MONITORING HEART RHYTHM

SECOND EDITION

Prepared by Charles P. Summerall III, M.D.

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Preface to the Second Edition

The second edition of *Monitoring Heart Rhythm* incorporates helpful suggestions from many users and reviewers of the first edition. I have revised the text and graphic material extensively to improve the clarity and efficiency of the self-instruction method. New text material emphasizes the conviction that an understanding of physiologic events is an essential basis for further growth in skill and knowledge. Discussion of the physiology of arrhythmias also provides learning reinforcement for the complex technical vocabulary that many students find difficult to master. The second edition includes a new unit on basic aspects of monitoring artificial paced rhythms and a glossary.

I hope that these changes will keep pace with the expanding interests and aptitudes of health professionals who participate in the coordinated care of heart rhythm disorders, one of the most rewarding advances for cardiology in the two decades since Hughes Day, M.D., opened the nation's first coronary care unit.

Preface to the First Edition

Electrocardiographic monitoring of heart rhythm has become an important extension of the nurse's traditional role in close observation of critically ill patients. The impact of specialized nursing in coronary care units has reached many other settings of patient care. Nurses now care for the monitored patient in a wide variety of special units and at times on general medical-surgical wards. A growing number of paramedical roles, such as that of the advanced emergency medical technician, also require an ability to recognize heart rhythm disorders.

Monitoring Heart Rhythm is an outcome of our experiences in training personnel from relatively small hospitals in basic aspects of coronary care. This self-instructional program is intended to assist nurses and other medical care workers in acquiring fundamental skills and related knowledge with minimal reliance on classroom teaching. The program has been constructively used both as a component of formal courses in coronary care and as a text for in-service training. Completion of the program provides a sound step toward more advanced topics, such as bundle branch block, to be mastered through further study and experience.

C.P.S.
J.M.
J.M.

Contents

Instructions

The study of arrhythmias is a difficult task that requires patience and self-discipline. An essential first step is to acquire the skills and knowledge needed to describe what you see on an electrocardiogram (EKG) rhythm strip. The type of heart waves that are present, their timing and relationship to each other, and their rate in beats per minute (bpm) lead to a rhythm interpretation. In patient care, rhythm strips that show two or more simultaneous disorders of rhythm are commonplace. A student should avoid guessing at the interpretation of a complex rhythm disorder.

Because this text primarily concerns interpretation of EKG rhythm strips, it may not give adequate emphasis to the importance of the individual patient. Students must understand at the beginning that the causes and effects, the outcome and significance of an arrhythmia will depend upon the patient, especially upon the severity of his or her heart disease. In a critically ill patient, a relatively minor rhythm disorder may require immediate attention. On the other hand, a major rhythm disorder that occurs in a healthy person may often be disregarded.

The self-instruction method used in this text emphasizes practice and repetition for learning. Repetition of key terms is particularly important for the study of heart rhythm disorders because students must master a difficult and often confusing vocabulary. Each lesson contains basic information for close study. At frequent intervals, questions or practice exercises provide an opportunity to apply basic knowledge and skills. Correct answers will follow the practice questions. You should check your answers to each question carefully. At the end of each unit, you will find a test to verify your mastery of the unit content. In technical quality, the EKG rhythm strips used as examples or practice exercises resemble those encountered in an average coronary care unit and are realistic, but not always optimal for interpretation. To analyze the rhythm strips, *you will need a pair of standard EKG calipers.*

This program allows you to proceed at your own rate through each of the seven units. You should work through the 41 lessons in sequence. In Unit 1, you will learn the characteristics of the EKG during a normal heart rhythm. Units 2, 3, and 4 concern rhythm disorders generally grouped according to the

severity of their effects and their frequency of occurrence. Unit 5 concerns various forms of heart block, and Unit 6 discusses the EKG waves that occur during artificially paced rhythms. Unit 7 concerns principles of drug therapy for heart rhythm disorders.

As you study the units of this text, keep in mind that you are participating in a far-reaching medical undertaking. The contributions of countless medical scientists and engineers have led to new knowledge and methods that have greatly improved the outlook for patients with one of the most common medical problems, a disorder of the heart beat. Progress in this field continues at a rapid rate, and the skills that you acquire will have increasing value for the future.

SPECIAL COMMENT FOR INSTRUCTORS AND STUDENTS REGARDING PRACTICE EXERCISES

Practice exercises in this text are not rigidly designed. In general they provide an opportunity for students to use important ideas from each lesson by making their own word choice for sentence completion. For many of these exercises, a number of different terms may be correct responses to the same question. Even in measuring rate per minute or duration of EKG waves, the numbers selected often need not be precise and in fact need not agree exactly with answers given in the text. On EKG rhythm strips, many measurements cannot be made precisely. A close approximation is adequate.

Learning Objectives

This self-instruction program is designed to prepare nurses and paramedical specialists to do the following:

From display on a monitor or EKG graph paper:

(a) to recognize a normal rhythm or minor variation from normal
(b) to recognize common arrhythmias and describe their characteristic appearance on the EKG
(c) to classify common arrhythmias according to:
    (1) heart rate
    (2) site of formation of abnormal beats
    (3) general degree of risk to the patient
(d) to recognize the principal forms of heart block
(e) to identify EKG patterns associated with an artificial electronic cardiac pacemaker

When assisting physicians in the treatment of cardiac arrhythmias:

(a) to recall and recognize appropriate drug type and dosage
(b) to recall the possible adverse effects of major antiarrhythmic drugs
(c) to understand the principles of electronic cardiac pacing

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EKG Waves

The EKG has been in medical use since 1900. Originally, the equipment needed to record an EKG was large enough to fill a small room, with the patient seated in the middle, his hands and feet placed in jars filled with a chemical solution. Remarkable advances in electronics now provide safe, convenient, and accurate EKG monitors that can be used almost anywhere, even in a space capsule on the moon.

In daily medical practice, the routine 12-lead EKG assists in the diagnosis of all types of heart disease and of other abnormal conditions that may alter the heart's electrical activity. Myocardial infarction, cardiac enlargement, low serum potassium level, and many other disorders cause major EKG abnormalities. This diagnostic use of 12-lead EKGs has no direct relationship to monitoring heart rhythm and will not be discussed in this text.

An EKG record of heart rhythm provides information that cannot be readily obtained by any other method. Proper use of this valuable tool requires well-organized application of basic principles. Hurried conclusions often result in unnecessary errors.

Unit 1 begins with a lesson about EKG graph paper and how it can be used. The unit includes six lessons about normal EKG waves and their relation to the function of the heart. It concludes with an important lesson about *artifacts*, which are EKG waves that do not come from the heart.

Objectives. Satisfactory completion of Unit 1 will enable you to:

(a) measure time intervals and width of waves on EKG paper.
(b) describe the pacing and conducting system of the heart.
(c) identify EKG waves seen when a normal rhythm is present.
(d) determine regular or irregular heart rates in beats per minute.
(e) identify common EKG artifacts or recording errors.

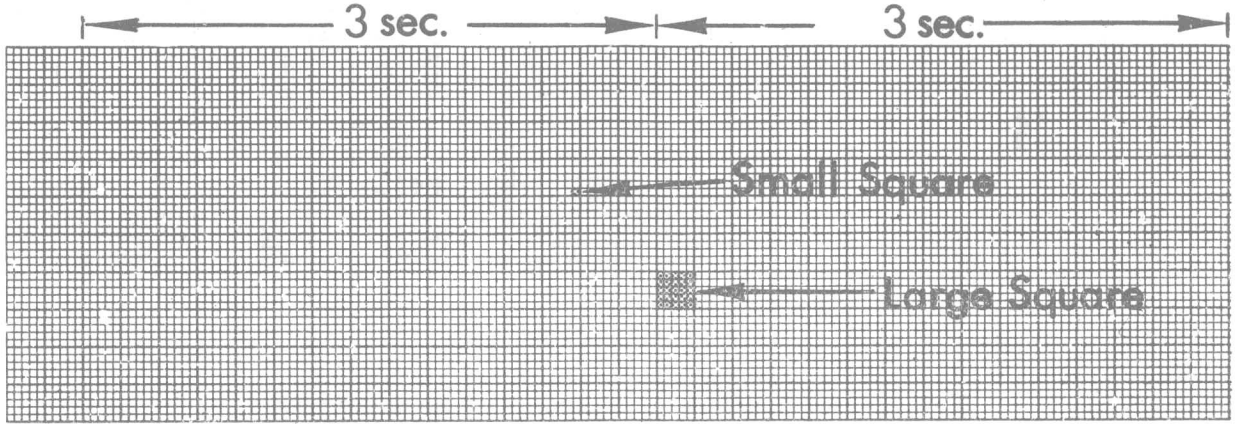
Unit 1 assumes that the student has basic familiarity with the anatomy and function of the heart chambers. To study this unit, you will need a pair of EKG calipers and a special ruler used for counting heart rate. A cutout ruler for this purpose is included as an insert.

Lesson 1

Using EKG Paper

Electrocardiogram (EKG) paper is graph paper for studying heart waves that is composed of small and large squares.

Examine EKG strip 1. Note that large squares have heavier, darker borders than the small squares. Each side of a large square is made up of five small squares. The small squares measure 1 millimeter (mm). Also note the small vertical marks along the top border of the EKG strip. Vertical marks or lines on the graph correspond to short time intervals as the paper moves beneath the EKG recording pen. At standard recording speed, the paper moves 25 mm per second (sec). At this speed, the distance between two small vertical lines on the top border corresponds to 3 sec.



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To help you learn, you will be given questions to answer in each of the lessons in this text. For each numbered question below, fill in the missing word:

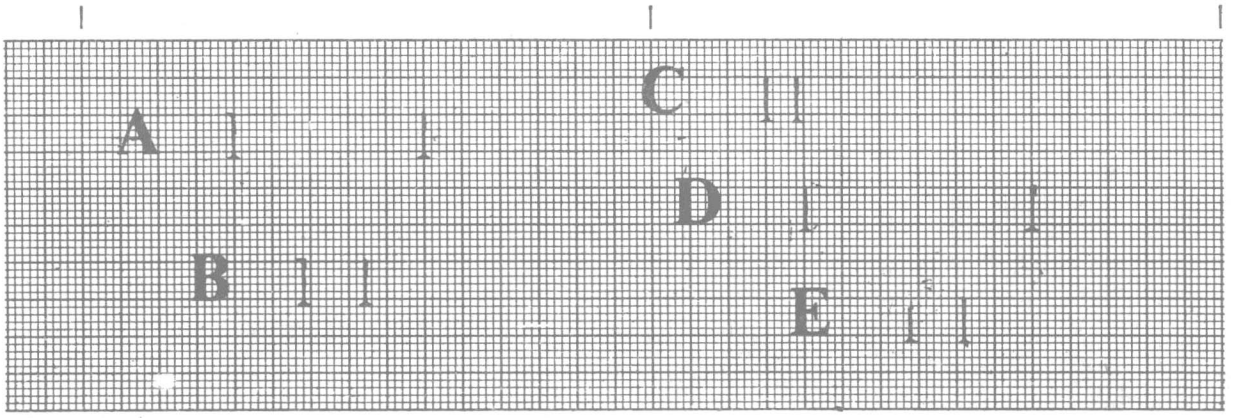
1. On EKG paper, there are _____ small squares on each side of the large square.

2. Each small square measures _____ mm.
3. The usual recording speed for EKG paper is _____ mm per _____.
4. At this speed, the distance between two consecutive vertical marks on the top border represents _____ sec.

After each group of questions you will find information needed to check your answers. This review and repetition will reinforce what you have learned. Always check your work and make corrections as necessary.

Review. On EKG paper, each side of a large square contains five small squares. Each small square measures 1 mm. At standard recording speed of 25 mm per sec, the small vertical marks along the top border measure 3-second time intervals. Did you answer the questions above correctly?

At standard recording speed, the width of each small square represents 0.04 sec. A large square has the width of five small squares and represents 0.20 sec. Examine strip 2. Count the large squares between the first pair of lines (A). The total of five large squares represents 1 sec (five times 0.20 sec = 1 sec). Now count the small squares between the second pair of lines (B). Eight small squares represents 0.32 sec (eight times 0.04 sec = 0.32 sec).



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Now for each numbered question, fill in the missing word.

1. The width of one small square represents _____ sec.
2. The width of one large square represents _____ sec.
3. Count the number of squares between the remaining pairs of lines (C, D, and E) on strip 2 and compute the time they represent.
   a. In C, _____ small squares represent _____ sec.

b. In D, _____ large squares represent _____ sec.

c. In E, _____ small squares represent _____ sec.

Review. By counting the small squares (0.04 sec) or the large squares (0.20 sec), we find that the time intervals between the pairs of lines are: in C, four small squares or 0.16 sec; in D, six large squares or 1.2 sec; and in E, seven small squares or 0.28 sec.

Examine Figure 1, an enlargement of standard EKG graph paper. The wide straight line (B) is the EKG baseline. If the EKG recorder is functioning properly, it records this line at a rate of 25 mm per sec, or 1 mm every 0.04 sec. An EKG wave is a change on this graph caused by an electrical force. EKG waves indicate the size and time duration of electrical forces. At A and C, the illustration shows typical EKG waves. Note that the graph returns to the baseline after each wave.

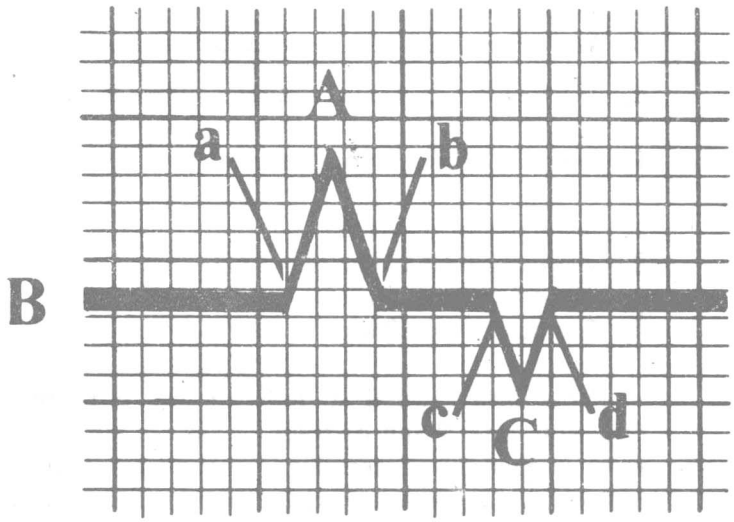
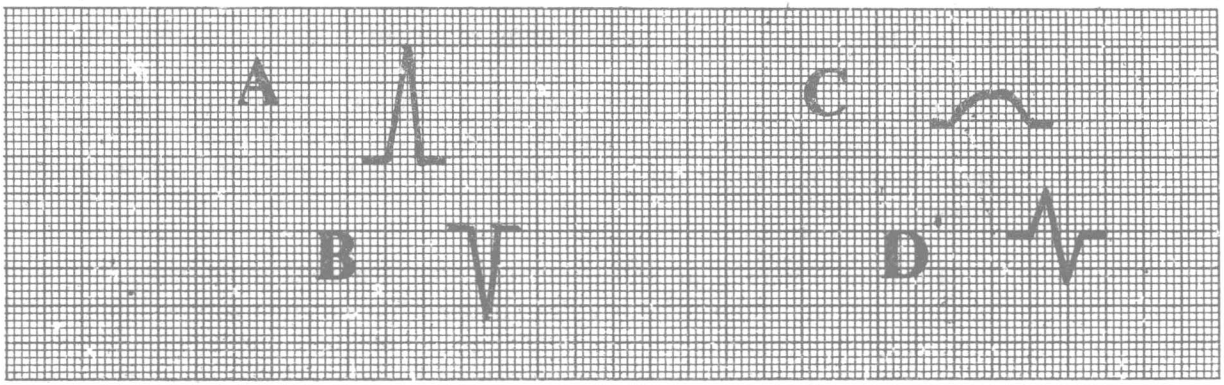


Figure 1

In monitoring the heart rhythm of critically ill patients, you will use vertical lines on EKG graph paper for many important measurements. Small squares are used, for example, to measure the width of an EKG wave. The width of the typical upright wave [(A) in Fig. 1] is measured from point *a*, where the graph leaves the baseline, to point *b*, where it returns to the baseline. The distance between these points is three small squares, and the duration of the wave is 0.12 sec. Similarly, the duration of the downward wave (C) is measured from point *c* to point *d*. This distance is two small squares or 0.08 sec.

Now examine strip 3, which illustrates different varieties of EKG waves. Measure the duration of each wave and fill in the missing words for each numbered question.



3

1. Wave A is _____ small squares or _____ sec wide.
2. Wave B is _____ small squares or _____ sec wide.
3. Wave C is _____ small squares or _____ sec wide.
4. Wave D is _____ small squares or _____ sec wide.

Review. Now check your answers.

1. 5 squares or 0.20 sec
2. 4 squares or 0.16 sec
3. 10 squares or 0.40 sec
4. 7 squares or 0.28 sec

You have learned to measure the duration of heart waves. The height, direction, and shape of these waves are also important. The height of a heart wave is generally determined by the size of the electrical force that the wave represents. A large electrical force will result in a large EKG wave. If the wave is upright, it is electrically positive. A downward wave is electrically negative. A wave that is partly upward and partly downward is called *biphasic*. A group of waves is often called a *complex*.

Examine the waves shown on strip 3. Practice measuring the height of these waves, remembering that the height of a small square is 1 mm and the height of a large square is 5 mm. Positive waves are measured from the top of the baseline, and negative waves are measured from the bottom of the baseline.

1. The height of wave A is _____ mm.
2. The height of wave B is _____ mm.
3. The height of wave C is _____ mm.
4. Wave A is electrically _____ .