Thank you for choosing SureFire CPR! This study guide is an outline to help you prepare for your upcoming ECG and Pharmacology course. Even though there is a lot of information in this guide, it will help you prepare for the course and be a resource for you in the future.

In the course we will teach you the basics for ECG and pharmacology for Advanced Cardiac Life Support (ACLS) and Pediatric Advanced Life Support (PALS). At the end of the course you will have the foundation to:

- Read and interpret heart rhythms
- Understand cardiac anatomy and electrophysiology
- Take ECG measurements and place 12 Leads
- Understand basic medications used during a cardiac event, including dosages, usages, and contraindications.

**Because the course covers a lot of material in a short amount of time, there is required prestudy material.**

Here is what you need to do before you come to class.

1. Read through this study guide
2. Go to [http://www.skillstat.com/Flash/ECGSim531.html](http://www.skillstat.com/Flash/ECGSim531.html) and play the 6 Second ECG Game to practice up on your EKG skills

We look forward to having you in class. If you need anything at all, please don’t hesitate to call us. Remember we also have ACLS, PALS, BLS, PEARs, and NRP for your training needs as well. Thanks again!

Take care,

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ECG and Pharmacology Study Guide

ECG interpretation is a skill that takes practice and time. The class will prepare you for ACLS and PALS and introduce you to the world of cardiology and rhythm interpretation. You will be given the tools and basic foundation to start learning how to read ECG rhythms. We will cover the basic rhythms, arrhythmias, and basic pharmacology that are used for ACLS and PALS.

Blood Flow Through the Heart

We will quickly go over the path of blood flow through the heart to help with your understanding of ECG interpretation. The heart is broken up into four main chambers, the right and left atria, and the right and left ventricles.

1. Blood enters the right atrium from the inferior and superior venae cavae.
2. Blood in the right atrium flows through the right AV valve (tricuspid) into the right ventricle.
3. Contraction of right ventricle forces the pulmonary valve open.
4. Blood flows through the pulmonary valve into the pulmonary trunk.
5. Blood is distributed by right and left pulmonary arteries to the lungs where it gathers O₂ and leaves CO₂ behind.
6. Blood returns from lungs via pulmonary veins to the left atrium.
7. Blood in the left atrium flows through the left AV valve (bicuspid) into the left ventricle.
8. Contraction of the left ventricle forces aortic valve open (this occurs at the same time as the contraction of the right ventricle).
10. Blood in aorta is distributed to every organ in the body where it distributes O₂ and accumulates CO₂.
11. Blood returns to heart via the venae cavae.
Electrical Activity of the Heart

1. An electrical impulse is sent out from the SA node.
2. The impulse travels through the atria to the AV node. (Atrial Contraction)
3. Then down through the Bundle of His
4. To the Bundle branches
5. Into the Purkinje Fibers of the ventricles. (Ventricular Contraction)

The electrical activity of the heart’s conduction is shown as an ECG. Below are the different actions of the heart as registers on the ECG.
• P wave = Atrial Depolarization
• QRS Complex = Ventricular Depolarization
• T Wave = Ventricular Repolarization
• (Atrial Repolarization is not visible on the ECG due to low amplitude)
• Depolarization is the electrical activation of the myocardium (heart muscle)
• Repolarization is the restoration of electrical potential of myocardial cells

Sodium/Potassium Pump and Depolarization

• The Sodium (Na\(^+\)) /potassium (K\(^+\)) pump is responsible for creating optimum conditions inside and outside of the cell.
• When there is an unfavorable gradient between the sodium outside of the cell and the concentration of potassium within, a resting potential is established.
• This electrolyte imbalance allows for depolarization to occur and a rapid shift within the cell from negative to positive.
• Sending Potassium back out and allowing for Sodium to enter back within the cell.

Excitation: Depolarization

![Diagram of voltage dependent K+ and Na+ channels showing depolarization process.]
ECG Basics

1. The view you see on the monitor screen, represents electrical conduction. In order to identify mechanical contraction, a pulse check of the patient is needed.
2. Basic ECG is used for rhythm identification. (4 or 5 lead)
3. Lead placement should be placed on the limbs (the patient’s arms and legs)
4. When obtaining a 12 lead, the leads should be placed on the limbs and V1-V6 should be placed on the chest. (See below for proper placement)
5. A 12 lead ECG is needed to diagnose a rhythm.

Basic about the heart’s electrical conduction:

1. The SA (sinus atrial node) is the heart’s pacemaker (controls the rate of the heart). The rate is 60-100 beats per minute.
2. The AV (atrial ventricular node) is next on the conduction pathway. The rate is 40-60 beats per minute.
3. The last is the ventricles. The rate is typically less than 40 beats per minute.

*Note: If the SA node fails to fire, then your hearts internal pacemaker becomes the AV node. If the AV node fails, then your hearts internal pacemaker becomes the ventricles.
How to Interpret ECG Rhythms

To begin, we are going to first start with the paper the ECG is printed on.

ECG paper:

1. When looking horizontally, that represents time.
2. Each small box is .04 seconds in time.
3. Each large box represents .20 seconds in time.
4. When looking vertically, that represents amplitude/strength of contraction.
5. Each small box is 1mm.

*What would the rate be if there is 1 QRS per second? ______ BPM
Basic Rules of ECG Interpretation:

By following the steps below, you will learn a systematic way to interpret rhythms. We will be covering these steps and practicing extensively in class.

1. Is the rhythm regular or irregular?
2. Is there a P wave present for every QRS complex?
3. Is the PRI interval normal (.12-.20 seconds)?
4. Is the QRS complex normal (less than .12)?
5. Is the rate fast or slow?
6. Does the T wave follow the QRS complex?
7. What is the atrial rate?
8. What is the ventricular rate?

As you look through the following rhythms, keep these rules in mind and try to apply them to each example. You have more examples in your book to study and practice as well as.

Sinus Rhythms:

Description: The normal regular rhythm of the heart is set by the natural pacemaker of the heart called the sinoatrial (or sinus) node. It is located in the wall of the right atrium (the right upper chamber of the heart). Normal cardiac impulses start there and are transmitted to the atria and down to the ventricles (the lower chambers of the heart).

Normal Sinus Rhythm

Description: Normal sinus rhythm occurs when the SA node fires at a rate that is normal for the person’s age. For adults, this is between 60 and 100 beats per minute.
**Sinus Bradycardia**

**Description:** Sinus bradycardia occurs when the SA node fires at a rate that is too slow for the person’s age. For adults, this is less than 60 beats per minute. Many athletes have a resting heart rate of less than 60, so it is important to only treat patients that are symptomatic (fatigue, dizziness, hypotension, altered mental status, etc.)

**Sinus Tachycardia**

**Description:** Sinus tachycardia occurs when the SA node fires at a rate that is too fast for the person’s age. For adults, this is generally between 101 and 150 beats per minute. In sinus tachycardia, all of the normal components of an ECG are present (P waves, QRS complexes, and T waves). Sinus tachycardia usually starts and stops gradually and is the result of pain or another cause that can be identified (fever, exercise, etc.)

**Atrial Arrhythmias:**

**Description:** A cardiac arrhythmia originating from the conduction system within the atria.

**Atrial Fibrillation**

**Description:** Atrial Fibrillation is the most common abnormal heart rhythm. It may cause no symptoms, but is often associated with palpitations, fainting, chest pain, or congestive heart failure. A-Fib may occur in episodes lasting from minutes to days (paroxysmal AF) or may be permanent in
A-Fib can result in a reduction of cardiac output or formation of blood clots in the heart. The risk of stroke is increased fivefold in individuals with A-Fib.

**Supraventricular Tachycardia**

`Image of ECG tracing`

**Description:** Supraventricular tachycardia, or SVT is a category of rhythms that have indistinguishable P waves due to a rate greater than 150 bpm. The P waves typically run into the preceding T waves. These rhythms have narrow QRS complexes because the impulses are generated above the ventricles (Supra = above). Specific SVT rhythms include: Atrial Tachycardia, Junctional Tachycardia, and occasionally Atrial Flutter, Atrial Fibrillation, and Sinus Tachycardia.

**Atrial Flutter**

`Image of ECG tracing`

**Description:** Atrial flutter occurs when an abnormal conduction circuit develops inside the right atrium, allowing the atria to beat excessively fast, about 250-300 beats per minute. A-Flutter is more consistent and less chaotic than A-Fib, and typically has a “sawtooth” pattern seen on ECG.

**Bradycardic Arrhythmias:**

**Description:** Any cardiac arrhythmia with a rate below 60 beats per minute.
1\textsuperscript{st} Degree AV Block

Description: In a first-degree AV block, everything is normal except for a prolonged PR interval. The interval is longer than .20 seconds (or 5 small boxes on the ECG strip). This conduction delay in the AV node rarely causes any problems.

2\textsuperscript{nd} Degree Block (Type I - Wenckebach)

Description: Second Degree, Type I block occurs at the AV node. The PR interval gets progressively longer until it drops the QRS complex. You can see 2 dropped QRS complexes on the strip above.

2\textsuperscript{nd} Degree Block (Type II - Mobitz)

Description: Second Degree, Type II block occurs below the AV node. The P waves are regular, but QRS complexes are dropped. The electrical impulses fail to pass through the AV node which results in atrial contractions that are not followed by ventricular contractions. This rhythm is more serious than the 2\textsuperscript{nd} Degree Type I, and transcutaneous or external pacing is usually recommended.
3rd Degree Block

Description: 3rd Degree, or Complete Heart Block is characterized by no communication between the SA and AV nodes. P waves and QRS complexes will be completely independent of each other. The ventricles will generate their own electrical signal through an accessory pacemaker in the lower chambers. The location of this “Escape Pacemaker” will determine if the QRS complexes are wide or narrow (Junctional = Narrow QRS, Ventricular = Wide QRS).

Ventricular Rhythms:

Description: All of the rhythms below originate in the ventricles and are very unstable.

**Monomorphic Ventricular Tachycardia (with pulses)**

Description: In monomorphic V-Tach the QRS complexes are the same size and shape.

**Polymorphic Ventricular Tachycardia (with pulses)**

Description: In polymorphic V-Tach the QRS complexes are different sizes and shapes.
**Torsades de Pointes**

*Description:* In Torsades de Pointes the QRS complexes are different sizes and shapes in a twisting pattern. This rhythm can be caused by low potassium or quinidine toxicity.

**Pulseless Rhythms:**

**Ventricular Fibrillation**

*Description:* Ventricular Fibrillation (also known as V-Fib or VF) is the most common rhythm to occur immediately after cardiac arrest. The ventricles quiver and are unable to pump blood to the rest of the body. Survival chances diminish rapidly while in ventricular fibrillation and immediate defibrillation is essential.

There are two types of V-Fib: Coarse and Fine. Coarse VF is more easily corrected with defibrillation than fine VF. Fine VF is more likely seen in a patient with a prolonged cardiac arrest.
Both types of ventricular fibrillation are treated with defibrillation.

**Ventricular Tachycardia (No Pulse)**

**Description:** Ventricular Tachycardia (also known as V-Tach or VT) occurs when the ventricular focus takes over control of the heart and fires at a tachycardic rate. The QRS complex is wide because it originates in the ventricles. This rhythm is treated identically as V-Fib when there are no pulses.

**Asystole**

**Description:** Asystole is when there is no detectable activity on the ECG. It may follow many rhythms, including VF, PEA, or 3rd Degree Heart Block. Always ensure that all leads are attached to the patient.

**Pulseless Electrical Activity (PEA)**

**Description:** Pulseless Electrical Activity (PEA) occurs when the heart is beating and has a rhythm, but the patient does not have a pulse. For example: Sinus rhythm without a pulse = PEA

For all patients without a pulse, CPR is the priority.

Pharmacology

We are going to review some standard medications used to treat arrhythmias per the AHA guidelines. You will also see these drugs used in the practice of treating real patients in the clinical environments.

Basic Rules to Administering Medications:

Before you administer drugs to a patient you must correctly “rights” and “dice” your medication. Below are the following things that must be checked every time prior to administration.

Rights and Dicing

5 Patient Rights +1

1. Right patient
2. Right dose
3. Right route
4. Right time
5. Right drug + Any Allergies

DICE

D - Check that you have the right Drug

I - Check the Integrity of the container (make sure that the box is intact and that the cap has not been tampered with or removed

C - Check the Clarity of the solution

E - Check the Expiration date of the drug
**Common Drugs:**

Below are several common drugs that you will see again in the ACLS and PALS curriculum. For a more detailed description of each, please refer to your textbook.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Drug Class</th>
<th>Clinical Use</th>
<th>Adult Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin</td>
<td>Platelet aggregate inhibitor</td>
<td>Acute Coronary Syndrome</td>
<td>324mg</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>Vasodilator</td>
<td>Chest Pain, CHF</td>
<td>0.4mg</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>Sympathomimetic</td>
<td>Cardiac Arrest</td>
<td>1mg*</td>
</tr>
<tr>
<td>Atropine</td>
<td>Parasympatholytic</td>
<td>Symptomatic Bradycardia</td>
<td>0.5mg</td>
</tr>
<tr>
<td>Amiodarone</td>
<td>Anti arrhythmic</td>
<td>VT, VF, and Pulseless VT</td>
<td>300mg, 150mg**</td>
</tr>
<tr>
<td>Adenosine</td>
<td>Antidysrhythmic</td>
<td>SVT</td>
<td>6mg, 12mg, 12mg***</td>
</tr>
<tr>
<td>Morphine</td>
<td>Narcotic Analgesic</td>
<td>Chest Pain</td>
<td>Varies</td>
</tr>
</tbody>
</table>

*The recommended dosage of epinephrine during cardiac arrest is 1mg of a 1:10,000 concentration.

**300mg is the recommended first dose during cardiac arrest and a second dose of 150mg is given if pulseless VT or VF persists 3-5 minutes later.

***6mg is the first dose, followed by two subsequent doses at 12mg if conversion out of SVT is unsuccessful.
Pharmacology Basics:

Always check and make sure that the concentrations are correct

Remember that the dose of medication in the solution is not always going to be the amount of ml’s administered.

Example:

- Atropine can come in a preload with a concentration of 1mg in 10ml’s of solution.
- If the patient requires 0.5mg of Atropine to be administered, you would push 5ml’s of the solution

Medications can come in Vials, Ampules, Pills, or premixed solutions

*Both of the vials above hold atropine, however, the amount of drug (mg) in the amount of solution (ml) varies considerably. The vial on the left holds 1mg/mL, while the vial on the right holds 8mg/20mL or (0.4mg/mL). Be aware that these differences can occur in all types of drugs and constantly check your dosage prior to administering any medication!
Routes of Administration

Medications can be administered as a:

- Rapid or slow push
- An infusion or drip (uses a pump or dialflow)
- IM (intramuscular injection)
- Subcutaneously
- Sublingual
- IN (intranasal)
- IV (intravenous)
- IO (intraosseous)

After administering IVP (Intravenous push) meds remember:

- Flush the IV with 20mls of saline.
- Always reassess your patient’s condition.
- Obtain a full set of Vital Signs (blood pressure, pulse rate, skin signs, respiratory rate).
- Assess the patient’s response to medication (did symptoms/problem resolve).

Practice Exercises

Exercise 1:

Label the parts of the heart with the following terms: SA node, AV node, Right atrium, Left atrium, Right ventricle, Left ventricle, Bundle of His, Purkinje fibers, Left bundle branch, Right bundle branch.
Exercise 2:

Match the stage of depolarization/repolarization with the appropriate pictures on the next page. (hint: each picture corresponds with the ECG across from it)

1) Ventricular depolarization is complete.
2) Ventricular repolarization is complete.
3) Ventricular depolarization begins at apex, causing the QRS complex. Atrial repolarization occurs.
4) Atrial depolarization, initiated by the SA node, causes the P wave.
5) Ventricular repolarization begins at apex, causing the T wave.
6) With atrial depolarization complete, the impulse is delayed at the AV node.
**Exercise 3**

Match the adult drug dosage with the correct drug description

<table>
<thead>
<tr>
<th>Drug Dosage:</th>
<th>Drug Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 1mg 1:10,000 concentration</td>
<td>A) 1st dose used for patients in VF</td>
</tr>
<tr>
<td>2) 300mg IVP</td>
<td>B) Used on patients in SVT</td>
</tr>
<tr>
<td>3) 12mg on second dose</td>
<td>C) Used in cardiac arrest</td>
</tr>
<tr>
<td>4) 0.5mg</td>
<td>D) Administered sublingual for patients experiencing chest pain</td>
</tr>
<tr>
<td>5) 0.4mg</td>
<td>E) Used for symptomatic bradycardia</td>
</tr>
</tbody>
</table>

**Exercise 4**

You are presented with an 81 year old female patient complaining of dizziness, shortness of breath and chest discomfort. Her blood pressure is 74/46, pulse rate is 46 and respirations are 20. What is the recommended drug and dosage, when presented with the rhythm below?

A) Epinephrine 1mg 1:10,000 concentration
B) Amiodarone 150mg
C) Atropine 0.5mg
D) Adenosine 6mg
Exercise 5

Complete the following:

1) Is the rhythm regular or irregular?
2) What is the approximate rate?
3) Are there any discernable P waves present?
4) Is the QRS complex normal?
5) What is the name of this rhythm?

What to Expect

1. Please come 10-15 minutes early to class to check in so that we can start on time.
2. Wear comfortable clothing, if you have long hair we recommend you bring a hair tie.
3. Feel free to bring food and drinks to class. We have a refrigerator and microwave for you to use if you need them. (We also have snacks and drinks for you in case you get hungry.)
4. We like to keep our classes small so that you have the best learning environment possible.
5. We promise to do whatever we can to make your experience fun, stress free, and educational.

Thank you again for taking our course and for your dedication to helping save lives. We look forward to seeing you in class and hope this study guide helps you prepare. If you have any suggestions on how we can make this guide or your course better, please let us know!