FORMULAE

Inpatient Census: Patients remaining at the previous census-taking time *plus* addition of new admissions and subtraction of the day's discharges (including the deaths).

Inpatient Service Days: Census plus A&Ds (those admitted and discharged the same day).

Average DIPC:

$$\frac{\text{Total IPSD for a period}}{\text{Total number of days in the period}}$$

A&C Average DIPC:

$$\frac{\text{Total IPSD (excluding NB) for a period}}{\text{Total number of days in the period}}$$

NB Average DIPC:

$$\frac{\text{Total NB IPSD for a period}}{\text{Total number of days in the period}}$$

Clinical Unit Average DIPC:

$$\frac{\text{Total IPSD for the clinical unit for a period}}{\text{Total number of days in the period}}$$

B. RATE FORMULA

$$\frac{\text{Number of times something happens}}{\text{Number of times it could happen}}$$

C. OCCUPANCY FORMULAE

Daily IP Bed Occupancy Percentage:

$$\frac{\text{Daily IPSD}}{\text{IP bed count for that day}} \times 100$$

Daily NB Bassinet Occupancy Percentage:

$$\frac{\text{Daily NB IPSD}}{\text{NB bassinet count for that day}} \times 100$$

IP Bed Occupancy Percentage for a Period:

$$\frac{\text{Total IPSD for a period}}{\text{Total IP bed count} \times \text{number of days in period}} \times 100$$

NB Bassinet Occupancy Percentage for a Period:

$$\frac{\text{Total NB IPSD for a period}}{\text{Total NB bassinet count} \times \text{number of days in period}} \times 100$$

Clinical Unit Occupancy Percentage for a Period:

$$\frac{\text{Total IPSD in a clinical unit for a period}}{\text{IP bed count total for that unit} \times \text{number of days in period}} \times 100$$

Occupancy Percentage for a Period with a Change in Bed Count:

$$\frac{\text{Total IPSD for the period}}{(\text{Bed count} \times \text{days}) + (\text{Bed count} \times \text{days})} \times 100$$

(Days refers to number of days in the period.)

D. DEATH RATES

1. General

Gross Death Rate:

$$\frac{\text{Total number of deaths (including NB) for a period}}{\text{Total number of discharges for the period (including deaths of NB + A\&C)}} \times 100$$

Net Death Rate:

$$\frac{\text{Total IP deaths (including NB)} - \text{deaths} <48 \text{ hrs for a period}}{\text{Total discharges} - \text{deaths} <48 \text{ hrs for the period}} \times 100$$

NB Death Rate:

$$\frac{\text{Total NB deaths for a period}}{\text{Total NB discharges (including deaths) for the period}} \times 100$$

2. Surgical Death Rates

Postoperative Death Rate:

$$\frac{\text{Total surgical deaths} <10 \text{ days postop for period}}{\text{Total patients operated upon for the period}} \times 100$$

Anesthesia Death Rate:

$$\frac{\text{Total deaths caused by anesthetic agents for period}}{\text{Total number of anesthesias administered for the period}} \times 100$$

3. Maternal/Fetal Death Rates

Maternal Death Rate:

$$\frac{\text{Total maternal deaths for a period}}{\text{Total maternal discharges for a period (including deaths)}} \times 100$$

Fetal Death Rate:

$$\frac{\text{Total number of intermediate and late fetal deaths for period}}{\begin{array}{c}\text{Total number of births for the period}\\ \text{(including live births, intermediate and late fetal deaths)}\end{array}} \times 100$$

E. AUTOPSY RATES

Gross Autopsy Rate:

$$\frac{\text{Total autopsies on IP deaths for a period}}{\text{Total IP deaths}} \times 100$$

Net Autopsy Rate:

$$\frac{\text{Total autopsies on IP deaths for a period}}{\text{Total IP deaths – unautopsied coroner's cases}} \times 100$$

Hospital Autopsy Rate:

$$\frac{\text{Total number of hospital autopsies for period}}{\begin{array}{c}\text{Number of deaths of hospital patients whose bodies are available for}\\ \text{hospital autopsy for that period}\end{array}} \times 100$$

NB Autopsy Rate:

$$\frac{\text{Autopsies on NB deaths for period}}{\text{Total NB deaths for period}} \times 100$$

Fetal Autopsy Rate:

$$\frac{\text{Autopsies on intermediate and late fetal deaths for period}}{\text{Total intermediate and late fetal deaths for period}} \times 100$$

F. OTHER RATES

Cesarean Section Rate:

$$\frac{\text{Total C-sections performed in a period}}{\text{Total number of deliveries for the period}} \times 100$$

Hospital Infection Rate:

$$\frac{\text{Total number of infections}}{\text{Total number of discharges (including deaths)}}$$

Consultation Rate:

$$\frac{\text{Total number of consultations performed}}{\text{Total number of discharges (including deaths)}}$$

Postoperative Infection Rate:

$$\frac{\text{Total number of postoperative infections}}{\text{Total number of surgical operations}}$$

Bed/Bassinet Turnover Rate—Direct formula:

$$\frac{\text{Total number of discharges (including deaths) for a period}}{\text{Average bed count during the period}}$$

Bed/Bassinet Turnover Rate—Indirect formula:

$$\frac{\text{Occupancy rate} \times \text{number of days in the period}}{\text{Average length of stay}}$$

G. LENGTH OF STAY

Average Length of Stay:

$$\frac{\text{Total discharge days (including deaths but excluding NB)}}{\text{Total discharges (including deaths but excluding NB)}}$$

Average NB Length of Stay:

$$\frac{\text{Total NB discharge days (including deaths)}}{\text{Total NB discharges (including deaths)}}$$

H. VITAL STATISTICS MORTALITY RATES

Maternal:

$$\frac{\text{Deaths due to maternal condition}}{\text{Number of live births}} \times 100{,}000$$

Infant:

$$\frac{\text{Infant deaths (neonatal and post neonatal)}}{\text{Number of live births}} \times 1{,}000$$

Neonatal:

$$\frac{\text{Number of neonatal deaths}}{\text{Number of live births}} \times 1{,}000$$

Perinatal:

$$\frac{\text{Number of neonatal deaths + fetal deaths}}{\text{Number of live births + fetal deaths}} \times 1{,}000$$

Post neonatal:

$$\frac{\text{Number of post neonatal deaths}}{\text{Number of live births}} \times 1{,}000$$

Fetal:

$$\frac{\text{Number of fetal deaths}}{\text{Number of fetal deaths + live births}} \times 1{,}000$$

I. INDUCED TERMINATION OF PREGNANCY RATES

Ratio I:

$$\frac{\text{Induced pregnancy terminations}}{\text{Number of live births}} \times 1{,}000$$

Ratio II:

$$\frac{\text{Induced pregnancy terminations}}{\text{Induced pregnancy terminations + live births + fetal deaths}} \times 1{,}000$$

Induced Termination of Pregnancy Rate:

$$\frac{\text{Induced pregnancy terminations}}{\text{Female population 15–44}} \times 1{,}000$$

J. MISCELLANEOUS RATES

Prevalence:

$$\frac{\text{Known cases of a disease (for a period)}}{\text{Population (for the period)}} \times 1{,}000$$

Incidence:

$$\frac{\text{Newly reported cases of a disease (in a period)}}{\text{Population at the midperiod}} \times 1{,}000$$

Complication Rate:

$$\frac{\text{Number of complications}}{\text{Number of patients at risk}} \times 100$$

Case Fatality Rate:

$$\frac{\text{Number of deaths for a given disease}}{\text{Number of cases of the disease reported}} \times 1{,}000$$

APPENDIX III

Abbreviations

A&C	Adults and Children
ACOG	American College of Obstetricians and Gynecologists
A&D	Admitted and Discharged
ADM	Admission/Admitted
AHA	American Hospital Association
AMA	American Medical Association Against Medical Advice
ALOS	Average Length of Stay
CCU	Coronary Care Unit
CDC	Center for Disease Control and Prevention
CEO	Chief Executive Officer
cf	cumulative frequency
cor	coroner/coroner's case
CTT	Census Taking Time
DD	Discharge Days
DIPC	Daily Inpatient Census
DIS/DC	Discharge/Discharged
DOA	Dead on Arrival
ECF	Extended Care Facility
ED	Emergency Department
ENT	Ear-Nose-Throat
ER	Emergency Room
f	frequency
HC	Home Care
HMO	Health Maintenance Organization
HP	Hospital Pathologist
ICD-9-CM	International Classification of Diseases-9th Revision—Clinical Modification
ICF	Intermediate Care Facility
ICU	Intensive Care Unit

IP	Inpatient
IPSD	Inpatient Service Day(s)
IRS	Internal Revenue Service
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
LOS	Length of Stay
LTC	Long Term Care
Med	Medicine/Medical
NB	Newborn
NCHS	National Center for Health Statistics
Neuro	Neurology
OB	Obstetrics/Obstetrical
Onco	Oncology
OP	Outpatient
Ophth	Ophthalmology
Ortho	Orthopedics
Ped	Pediatrics
PPO	Preferred Provider Organization
PRO	Peer Review Organization
Psych	Psychiatry/Psychology
RCF	Residential Care Facility
Rehab	Rehabilitation
SNF	Skilled Nursing Facility
SSA	Social Security Administration
Surg	Surgery/Surgical
TRF-in	Transfer-in
TRF-out	Transfer-out
Urol	Urology/Urological
$>$	Greater than
$<$	Less than
$\bar{c}$	with
$\bar{s}$	without
Σ	summation

APPENDIX

IV

Answers to the Self-Tests

CHAPTER 2

Self-Tests

1. **Fractions:**
   Caucasian, 43/85; African American, 25/85 or 5/17; Hispanic, 12/85; Oriental, 5/85 or 1/17
2. **Numerator:**
   a. 3
   b. 10
   c. 6
3. **Denominator:**
   a. 17
   b. 10
   c. 8
4. **Quotient:**
   a. 24
   b. 0.375
   c. 0.45
5. **Decimals:**
   a. 0.10
   b. 0.004
   c. 0.045
6. **Percentage:**
   a. 24%
   b. 40%
   c. 0.3%
   d. 0.52%
7. **Ratio/Proportion**
   5/120 or 4%
8. **Ratio/Proportion**
   Orthopedic, 20/100 or 20%
   Gynecological, 12/100 or 12%
   Ophthalmological, 18/100 or 18%
   Urological, 22/100 or 22%
   General surgery, 28/100 or 28%
9. **Averaging:**
   1. 8
   2. 4
   3. 19
   4. 6
   5. 2
10. **Rounding:**

1.	a. 65	e. 7051	i. 148
	b. 66	f. 1	j. 10
	c. 66	g. 38	k. 16
	d. 71	h. 596	l. 56
2.	a. 12.4	e. 457.0	i. 6.6
	b. 27.6	f. 699.0	j. 76.0
	c. 31.7	g. 84.0	
	d. 0.0	h. 1.1	
3.	a. 65.70	e. 126.00	i. 100.06
	b. 68.64	f. 65.67	j. 1.15
	c. 0.01	g. 18.00	
	d. 953.80	h. 80.00	
4.	a. 3300	e. 4,000,000	
	b. 5.8	f. 2180	
	c. 0.005	g. 43.88	
	d. 46.74	h. 46,000	

11. **Fraction to Percentage:**
    a. 83.3%
    b. 78.3%
    c. 14.3%
    d. 87.5%
    e. 35%

12. Ratio to Percentage:
a. 33%
b. 64%
c. 83%
d. 65%
e. 25%

13. Decimal to Percentage:
1. a. 125% e. 0.6%
   b. 63.5% f. 82.35%
   c. 30% g. 1.62%
   d. 3% h. 55%
2. a. 325% d. 56%
   b. 46% e. 2%
   c. 1% f. 4%

14. Percentage to Decimal:
a. 0.05 c. 0.005
b. 0.114 d. 1.25

15. Percentage to Fraction:
a. 3/4 e. 1/5
b. 7/8 f. 84/100 = 21/25
c. 1/3 g. 1/2
d. 9/8 h. 98/100 = 49/50

16. Computing with a Percentage:
1. 1/4 6. 0.12
2. 5/8 7. 420
3. 3/5 8. 67
4. 0.005 9. 23
5. 0.03 10. 46

CHAPTER 4

Self-Tests

17. Census:
1. a. 469
   b. 475
   c. 475
2. 23
3. a. 99
   b. 102
   c. 102
4. a. 151
   b. 152
   c. 152
5. a. 1250
   b. 47
   c. 379
   d. 42
6. Final census = 24
   IPSD = 24

18. Average Census:
1. Jan–Apr 364.375
   May–Aug 481.447
   Sept–Dec 535.926
2. a. 238.06
   b. 18
3. a. A&C = 135; NB = 7
   b. A&C = 141.2
   c. NB = 13.7
4. a. Ped = 11.5; Ortho = 14.4; Psych = 9.5
   b. Ped = 8; Ortho = 11; Psych = 7
   c. 1061

CHAPTER 5

Self-Tests

19. Percentage of Occupancy:
1. 61.7%
2. 70.6%
3. 106.7%
4. 96.2%
5. 86.7%
6. a. 7
   b. 58.3%

20. Occupancy for a Period:
1. a. Dec. 1 thru Dec. 10
   b. 90.86%
2. August thru October
3. a. 96%
   b. February 4 and February 19
   c. 87.86%
   d. February 15 thru 21; 90.29%
4. a. 92.38%
   b. 11
5. a. Medical, 95%
   Surgical, 96.86%
   Pediatric, 93.78%
   Orthopedic, 92.96%
   Obstetric, 90.67%
   Newborn, 97.04% = Best
   b. 94.58%

21. Change in Count:
1. a. Jan. thru Mar. 95.42%
   Apr. thru June 96.07%
   July thru Sept. 96.65%
   Oct. thru Dec. 96.22%
   b. Jan. thru Mar. 93.67%
   Apr. thru June 90.99%
   July thru Sept. 90.54%
   Oct. thru Dec. 94.78%
   c. 96.12%
   d. 92.43%
   e. July thru Sept.

2. 81.57%
3. 95.32%
4. 95.89%
5. a. 98.39%
   b. 94.07%
   c. 93.72%
   d. 91.57%
   e. 95.22%
   f. 93.63%
   g. Oct. thru Dec.
   h. Apr. thru June
6. a. 96.26%
   b. 85.92%

CHAPTER 6

Self-Tests

22. Gross/Net/Newborn Deaths
1. a. 5.5%
   b. 4.6%
   c. 8.3%
2. a. 7.9%
   b. 6.1%
   c. 5.3%
   d. 7.8%
   e. Psychiatric
3. 2.4%
4. a. 3.8%
   b. 2.8%
   c. 3.1%
   d. 3.96% or 4.0%
5. 0.84% or 0.8%
6. a. 5.0%
   b. 4.0%
   c. 3.5%

23. Postop Death Rate:
1. 1.07%
2. 2.66%

24. Anesthesia Death Rate:
1. a. 0.11%
   b. 0.65%
   c. 2.16%
   d. 1.68%
2. a. 0%
   b. 0.77%
   c. 3.44%
   d. 2.32%

25. Maternal Death Rate:
1. 0.24%
2. 0.15%
3. 0.31%

26. Fetal Death Rate:
1. a. 0.83%
   b. 0.42%
2. a. 1.49%
   b. 0.77%
3. a. 1.29%
   b. 0.32%

27. Vital Statistics:
a. 13.15
b. 11.30
c. 6.65
d. 58.86%
e. 14.46
f. 4.65
g. (1) 8.60
   (2) 7.86

CHAPTER 7

Self-Tests

28. Hospital Autopsy:

1. Yes	7. No
2. Yes	8. Yes
3. No	9. Yes
4. Yes	10. Yes
5. Yes	11. No
6. No	

29. Gross Autopsy Rate:
1. a. 44.44%
   b. 2.26%
2. a. 38.89%
   b. 2.02%
3. a. 51.35%
   b. 2.91%
   c. 1.34%

30. Net Autopsy Rate:
1. a. 57.89%
   b. 50%
2. a. 38.71%
   b. 0.90%
   c. 33.33%
   d. 1.29%
   e. 0.42%
   f. 0.52%

31. Hospital Autopsy Rate:
1. a. 66.67%
   b. 50%
   c. 1.46%
2. a. 66.67%
   b. 60%
   c. 1.84%
3. a. 19.66%
   b. 20.65%

c. 16.67%
d. 21.55%
e. 2.77%
f. 1.16%
g. 3.33%
h. 2.20%
i. 2.13%
j. 159.51 patients
k. 14.42 NBs
l. 91.15%
m. 96.13%
4. a. 75%
b. 57.14%
c. 66.67%

32. Newborn Autopsy Rate:
1. a. 50%
b. 0.89%
2. 100%
3. 100%

33. Fetal Autopsy Rate:
1. a. 50%
b. 100%
c. 0.85%
d. 0.41%
2. a. 50%
b. 1.13%
c. 0%
d. 0.29%

CHAPTER 8

Self-Tests

34. LOS:

1. 1 day	6. 37 days
2. 1 day	7. 15 days
3. 14 days	8. 75 days
4. 7 days	9. 119 days
5. 2 days	10. 522 days

35. Average LOS:
1. a. 7 days
b. 3 days
c. 6.20 days
2. a. 8.06 days
b. 2.21 days
3. a. 10.6 days c. 9.67 days
b. 14.4 days d. 2.5 days
4. a. A&C = 5.05 days
b. 4.91 days
c. 7.65 days
d. 2.93 days
e. 2.94 days
f. 2.50 days
g. 81.23%
h. 45.54%
5. a. 5.01 days
b. July–September
c. October–December
6. a. 6.37 days
b. Neurosurgery
c. EENT
d.

EENT	2.17 days
Neurosurgery	9.29 days
Thoracic	8.09 days
Abdominal	6.97 days
GU	5.97 days
Other	4.23 days

36. NB:
1. a. 2.09 days
b. 87.74%
2. a. 2.62 days d. 58%
b. 2.69 days e. 62%
c. 2.5 days f. 54%
3. a. 2.6 days
b. 2.5 days
c. 2.67 days
d. 7 lb 8 oz
e. 8 lb 10 oz
f. 6 lb 15 oz

CHAPTER 9

Self-Tests

37. C-Section/OB:
1. 1.35%
2. a. 59
b. 56
c. 0
d. 30.36%
3. a. 68
b. 1
c. 69
d. 23.19%
4. a. (Delivered for first time divided by total deliveries) × 100
b. 23.33%
c. (C-section for first delivery divided by number delivered for the first time) × 100
d. 33.3%
e. 14.29%

38. Consultation Rates:
1. a. 48.05%
b. 24.06%
2. a. 27.05%
b. Newborn
c. Surgical

3. a. 28.57%
   b. 21.43%
   c. 3.57%
   d. 100%
   e. 80.65%

39. Hospital Infection Rate:
1. 0.35%
2. a. 1.86%
   b. 3.53%
   c. Orthopedics
   d. Medical
3. a. 1.78
   b. 0.03
   c. 0.04%
   d. 0.43%
4. a. 384.62
   b. 175.93
   c. 1409.09

40. Postoperative Infection Rate:
1. a. 2.44%   d. 28.87%
   b. 1.45%   e. 86.91%
   c. 1.41%   f. 0.60%
2. a. 1.20%   e. 0.59%
   b. 1.62%   f. 2.91%
   c. 1.16%   g. 1.76%
   d. 27.91%   h. 82.66%
3. a. March   f. 90.22%
   b. 1.23%   g. 0.86%
   c. 0.30%   h. 32.48 = 32 patients
   d. 1.14%   i. 2.01%
   e. March
4. a. 30
   b. 36.29 = 36 patients
   c. 90.71%
   d. 6.45%
   e. 2.70%
   f. 3.03%
   g. 2.78%

41. Turnover Rate:
1. a. 76.28%   e. 88.51%
   b. 7.64 days   f. 3.93 days
   c. 36.72   g. 83
   d. 36.44   h. 82.20

CHAPTER 10

Self-Tests

42. Frequency Distribution:
1. (1a) 3   (1b) 15
   (2a) 5   (2b) 13
   (3a) 15   (3b) 13
   (4a) 2   (4b) 13
2. a. 11   c. 12
   b. 39   d. 15
3. a. 227   b. 122   c. 0.63
4. a. 55.5–58.4
   b. 24.5%–75.4%
   c. 0.275–0.304
5. 8, 28; 6, 20; 7, 14; 7, 7
6. Lower interval limits, 85-89
   Upper interval limits, 165-169

CHAPTER 11

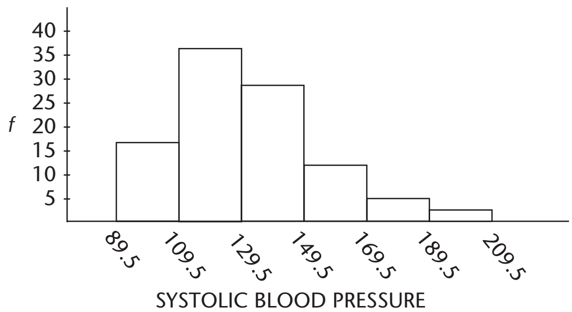
Self-Tests

43. **Central Tendency:**
    Arithmetic Mean = 10.8 or 11
44. Weighted Mean = 87.14
45. Grouped Mean = 61 years of age
46. Median = 54.5
47. Mode: a. 73   b. 77   c. 77
48. a. 88   c. 93
    b. 85   d. 78

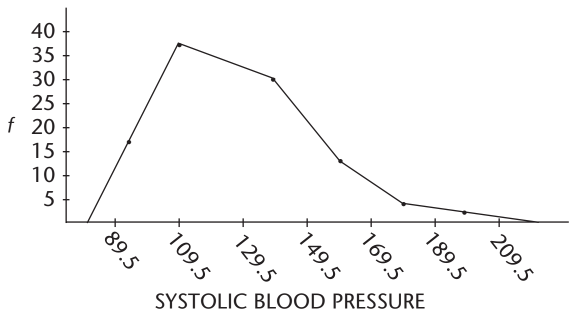
CHAPTER 12

Self-Tests

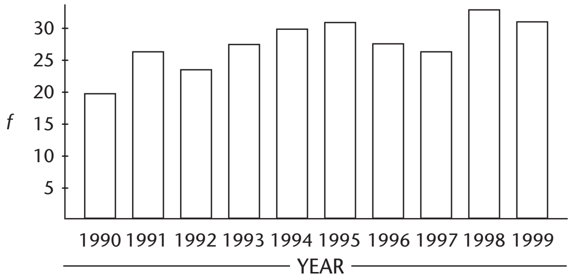
49. Graph:



50.Graph

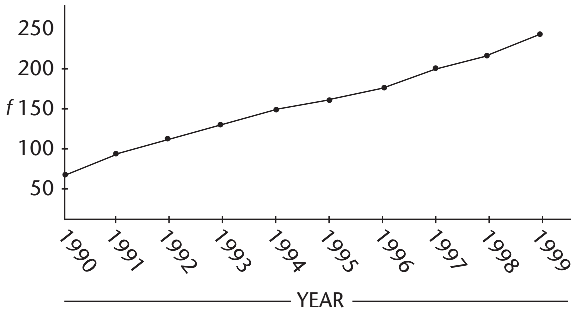


51. Graph



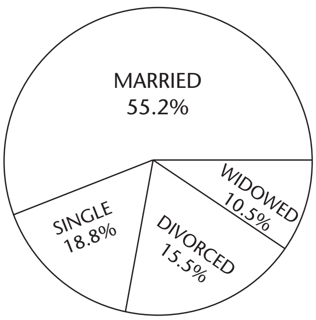
ECTOPIC PREGNANCIES

52. Graph



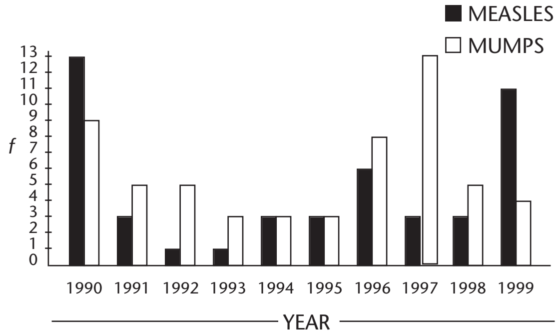
OB DELIVERIES <16 YRS OF AGE

53. Graph



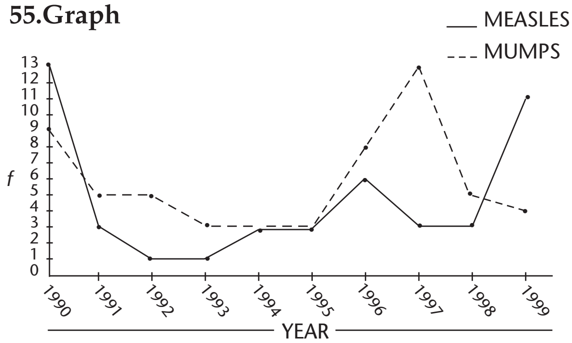
MARITAL STATUS OF HOSPITALIZED PATIENTS OVER AGE 14 IN THE PAST YEAR

54. Graph



COMPARISON OF CONFIRMED CASES OF MEASLES AND MUMPS

55. Graph



COMPARISON OF CONFIRMED CASES OF MEASLES AND MUMPS

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