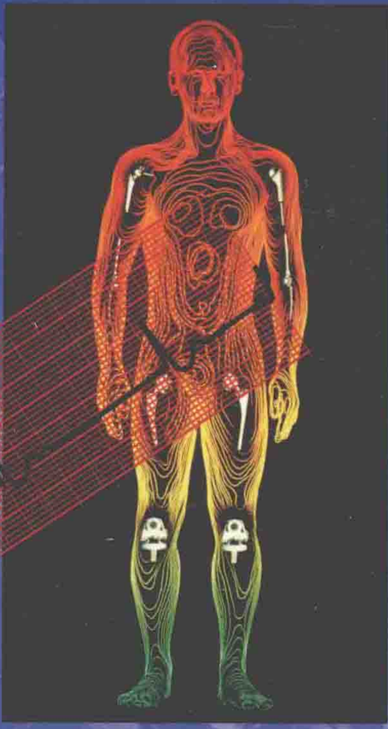
ECGs MADE EASY

POCKET REFERENCE



BARBARA AEHLERT, RN

ECGs Made Easy Pocket Reference

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Illustrations (except ECGs and those otherwise noted) by Kimberly Battista

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PREFACE

The purpose of this pocket reference is to provide the health care provider with a handy, easy-to-use manual containing the primary information needed to interpret basic cardiac dysrhythmias. ECG characteristics of each dysrhythmia are provided in table format for quick reference with possible patient signs and symptoms related to the dysrhythmia.

This material focuses on the essential information needed to interpret basic dysrhythmias and understand their significance. Characteristics of each dysrhythmia are provided with possible patient signs and symptoms related to the dysrhythmia. Where appropriate, current recommended treatment for the dysrhythmia is discussed. All rhythm strips were recorded in lead II unless otherwise noted.

Every attempt has been made to provide information that is consistent with current literature including the American Heart Association guidelines, however, the reader is advised to learn and follow local protocols as defined by his/her medical advisors.

I hope you find this pocket reference of assistance and welcome your comments and suggestions.

Barbara Aehlert, R.N.

For

Kathryn M. Lewis, R.N., PhD

my mentor and friend.

Your wealth of knowledge and gift for teaching
are a blessing to all of us.
My sincere thanks for everything
you have taught me.

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ABOUT THE AUTHOR

Barbara Aehlert, R.N., is currently the President of Southwest EMS Education in Glendale, Arizona. She has been a registered nurse for over 20 years with clinical experience in medical/surgical and critical care nursing and more than 10 years' experience in prehospital education. As an active ACLS Instructor and ACLS Regional Faculty member, Barbara regularly teaches ACLS courses and takes a special interest in teaching basic dysrhythmia recognition in paramedic education programs.

In addition to this pocket reference and its accompanying text, *ECGs Made Easy*, Barbara is the author of the following Mosby publications: *ACLS Quick Review Study Guide, ACLS Quick Review Study Cards, ACLS Quick Review Slide Set, Mosby's ACLS Test Generator,* and *PALS Pediatric Advanced Life Support Study Guide.* Barbara has also acted as a consultant on other Mosby educational materials, including the *American Heart Association ACLS Video Series,* a reviewer of several EMT-B texts, and a contributor to several ACLS CD-ROM projects.

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CHAPTER 1

Cardiovascular Anatomy and Physiology

Table 1-1. The Layers of the Heart Wall.

Epicardium (visceral pericardium)	External layer of the heart Coronary arteries are found in this layer
Myocardium	Middle and thickest layer of the heart Responsible for contraction of the heart
Endocardium	Innermost layer of the heart Lines the inside of the myocardium Covers the heart valves

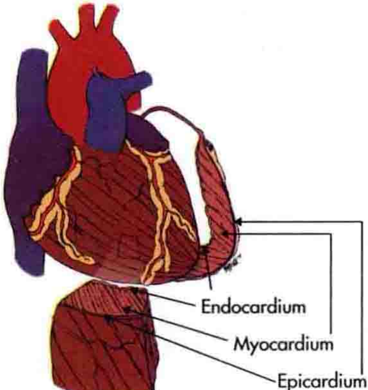

Figure 1-1. The layers of the heart wall.

Table 1-2. The Valves of the Heart.

Valve Type	Name	Location
Atrioventricular (AV)	Tricuspid	Separates right atrium and right ventricle
	Mitral (Bicuspid)	Separates left atrium and left ventricle
Semilunar	Pulmonic	Between right ventricle and pulmonary artery
	Aortic	Between left ventricle and aorta

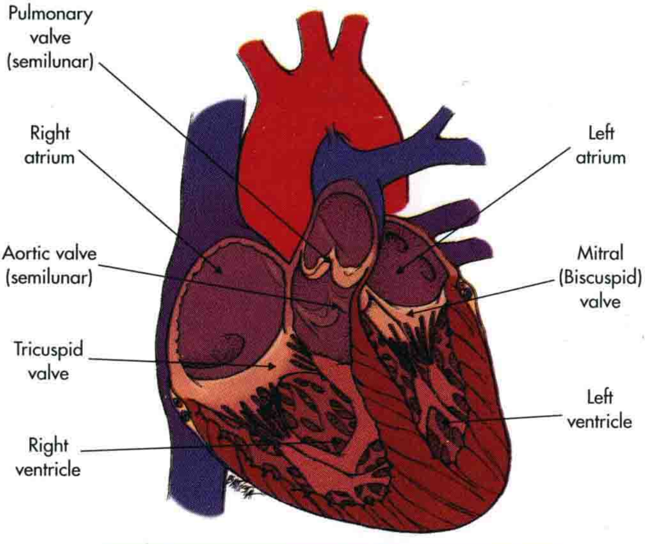

Figure 1-2. The valves and chambers of the heart.

Table 1-3. The Coronary Arteries.

Coronary Artery and Its Branches	Portion of Myocardium Supplied	Portion of Conduction System Supplied
Right • Posterior Descending • Right Margin (AV Nodal)	• Right atrium • Right ventricle • Inferior and posterior surfaces of the left ventricle • Lower one third of the interventricular septum	• AV node (90% of population) • SA node (55%) • Bundle of His • Posterior division of left bundle branch
Left • Anterior Descending • Circumflex	• Anterior and lateral walls of the left ventricle • Left atrium • Part of right ventricle • Upper two thirds of the interventricular septum	• AV node (10%) • SA node (45%) • All bundle branches

Modified from: Conover, M. *Electrocardiography, A Home Study Course*. St. Louis: C. V. Mosby Company, 1984.

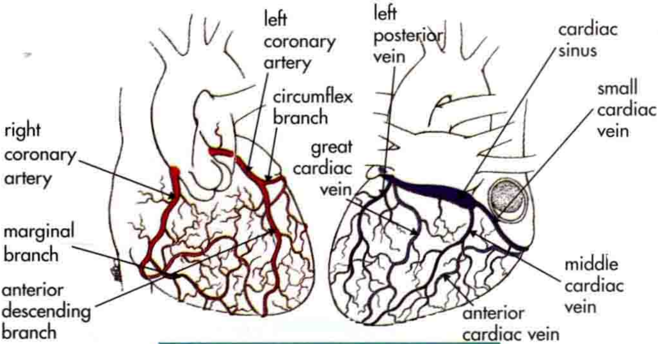

Figure 1-3. The coronary circulation.

The heart is innervated by both the sympathetic and parasympathetic nervous systems. The medulla in the brain contains two cardiac centers - the accelerator center and the inhibitory center. Stimulation of sympathetic nerve fibers, which reach the myocardium by way of accelerator (sympathetic) nerves, results in the release of norepinephrine, a neurotransmitter, which increases the force of ventricular contraction, heart rate, blood pressure, and cardiac output. Sympathetic nerve fibers innervate both the atria and the ventricles, but primarily the ventricles.

Parasympathetic nerve fibers from the inhibitory center in the medulla supply the SA and AV nodes of the heart by means of the vagus nerve. Stimulation of these nerve fibers causes the release of acetylcholine, which results in a slowing of the rate of discharge of the sinus node and slowing the rate of conduction through the AV node, resulting in slowing of the heart rate.

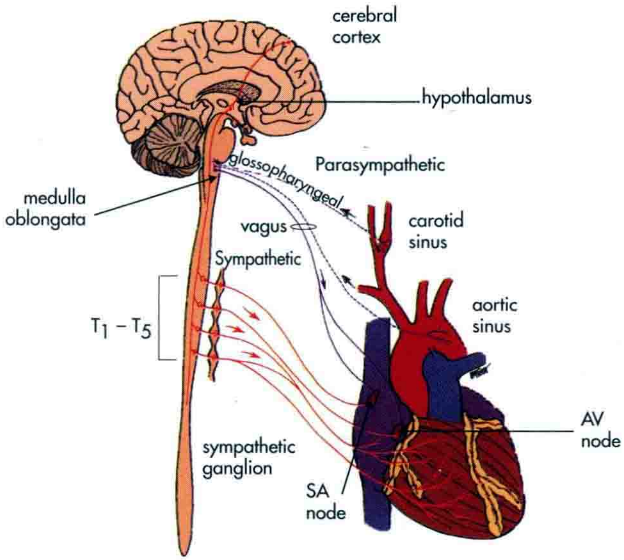

Figure 1-4. Autonomic nervous system innervation of the heart.

Basic Electrophysiology

Table 2-1. Myocardial cell types.

Kinds of Cardiac Cells	Where Found	Primary Function	Primary Property
Myocardial cells	Myocardium	Contraction and relaxation	Contractility
Specialized cells of the electrical conduction system	Electrical conduction system	Generation and conduction of electrical impulses	Automaticity Conductivity

Modified from Huszar, RJ: *Basic Dysrhythmias: Interpretation and Management,* 2/e, St. Louis, 1994. Mosby-Year Book, Inc.

Cardiac cells have four primary characteristics:

Excitability (or irritability) is a characteristic shared by all cardiac cells and refers to the ability of cardiac muscle cells to respond to an outside stimulus. Cardiac muscle is electrically irritable because of an ionic imbalance across the membranes of cells. Excitability may be increased as a result of epinephrine and norepinephrine secretion by the adrenal medulla.

Automaticity is the ability of cardiac pacemaker cells to spontaneously initiate an electrical impulse without being stimulated from another source (such as a nerve). The SA node, AV junction, and Purkinje fibers possess this characteristic.

Conductivity refers to the ability of a cardiac cell to receive an electrical stimulus and conduct that impulse to an adjacent cardiac cell. All cardiac cells possess this characteristic.

Contractility refers to the ability of cardiac cells to shorten, causing cardiac muscle contraction in response to an electrical stimulus. Contractility can be enhanced through the use of certain medications, such as digitalis, dopamine, and epinephrine.

THE CONDUCTION SYSTEM

The specialized electrical (pacemaker) cells in the heart are arranged in a system of pathways called the conduction system. Normally, the pacemaker site with the fastest firing rate controls the heart.

Sinoatrial (SA) Node

The sinoatrial (sinus or SA) node is a cluster of cells located in the upper posterior portion of the right atrium at the junction of the superior vena cava and the right atrium. Because the sinoatrial node normally depolarizes more rapidly than any other part of the conduction system, it normally paces the heart. Other areas of the heart can take over control by discharging impulses more rapidly than the sinus node or by passively taking over, either because the normal pacemaker has failed or because it is generating impulses too slowly.

The SA node normally fires at a rate of 60-100 beats per minute. The pacemaker cells have an intrinsic rate that becomes slower and slower from the SA node down to the end of the His-Purkinje system. The normal heart beat is the result of an electrical impulse that originates in the SA node.

As the impulse leaves the SA node, it causes depolarization of adjacent myocardial cells, resulting in their contraction. The impulse continues to spread from cell to cell in wavelike form across the atrial muscle, resulting in atrial contraction. The electrical impulse then spreads to the atrioventricular (AV) node.

Atrioventricular (AV) Node

The AV node is a group of specialized cells located in the lower portion of the right atrium, above the base of the tricuspid valve. The AV node itself possesses no pacemaker cells. The AV node has two functions. The first is to delay the electrical impulse in order to allow the atria to contract and complete filling of the ventricles before the next ventricular contraction. The second function is to receive an electrical impulse and conduct it to the ventricles.

Bundle of His

After passing through the AV node, the electrical impulse enters the bundle of His (also referred to as the common bundle). The bundle of His is located in the upper portion of the interventricular septum and connects the AV node with the two bundle branches. The bundle of His has pacemaker cells that are capable of discharging at an intrinsic rate of 40-60 beats/minute. The AV node and the bundle of His are referred to as the **AV junction**. The bundle of His conducts the electrical impulse to the right and left bundle branches.

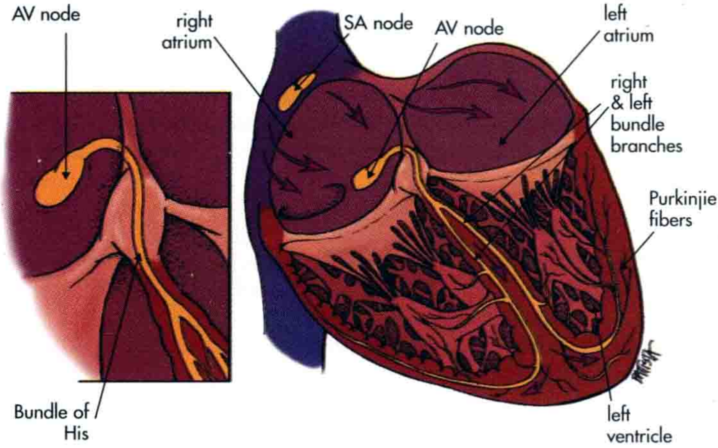

Figure 2-1. The conduction system.

Right and Left Bundle Branches

The right bundle branch innervates the right ventricle. The left bundle branch divides into two bundles, called fascicles, to supply the left ventricle — which is thicker and more muscular than the right ventricle. The left bundle branch divisions are called the left anterior fascicle and the left posterior fascicle.

Purkinje Fibers

The right and left bundle branches divide into smaller and smaller branches and eventually connect with the Purkinje fibers which are an elaborate web of fibers that penetrate about 1/3 of the way into the ventricular muscle mass and then become continuous with the cardiac muscle fibers. The electrical impulse spreads rapidly through the right and left bundle branches and the Purkinje fibers to reach the ventricular muscle, causing ventricular contraction. The Purkinje fibers have an intrinsic pacemaker ability of 20-40 beats per minute.

DEPOLARIZATION AND REPOLARIZATION

Before the heart can mechanically contract and pump blood, cardiac muscle cell depolarization must take place. The terms depolarization and repolarization are used to describe the changes that occur in the heart when an impulse forms and spreads throughout the myocardium.

A difference between electrical charges must exist in order for electrical current to be generated. The major electrolytes that affect cardiac function are sodium, potassium, and calcium. The exchange of electrolytes in myocardial cells creates electrical activity, which appears on the ECG as waveforms. Depolarization and repolarization occur in a five-phase cycle known as the action potential which is a reflection of the difference in the concentration of these ions across the cell membrane at any given time. The action potential is measured in millivolts.

It is important to understand that depolarization occurs as a result of the movement of ions across the cell membrane. Depolarization is not the same as contraction. Depolarization is an electrical event expected to result in contraction (a mechanical event), however, it is possible to view electrical activity on the cardiac monitor, yet evaluation of the patient reveals no palpable pulse. This clinical situation is termed ***pulseless electrical activity***.

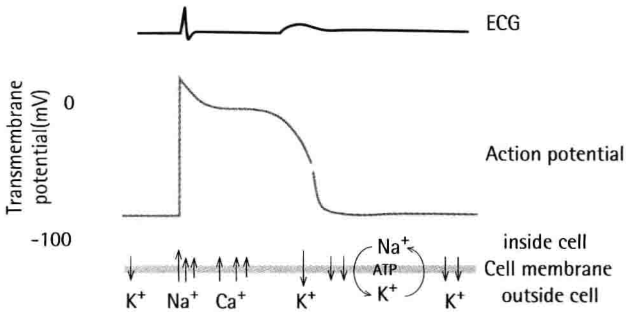

Figure 2-2. Action potential of the ventricular myocardial working cell. From: Aehlert, B: *ACLS Quick Review Study Guide*. St. Louis, Mosby Lifeline, 1994.

REFRACTORY PERIODS

The **absolute** refractory period (also known as the effective refractory period) corresponds with the onset of the QRS complex to the peak of the T wave. During this period, the myocardial working cells cannot contract and the cells of the electrical conduction system cannot conduct an electrical impulse — no matter how strong.

The **relative** refractory period (also known as the vulnerable period) corresponds with the downslope of the T wave. During this period, some cardiac cells have repolarized to their threshold potential and can be stimulated to depolarize if the stimulus is strong enough.

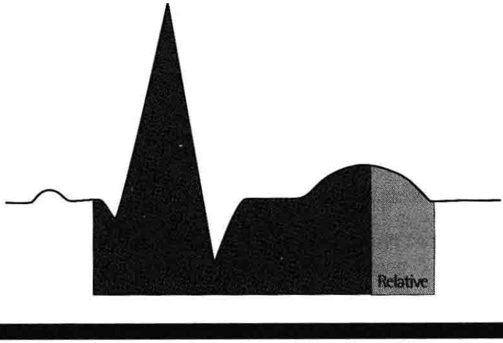

Figure 2-3. Refractory periods. From: Aehlert, B: *ACLS quick review study guide*. St. Louis, Mosby Lifeline, 1994.

ELECTRODES AND LEAD SYSTEMS

Electrodes are adhesive pads that contain a conductive gel and are attached to the patient. Color-coded wires (leads) connect the electrodes to a cardiac monitor. Check to be sure the conductive jelly in the center of the electrode is not dry and avoid placing the electrodes directly over bony prominences.

Leads I, II, and III record electrical activity between two electrodes and are referred to as "limb" leads or "bipolar" leads. Electrodes placed on the right arm, left arm, and left leg form a triangle (Einthoven's triangle). One of these electrodes is always positive and one is negative — the positive electrode is the recording electrode. The third electrode is a ground which minimizes electrical activity from other sources.