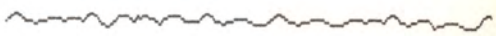
CARDIAC ARREST!

Cardiac Arrest! is a true "mega-code" simulator — not an IF-THEN or CHOOSE A,B,C type program. There are 45 patient data files on the disk — but then each patient will behave differently each time that patient is resuscitated. The patient's history is presented, and the resuscitation efforts begn. You read the EKG on the computer screen, interpret the vital signs, and tell the head nurse what you want done. The effects of your order on the patient are calculated mathematically, and a new EKG and vital signs are printed.

As you try to resuscitate the patient, you type your "orders" in plain English. You can order virtually anything you want in any way you want. The computer just follows orders. To help you learn, the 52-page manual is organized to quickly give you the specific medical information you need, whether you're learning to read the EKG, or just need to review a drug dose.

```
TIME: 11:47   RATE = 38   WEAK PULSE
B.P.= 68/0  SHALLOW RESP.  UNRESPONSIVE
7 PVC'S per minute
ORDERS: ?0.5 MG ATROPINE VIA E.T. TUBE
```



```
TIME: 19:04   RATE = 0   NO PULSE
C.P.R. BEING PERFORMED

ORDERS: ?DRAW BLOOD GASES, PLEASE
```

This simulator goes way beyond the standard "ACLS." It poses difficult therapeutic priorities, and presents patients with problems beyond heart attacks — such as hypocalcemia, hypothermia, hyperkalemia, etc. It's more true-to-life than anything you've seen before. The teaching depth of the Cardiac Arrest! simulator makes it valuable for physicians as well as first-time learners.

Mad Scientist Software's other teaching disks — such as ACLS Protocols, EKG Teaching, CardioQuiz, and Blood Gases — can be added to Cardiac Arrest! to form a complete ACLS teaching system.

Mad Scientist Software

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(801) 785-3028



MAD SCIENTIST SOFTWARE
PRESENTS . . .

CARDIAC ARREST!

the incredible
CARDIAC RESUSCITATION SIMULATOR

BY BRUCE ARGYLE, MD



*** QUICK REFERENCE ***

PROCEDURES

Cooling
Defibrillate
Endotracheal tube
Hyperventilate
I.V.
Nasogastric tube
Precordial thump
Transfer
Warming

LAB

Blood gases
Dextrostix
Electrolytes
Temperature

DRUGS (BOLUS)

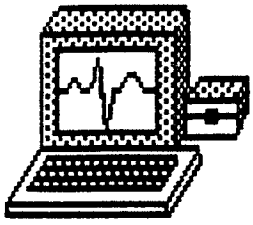
Atropine
Bicarbonate
Bretylium
Calcium
Dextrose
Diazoxide
Digoxin
Epinephrine
Insulin
Lidocaine
Morphine
Naloxone
Propranolol
Verapamil

DRUGS (INFUSIONS)

Dobutamine
Dopamine
Epinephrine
Insulin-glucose
Isoproterenol
Lidocaine
Potassium
Saline

OTHER

Help
History
Observe
Quit



CARDIAC ARREST!

* *
*
* Advanced *
* Cardiac Life Support *
* Simulation Program *
*
* MAD SCIENTIST SOFTWARE *
* Copyright 1986 *
* Bruce Argyle, MD *
* *

An educational simulation for computer.

TABLE OF CONTENTS:

Distributed by:
Mad Scientist Software
2063 North 820 West
Pleasant Grove, UT 84062

*** QUICK REFERENCE ***

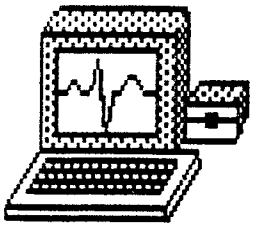
PROCEDURES
Cooling
Defibrillate
Endotracheal tube
Hyperventilate
I.V.
Nasogastric tube
Precordial thump
Transfer
Warming

LAB
Blood gases
Dextrostix
Electrolytes
Temperature

DRUGS (BOLUS)
Atropine
Bicarbonate
Bretylium
Calcium
Dextrose
Diazoxide
Digoxin
Epinephrine
Insulin
Lidocaine
Morphine
Naloxone
Propranolol
Verapamil

DRUGS (INFUSIONS)
Dobutamine
Dopamine
Epinephrine
Insulin-glucose
Isoproterenol
Lidocaine
Potassium
Saline

OTHER
Help
History
Observe
Quit



CARDIAC ARREST!

For ATARI 800/XL/XE, Atari ST, Apple IIc/IIe, and IBM/compatable computers
800/XL/XE series require 48K RAM, BASIC language
IBM/compatables require color graphics capability, DOS 2.0 or higher

Update 1987

INTRODUCTION: You're the emergency specialist in the local hospital emergency room. You've just treated a broken arm and are looking forward to a bite to eat, when the nurse shouts for you. Your next patient awaits you. But this patient is, well, dead.

Whether this "dead" patient can be revived depends entirely on your efforts. You call the shots. You have at your disposal a highly trained team. They'll automatically begin "basic life support," artificially breathing oxygen into the patient and compressing the chest to circulate the blood. But further treatment awaits your orders. Don't blow it.

This is not a program for kiddies. The patients are real patients; the drugs you use are real drugs. Proper use of drugs and proceedures will save a life--inappropriate use of a drug or therapy may kill the patient. With the help of the manual and some practice, a person who knows nothing about medicine can soon begin to "save lives." The more difficult patients would present a challenge even to the emergency specialist.

Although every effort has been made to ensure that this manual and the Cardiac Arrest! simulator are accurate, no guarantee of medical correctness is made. These materials are not designed to replace ACLS education. The application of clinical knowledge is the responsibility of the user.

CARDIAC ARREST! has supporting programs, including EKG Teaching, CardioQuiz, ACLS Protocols, and Blood Gases which are designed to help the user learn advanced cardiac life support (ACLS).

HOW DOES IT WORK?

Atari 800/XL/XE: Place the disk in the drive, then turn the keyboard on (800 and 1200XL users need to insert the BASIC cartridge first). The disk will boot automatically to the main menu. XL/XE series users should NOT press the option key during disk boot.

Atari ST: When cold-starting with TOS in ROM, the desktop will automatically open to reveal the file "CARDIAC.PRG" when the disk is in drive A. Double-click on the program icon. The resuscitation simulator is contained in the folder "CARDIAC", which may be moved to RAMdisk or to hard disk.

Apple IIc/IIe: Place the disk in the drive, then turn on the computer. The program will execute automatically.

IBM/Compatables: Insert the system disk into drive A, and boot MS-DOS. At the "A:>" prompt, type "START" and press RETURN. The program will then load and execute. Most users will, however, want to create an autoboot disk. First format a blank disk as a "system" disk (see your user's manual). Then copy each file from the program disk to your new system-formatted disk (you can omit the "start.bat" file if disk space is critical). The disk is then ready to boot the program automatically, either on power-up or on pressing the CTRL-ALT-DEL key combination.

PROGRAM FUNCTION:

BACKUP YOUR DISK! For your convenience, the Cardiac Arrest! disk is not copy protected. You can make an archive copy (FOR YOUR OWN USE ONLY) with any disk-copy utility.

NOTE: DO NOT WRITE-PROTECT the Cardiac Arrest! disk, or it will not function properly. The disk also needs to remain in the drive during program use.

From the main disk menu, you can choose a patient either by category (easy, difficult, pediatric), by specific problem (hypothermia, hypocalcemia, asystole), or at random. There are 45 patients on the disk. However, a patient will behave differently each time he is resuscitated.

After the resuscitation program and patient data load, you'll see the patient's history. Pay attention. Often there are powerful clues to the patient's problems. Of course, just like in real life, there are occasional tantalizing bits of history which have nothing whatsoever to do with the patient's problem.

The computer determines the patient's heart rhythm and vital signs, printing out a sample electrocardiogram, pulse rate, blood pressure, quality of breathing, and level of alertness. Then it asks you for orders.

CARDIAC ARREST! is a "free-form" simulator. You type in an order in regular English. Be sure words and numbers are separated by spaces. The computer scans your order to see if it means anything. You'll see the words that are in the program's vocabulary echoed back to the screen. If the program can assemble something meaningful from what you typed in, it acts on that order, and advances the simulation one "minute" in time.

As you re-evaluate your patient, you must understand that this is NOT a knee-jerk, IF/THEN-type program. You may do exactly the right thing, but because of the patient's illness, the next screen may show him to be worse than before. The computer determines the patient's status by calculating cardiac parameters (contractility, irritability, functional blood volume, etc) from base variables (cardiac damage, serum potassium, sensitivity to hypoxia, etc). It arrives at a "probability" of various rhythms, then rolls the dice.

After twenty cycles, you can transfer the patient to the Intensive Care Unit (ICU). The patient should have a good blood pressure and rhythm at that time. You may give up at any time, however, by using the word "QUIT." After 45 cycles the program will cut off automatically.

When you exit the simulator program, the computer gives you a final outcome for your patient, and informs you of any special problems it detected. You can try the same patient again, or return to the main menu. Unlike real life, every patient on the disk can be saved IF you do things right.

A FOOTNOTE FOR PURISTS:

The program does not exactly duplicate real life. First, a home computer simply does not have enough memory to follow every single variable and "what if." If you play around, throwing in every drug you can think of, you might see an effect which has no relation to real life. Because my wife put the computer in the fish pond after I had spent a mere 15,000 hours "fine tuning" this program, there are undoubtedly some quirks that I haven't found yet. Secondly, real life is too boring. Certain factors in the program have been deliberately exaggerated for educational purposes. So things happen faster and more dramatically than in real life.

Yes, one should never try to diagnose such things as electrolyte abnormality and heart attack from the monitor screen. You need a twelve-lead EKG. But here you have only one sample tracing (Modified Lead II, like you'd see from standard monitoring). Allow the sample EKG to SUGGEST a problem (such as hypocalcemia) to you, but confirm your suspicion with tests before you inject anything dangerous into the patient.

HOW TO USE THE MANUAL

As you resuscitate your patient, keep the manual handy. If you're just learning cardiac resuscitation, read the manual all the way through, preferably twice. Study Appendixes A,B,C, and D. If you already know advanced cardiac life support (ACLS), scan through these first instructional sections. See what the computer will allow you to do, then go kill a patient.

Look at the sample EKG on the screen. What's the rhythm? Not sure? Look through "SAMPLE ELECTROCARDIOGRAMS" in Appendix J. Does it look a little funny in other ways? Look further in "SAMPLE ELECTROCARDIOGRAMS." You'll find a hint about other problems.

Read about the rhythm under "SOME SPECIFIC PROBLEMS" in Appendix D. Is some other problem suggested by the EKG? Read about that problem also under "SOME SPECIFIC PROBLEMS." Do you need to order a test to confirm that problem? Are there problems evident in the vital sign printout which are NOT explained by the rhythm alone? Examples would be low blood pressure (hypotension), or coma persisting DESPITE a good cardiac rhythm. If so, look it up in Appendix D. As your lab tests come back, compare them to "REFERENCE VALUES FOR THIS SIMULATION," Appendix H. If something's out of line, then read about that problem under, you guessed it, "SOME SPECIFIC PROBLEMS" in Appendix D.

Big words getting to you? Look them up in "GLOSSARY," which is Appendix K.

Now you've read about the problems. Which do you treat first? If you don't know, read "A GENERAL LOOK AT TREATMENT" in Appendix C. More advanced users might just refer to "A SIMPLIFIED APPROACH," Appendix I. No idea what to do? Read about the problems again in "SOME SPECIFIC PROBLEMS." Treatments are outlined there. You can read about any treatment you plan in the order listing, under "PROCEDURES" (Appendix E), "LAB TESTS" (Appendix F), or "DRUGS" (Appendix G). Pay attention to the paragraphs "Indications" and "Precautions." "Indications" means proper reasons for use of a drug or proceedure.

GENERAL INFORMATION ON ORDERS

You may order any proceedure, drug, or test which is in the CARDIAC ARREST! vocabulary, using regular English. A listing of options can be found in "Quick Reference." There's a discussion of each possible order in Appendixes E, F, and G. You will notice that most orders cost you one "minute" of resuscitation time. This forces you to determine priorities.

Besides lab tests and therapies, you can ask to cheat ("HELP" will show you the patient's diagnosis and/or teaching points) or ask to re-read the HISTORY. You never need to order chest compressions, oxygen, or artificial respirations, because these "basic life support" steps are done automatically by your "team" when needed. Towards the end, you can OBSERVE the patient while waiting for lab test results or for treatments to have an effect. When you think you're finished, you order TRANSFER TO ICU for the patient, or QUIT in disgust.

Orders should consist of a single step. Be careful not to make your order too complex, or the computer will get confused. The computer can accept only one proceedure or one drug, one numerical value (dose), one route (IV vs endotracheal), one unit of measure (cc vs mg), and one adjective (pediatric vs adult strength) per order. For example: "GIVE NALOXONE, 2 PEDIATRIC AMPULES I.V." contains one drug (naloxone), one dose (2), one adjective (pediatric), one unit of measure (ampules), and one route (IV).

If you stick to the form found in the sample order which follows each individual drug or proceedure in Appendixes E, F, and G, you shouldn't go wrong. Extra words in the order are ignored by the computer, but if you accidentally throw in a word which the computer recognizes, it may think you meant something else. It may refuse the order or do something you didn't intend. For example, if you say, "HOLD HIM DOWN AND START AN I.V." the program will recognize "HOLD" (as in "STOP") and "DOWN" (as in "TURN DOWN"). It'll tell you there isn't an IV to turn down.

Doses MUST be given in NUMBERS, not words. You must leave a space between each word, AND a space between the dose and the units. For example, the order "2CC EPINEPHRINE IV" will be refused--the program will not recognize "CC" as a unit of measure because no space was left between "2" and "CC." (When an order is refused because it's incomplete, you'll be told what's missing, but you should re-enter the entire order.)

For drips (infusions), simply order the drug by name

(for example, "DOPAMINE DRIP"). The nurse will prepare a standard solution and ask you for the rate of infusion (usually in micrograms per kilogram of body weight). You can't order the drip and specify the rate at the same time, because the program considers setting up the drip and adjusting the rate as two separate steps. The computer will NOT honor any special mixing instructions you give it.

If you don't specify a route for a drug (such as I.V., endotracheal, or infusion), it will be assumed that you want the drug given IV bolus. You can't give drugs subcut., I.M., or P.O., 1) because you shouldn't give them that way in cardiac arrest, and 2) because I was too lazy to work out the pharmacokinetics.

The program has some features to try to head off errors. This will prevent the computer from killing your patient just because you ordered something a little differently. If your "reasonable" order has the computer hissing at you, simplify it down to the bare essence. Watch as the vocabulary search echoes the words back to the screen. If you don't see a word, it is either misspelled or not in the program's vocabulary, or you haven't left a space between the word and an adjacent word or dose. Check your spelling. If all else fails, read the manual.

<u>What can't the program do?</u> Any drug (such as dexamethasone) which takes a long time to have an effect is not available in CARDIAC ARREST! Also, drugs which are rarely used in the ER have been eliminated in order to save time and computer memory. For most of these "refused" orders, the program will acknowledge your order but will tell you it's NOT going to do it.

The computer accepts most abreviations and slang terms, but a couple of drugs must be ordered in a specific way because of the way the "intelligence" in the program works--for example, 50% dextrose must be ordered as "1 AMP DEXTROSE" rather than "1 AMP D50." You'll find any precautions discussed in the individual drug listing (Appendix G).

A pacemaker isn't included in CARDIAC ARREST! in order to give practice with drug therapy for bradycardia and asystole. Realize that a new external cardiac pacemaker would be an excellent treatment for many patients on the disk, but forgive me for having "all available pacemakers in use in the ICU."

You're allowed only a routine IV (this gives you practice with endotracheal medication when the IV is delayed). So cutdowns and subclavians won't be performed by the computer, nor will it allow intracardiac injection.

EXAMPLES OF ORDERS: Scan through the orders listed below. You'll get an idea of the capabilities of the CARDIAC ARREST! simulator.

Acceptable orders:

OBSERVE FOR 10 MINUTES
RECTAL TEMPERATURE
DEFIBRILLATE 200 JOULES
ELECTROLYTES
SHOW ME THE HISTORY AGAIN
SALINE INFUSION
.3 CC EPI BY VEIN
DEXTROSE 1 AMP
HYPERVENTILATE THE PATIENT
WARM NASOGASTRIC LAVAGE
EPI 1 AMP BY E.T. TUBE
START AN IV, PLEASE
DOPAMINE DRIP
WHAT'S THE DIAGNOSIS?
BICARB 25 CC IV
LET'S QUIT, HE'S DEAD.
PEDIATRIC NARCAN, 2 AMPULES
PLACE ENDOTRACHEAL TUBE

Incorrect orders:

LIDOCAINE 1 MG/KG IV PUSH (the "nurse" will not calculate bolus drug doses for you)
CALCIUM 5 CC OF 10% SOLUTION (contains more than one number)
ONE AMP EPI (dose not in numbers: order "1 AMP EPI")
EPINEPHRINE 3CC (no space between dose and units)
GIVE 1 AMP EPI THEN DEFIBRILLATE (two orders)
2 AMPS ISUPREL IN 500 CC, 20 DROPS PER MINUTE (just order ISUPREL DRIP)
LIDOCAINE 75 MG THEN HANG DRIP (two steps)
INSULIN AND GLUCOSE DRIP (see INSULIN-GLUCOSE in drug listing)

Just remember ONE STEP, DOSES ARE NUMBERS, and LEAVE A SPACE. That's about all you need to remember to make the CARDIAC ARREST! simulator understand you.

SO WHAT'S THE PLAN?

Your purpose in using the CARDIAC ARREST! simulator is to save the patient's life while preserving as many of his brain cells as possible. While random chance may play a significant role, your best plan is to follow the standard ACLS protocols where possible. You can practice the protocols on the ACLS Protocols disk (also from Mad Scientist Software). Approach the patient as you would a real one--the program is weighted to "punish" you if you "shoot from the hip."

Order lab tests (blood gases and electrolytes) at the earliest optimum moment. This optimum time is usually immediately. However, since the lab can't run two samples at once, if you plan to give bicarbonate you might wait until after it's been given to order ABG's.

Another helpful hint to improve your patient's outcome is to order hyperventilation right at first. It doesn't take up any time, and decreases the rate of brain damage. Come to think of it, that's not such a bad idea for real patients, either.

You might be tempted to put off intubation in favor of something which seems more immediately helpful, such as lidocaine and another try at defibrillation. I wouldn't. Brain cells and cardiac muscle cells die faster when you don't control the airway. Many other sneaky program functions are designed to insure that the best approach to these "simulated patients" is the same as for a real patient. Try to follow the ACLS treatment protocols as closely as possible.

Particularly with the difficult patent category, stop and think about what clues you've been given in the history. Remember that you can review the history by typing "CHART" or "HISTORY." Here you may need to deviate from the "cookbook" protocols, asking for a body temperature, dextrostix, or special therapies. Consider these extra steps as "inserted" into the protocol, continuing on with the standard approaches.

Although the program will refuse to allow you to cheat during the first few minutes, you might want to check the patient's diagnosis sometime by typing "HELP." Some patients have general treatment hints as well. This is different than on the "ACLS Protocols" disk, where typing "HELP" gets you a complete protocol flowchart.

Some of the more difficult patients present a treatment dilemma. For example, one such dilemma is the patient who can be defibrillated into a pulseless bradycardia, then slips

back into fibrillation. You can waste a lot of valuable treatment time going around in circles. Once you recognize the problem, fix the problems (irritability, conduction block), THEN go back and try to fix the rhythm.

If you succeed in preventing death, stabilize your patient in every way possible before ordering the patient transferred. That means raise a low blood pressure, replace suspected fluid losses, treat continued irritability of the heart. If you don't adequately fix these things, you may find that your patient died in the ICU a few hours later. Assume that the "internist on call" might not get to your patient right away. While you're waiting for IV fluid replacement, or some other therapy, you can just say "OBSERVE 10 MINUTES" to pass the time.

When the evaluation program looks at your performance, keep two things in mind. First, remember that the program only detects SOME problems. It doesn't detect deviation from protocol or less-than-perfect performance. What the evaluation program looks for are gross therapeutic errors and failure to address the patient's underlying problems. For testing how well you apply the ACLS protocols to clinical situations, try the ACLS Protocols disk. Second, be aware that the program may criticize something which really was the best thing to do under the circumstances. This will be quite rare.

With good management, every patient on the disk can be returned to a useful existence. A couple of the more extremely sick patients may do poorly even with perfect management if "Lady Luck" turns against you. Just try again.

The remainder of the manual consists of appendixes designed as references to be used as needed. You'll find them helpful.

APPENDIX A

A BASIC UNDERSTANDING OF CARDIAC ARREST

The heart is a pump. If it's pumping enough blood around, the heart's owner is alive. If the heart doesn't pump enough blood, the person's organs become damaged from lack of oxygen. If the lack of blood flow lasts long enough, the damage to the brain becomes permanent. The heart is also quite sensitive to lack of oxygen, and becomes damaged permanently.

If there's no blood flow at all, we call this cardiac arrest. There's no pulse, and the patient is unconscious and not breathing. Cardiac arrest doesn't mean one specific rhythm (like ventricular fibrillation or asystole); it means that the heart isn't pumping well enough to cause a pulse.

If there's a little blood flow, but not enough to prevent tissue damage, we call it "shock." Shock is diagnosed by a low blood pressure (hypotension). A pulse can be felt. The tissue damage doesn't occur very quickly with shock compared to cardiac arrest, because the organs are getting SOME blood flow.

WHAT'S GOING ON? There are several reasons why the heart might not pump enough blood. For the purposes of this computer simulation, these reasons are 1) abnormal heart rhythm, 2) too little blood to pump around, 3) too much heart damage (severe heart attack) for the heart to pump effectively, 4) effects of drugs on the heart and blood vessels, and 5) abnormalities of blood chemistry or body temperature which affect the heart's function.

1) Abnormal rhythm: The heart has an electrical system which makes it pump just over once a second. This pacing system can become out-of-order because of heart attack, drugs, cold, or abnormal blood chemistry. A pace which is too fast or one which is too slow can prevent the heart muscle from pumping blood effectively. If an abnormal rhythm results in low blood pressure, it needs to be treated. If the blood pressure is O.K., don't treat the rhythm itself, but consider what problem might be developing that the rhythm disturbance is warning you about.

2) Too little blood: If the blood volume is very low, then the heart cannot get blood to vital organs even if it's working perfectly. The blood volume may be decreased because of bleeding, or may be decreased because of dehydration. Fluid may be lost from the blood stream through drugs (water

pills), vomiting or diarrhea, uncontrolled diabetes, or prolonged lack of drinking. Lack of blood volume is treated by giving fluids by vein.

3) Heart damage: When enough of the heart muscle is damaged by lack of oxygen (heart attack), the heart can't pump effectively even if everything else is normal. We call this "cardiogenic shock." This can be helped somewhat by giving the heart more fluid to pump, drugs to help the remaining heart muscle contract more effectively, and drugs which raise blood pressure by constricting blood vessels. All of these measures, however, have hazards and must be used carefully.

4) Drugs: Drugs can disturb the heart rhythm, decrease the ability of the heart to pump, and can dilate the blood vessels so that less blood comes back to the heart (blood vessel dilation deprives the heart of blood just like bleeding). Some such drug effects can be reversed with other drugs, but others will last as long as the drug is in the body.

5) Chemical and temperature changes: The heart uses potassium, calcium, and sodium for its electrical activity and pumping action. Too much or too little of any electrolyte (the name given to any normal body chemical which affects electrical activity) can make the heart malfunction. Too much acid or too much bicarbonate in the blood stream also prevents normal heart activity. Abnormally low temperature slows the heart, then finally upsets the rhythm.

APPENDIX B

WHAT HAPPENS DURING RESUSCITATION

First, the diagnosis of cardiac arrest is made based on unresponsiveness, absent respirations, and absent pulse. The resuscitation team rushes to begin their duties. The team members are: a triage nurse; medication nurse; recording clerk or nurse; a nurse or EMT to give chest compressions; and a respiratory therapist to give artificial respirations. The emergency physician interprets the EKG, gives orders, and performs certain proceedures.

A "crash cart" is rolled up to the patient. It contains the drugs used in cardiac resuscitation, plus supplies such as endotracheal tubes. An EKG monitoring screen often sits on top of the cart, with a defibrillator.

One team member begins chest compressions. The sternum is pushed down about 2 inches to pump blood through the chest. This pumping, however, does not provide enough blood to keep the patient alive for long, so it is important to get the heart beating again.

Another team member is providing respirations, either with a bag and mask, or through the endotracheal tube after it is passed. In some hospitals, the chest compressions and respirations are done by a machine called a "Thumper."

Electrical cables on the patient transmit the heart's electrical activity to the EKG monitor. An IV is started.

The medication nurse prepares and administers medicines when ordered, and charges the defibrillator (since it usually sits on top of the crash cart containing the medicines).

The triage nurse assists in seeing that the physician's orders are carried out smoothly, helping with medication and supplies. This nurse "directs traffic."

The recorder jots down medication and proceedures, noting the time each order is carried out. He/she may remind the doctor if the patient is ready for another bicarb or epi dose.

The emergency specialist's main job is to gather the facts, think, and order. He decides when the patient is doing well enough to transfer. He may order the resuscitation stopped and declare the patient dead if the situation is looking hopeless. Usually resuscitation efforts are kept up at least 30 minutes.

APPENDIX C

A GENERAL LOOK AT TREATMENT

FIX THE ABNORMAL RHYTHM AS QUICKLY AS POSSIBLE. Don't even think about the underlying cause of a cardiac arrest until you have tried to restore the heart rhythm to normal. Go through the therapeutic plan while waiting for tests to come back. Slow rhythms get drugged, fast rhythms get shocked. In the patient is in V-fib, defibrillation is the first thing you do. Remember, though, if an abnormal rhythm produces a good pulse and a decent blood pressure, DON'T "fix" it. In that case you get lab tests, stabilize the problems, THEN convert the rhythm back to normal.

EVERY CARDIAC ARREST PATIENT NEEDS AN IV. An IV is essential to give the patient the medication he needs. Ordering the IV started should be the first thing you do for the patient with a slow rhythm (see "A Simplified Approach"). If the patient has a rapid rhythm as a cause of cardiac arrest, such as ventricular fibrillation, you try defibrillating first.

STIMULATE THE HEART. Stimulate the heart and constrict the blood vessels with epinephrine (adrenaline). In every type of cardiac arrest (NO PULSE!), epinephrine is the first drug used. The epinephrine is repeated every 5 minutes until a blood pressure is obtained. An epinephrine drip is a good way of delivering adrenaline to the patient who continues to need it.

IF THE PATIENT ISN'T BREATHING ON HIS OWN, INTUBATE. A tube put through the mouth into the lungs gives control of the airway. The endotracheal tube allows better artificial respirations, makes CPR more efficient, and prevents vomit from getting into the lungs. One does not, however, delay immediately beneficial steps in order to get the ET tube in. For example, if a patient is in ventricular fibrillation, you don't spend your first minute intubating--you grab the paddles, and a few seconds later the patient is alive and well. But if the cardiac arrest continues, intubate as soon as practical. Generally, intubation is done at the same time the IV is started, or as the first drugs are given IV.

TREAT IRRITABILITY. If the patient keeps going back into V-fib or V-tach, or can't be shocked out of the bad rhythm, treat the irritability of the heart with drugs. Then see if the cause of the irritability is one you can fix--such as acidosis.

ORDER LAB TESTS. Order electrolytes and blood gases promptly. They don't do much good if the results come back after you've given up and called the mortuary. Blood gases should be repeated as often as necessary to keep the serum pH near normal.

CORRECT ANY ACIDOSIS. The patient may not respond at all to your efforts if he has acid buildup (acidosis). Although routine use of bicarbonate is no longer recommended, consider using it on the patient who was "down" a long time before CPR was started and is not responding to the usual treatment. Otherwise, use blood gases to help you decide if extra bicarbonate is needed.

FIX WHAT NEEDS FIXING. Blood volume and blood chemistry should be corrected if possible. A word of caution: it's best to leave MILD abnormalities alone. You can do the patient a lot of harm by trying to treat something which isn't bothering him at all.

OBSERVE. After cardiac arrest, the organs take a little while to get going again. The patient will take a few minutes to wake up. In this simulation, observe at least 10 minutes after the patient gets a pulse to see how much he will recover.

FOLLOW THE REGULAR GAME PLAN. Stick to the treatment instructions. Do exactly what is needed for the patient--no more, no less. If you can't think of anything to do at the moment, continue CPR while awaiting tests. In the simulation, just hit [RETURN] to advance one minute. Don't be tempted to give a drug which you haven't PROVEN a need for just because you think you "have to do something". You won't help your patient by "shooting from the hip."

KEEP A RECORD. Keep a "flowsheet" on which you record each order, and the time of the order. Record also lab tests as they return. The flowsheet helps prevent errors. You might want to start your flowsheet with key data from the history: date, time, age, weight, important history.

APPENDIX D

SOME SPECIFIC PROBLEMS

Acidosis. Acid builds up in the blood stream when the tissues do not get enough oxygen-rich blood delivered to them. In the patient who is alive, acidosis can result from kidney failure, diabetic ketoacidosis, poisonings (like cyanide), and shock. Any patient in cardiac arrest becomes acidotic. Acid makes the heart more irritable and makes it pump less effectively. This acid buildup can be neutralized with sodium bicarbonate if it's severe. Bicarbonate is NOT given routinely any more--consider the situation, then give it only if you think it's needed. A typical starting dose of bicarbonate is 1 mEq per kg. Monitor the acid-base status with blood gases (ABG). You can calculate the amount of bicarbonate needed from the base excess (B.E.). An approximate bicarbonate replacement dose is one tenth of the person's weight in kilograms times the base excess (Additional bicarb = 0.1 x (weight in kg) x B.E.). Overcorrecting the pH (alkalosis) may be harmful, so be careful. Leave a mild acidosis (pH above 7.25) alone.

Agonal rhythm. Occasional wide, abnormal electrical waves are seen, but there is no pulse. This rhythm means trouble. It usually means that the patient has already suffered such severe heart damage that there is no hope of recovery. Treat it essentially like asystole (see below).

Alkalosis. Too much bicarbonate in the blood stream usually results from too much bicarbonate being given by vein. It can occur also by prolonged vomiting up of stomach acid or severe hyperventilation. Alkalosis is very difficult to treat. Since there is nothing on the usual "crash cart" to treat it, this program gives you no way to save the patient if you give an overdose of bicarbonate. Alkalosis makes the heart very difficult to defibrillate and makes the delivery of oxygen from the red blood cells less effecient. If the pH is above 7.25, be happy and don't risk alkalosis by giving extra bicarb.

Anaphyllactic shock. A severe allergic reaction sometimes causes dilation of all blood vessels in the body. This results in low or absent blood pressure and coma. The rhythm is usually sinus tachycardia. Treatment with epinephrine usually gives immediate, dramatic improvement. By constricting all the body's blood vessels, epinephrine gives back to the heart the blood which has pooled in the dilated arteries and veins.

Anemia. See Hemorrhage.

Asystole. No electrical activity at all on the monitor usually means a grim future. It very rare for anyone in

asystole to leave the hospital alive. No electrical activity means a very severely affected heart. If it results from electrolyte problems, you may save the patient. Get the pH as close to normal as possible. While awaiting lab, make sure that epinephrine is given frequently. Give atropine up to the maximum dose. Give maximum doses of epinephrine (consider an epinephrine drip). Try an isoproterenol infusion as a last resort. A pacemaker may be tried, but is not available (or required) in this program. Try defibrillating just in case the asystole is really very fine ventricular fibrillation.

Atrial fibrillation. Unorganized activity in the upper chamber (atrium) can allow electrical impulses to get into the lower chamber irregularly. It's recognized by irregularly spaced QRS complexes, and an irregular baseline between beats. If the rate is close to normal and there is a good blood pressure, then leave it alone. If there is no pulse or very low blood pressure, then defibrillate. If the rate is rapid but there is a fair blood pressure, treat with drugs which increase conduction blockage (digoxin, verapamil).

Atrioventricular conduction block. see conduction block.

Block. see conduction block or bundle branch block.

Bradycardia. A heart rate which is much too slow does not provide good blood flow. It often results from a heart attack or drugs, but can also be seen in hypothermia or electrolyte problems. If the blood pressure is good, do not treat the bradycardia. Treat bradycardia first with atropine, up to the maximum dose. Epinephrine provides temporary stimulation if the patient has a poor or absent pulse. If still severe, try an isoproterenol infusion. Alternatively, an epinephrine infusion may be tried. A pacemaker should be prepared if the patient requires more than atropine for the bradycardia, but this program does not allow you to use it.

Bundle branch block. Part of the conducting system is not working right. It may occur because of electrolyte problems, heart attack, or hypothermia while the rest of the conducting system is still working. While it may alert you to a problem, by itself it requires no treatment. Often, however, bundle branch block is accompanied by AV conduction block which DOES require treatment (see below, conduction block).

Cardiogenic shock. When enough heart muscle is damaged, the heart can no longer pump effectively. When the blood pressure stays low despite a good rhythm, with no cause other than a heart attack, consider cardiogenic shock. If there is some reason to think that the patient has low blood volume, such as use of diuretics (water pills), carefully try a

little saline infusion (about 500 cc over 15 minutes--remember to tell the nurse to turn the thing off). Dopamine or dobutamine can help raise blood pressure, but also must be used carefully. Dopamine increases the irritability of the heart, so in the case of a heart attack, you might want to give lidocaine beforehand. Depending on how much "reserve" the patient has, if over 40 to 45% of the heart muscle has been destroyed, the patient will ultimately die. Sorry, fans, but nitroprusside (Nipride) is not available in this version of Cardiac Arrest!

Coma. Coma means unconsciousness. It may be temporary following cardiac arrest, in which case the patient will become conscious within a few minutes. Prolonged or unexplained coma may be due to brain damage, drugs such as narcotics, severe hypoglycemia, heat stroke, hypothermia, or electrolyte problems. A standard approach to unexplained coma is to draw lab, then give DEXTROSE and NALOXONE (NARCAN) I.V.

Conduction block. When the impulses from the atrium are being stopped from reaching the ventricle, the heart rate can slow enough to cause shock or cardiac arrest. If the impulses are merely being slowed (first degree AV block) but not stopped from reaching the ventricle, this requires no treatment. Conduction block can be caused by heart attack, drugs, hypothermia, or electrolyte problems. Atropine is the first choice--give the maximum amount before trying anything else. An isoproterenol drip is the second choice. Epinephrine is worth a try, and may be very useful in the hypotensive patient. An artificial pacemaker is the next step (for educational purposes, this program requires that you rely on drugs).

Dehydration. Loss of fluid from the blood stream can result in shock, but it usually does not result in cardiac arrest until other problems develop (acidosis, electrolyte abnormality). When dehydration develops, there is usually a loss of electrolytes along with the fluid (usually potassium). Dehydration can result from use of diuretics, severe vomiting or diarrhea, kidney disease, hormone abnormalities, diabetes, losses through the skin (burns or severe sweating), or reduced fluid intake. Clues to dehydration will be found in the history, but also watch for a higher than normal hemoglobin concentration on the ABG, and hypotension with tachycardia. Treat by replacing fluids with saline or ringer's until the blood pressure is normal. Watch the electrolytes.

Drug overdose. See narcotic overdose, overdose.

Fibrillation. See ventricular fibrillation, atrial fibrillation.

Heart attack. See myocardial infarction.

Heatstroke. See hyperthermia.

Hemorrhage. Hemorrhage is loss of blood through bleeding. It may not be obvious if the bleeding is into the chest or abdomen. There should be a history of trauma or obvious blood loss. The blood hemoglobin (Hgb) will fall as the body puts other fluids into the blood stream to try to keep the total blood volume up. Expect tachycardia, then falling blood pressure as shock develops. Treatment is to support the blood pressure with fluids. Support of the blood pressure with dopamine may help, but this only buys time--it does not "fix" the problem. Ultimate treatment is blood transfusion, with an operation if the bleeding is internal. Blood transfusion is not available on this version of Cardiac Arrest!

Hypercalcemia. Too much calcium in the blood stream can result from hormone problems, cancer in the bones, or kidney trouble. Calcium effects the electrical system of the heart, lengthening the PR interval, shortening the ST interval, and shortening the T wave. The heart becomes more irritable. A patient with severe hypercalcemia will usually also be severely dehydrated. Deliberately causing a MILD hypercalcemia by giving calcium by vein helps stabilize the heart when too much potassium is present (see hyperkalemia). Treatment for hypercalcemia is to treat heart block (if present) with atropine, reduce irritability (see below) if present, and to start a rapid saline infusion to correct dehydration and to flush the calcium out the kidneys (assuming the kidneys work). The program does not allow you enough time to see the calcium level fall.

Hyperglycemia. A high blood glucose is called hyperglycemia. Do not treat mild hyperglycemia. A severely high blood sugar by itself does not cause cardiac arrest, but the dehydration which it causes can cause shock, with cardiac arrest following. Diabetic acidosis (called ketoacidosis if ketones are present in the blood) is diagnosed by glucose above 250 and low pH. There is usually tachycardia, plus hyperventilation if the patient is breathing on his own. There may be a lack of potassium as well, even though the potassium may appear normal on an initial electrolyte test. Keep in mind that diabetic ketoacidosis often is caused by a major stress, such as a heart attack. Treatment is insulin, rapid fluid infusion, and bicarbonate if needed. Watch the electrolytes.

Hyperkalemia. High blood potassium is called hyperkalemia. It can result from kidney failure, certain drugs, crushed muscles, hemolysis (red blood cells bursting in the blood), or potassium-containing pills or liquids. As the potassium increases, one first sees tall, peaked T waves, then at a

potassium level of around 6.8 to 7.5 the QRS widens, and conduction block or bundle branch block may develop. The P wave may disappear. The heart becomes prone to fibrillation. Treatment is calcium (this changes some of potassium's effects on the heart) and enough bicarbonate to make the patient a little alkalotic (pH about 7.5). The serum potassium varies inversely with the pH: if the patient is acidotic, the potassium is higher; if alkalotic the potassium level decreases somewhat. A glucose-insulin infusion drives potassium into the cells, decreasing the blood level. Use it carefully, watching the potassium level.

Hypertension. High blood pressure should not be treated on an emergency basis unless complications of the high blood pressure are evolving (intracerebral bleeding, dissecting aortic aneurism, worsening heart attack, etc). A high blood pressure increases the work of the heart, and therefore makes it need more oxygen. Hypertension may worsen a heart attack. It may be treated in various ways, most of which you might later regret. But if the patient needs it, you can lower blood pressure with PROPRANOLOL, DIAZOXIDE, VERAPAMIL, or MORPHINE. In the setting of a heart attack, relieving the pain with morphine is a desireable goal, and will usually also bring the blood pressure down. If MORPHINE alone is not effective to stop the hypertension, then DIAZOXIDE is the next choice. Be careful. PROPRANOLOL and VERAPAMIL are best avoided if possible, but there may be a situation where one of these might be needed.

Hyperthermia. Heatstroke can occur when exercizing in a hot environment. Dehydration or underlying medical problems make heatstroke more likely. Diagnosis is by finding an altered mental status with rectal temperature above 106 degrees. There may be other problems present also. Treat any immediate instability, then dunk the patient in an ice bath. Monitor the temperature so you don't freeze the patient.

Hyperventilation. A conscious patient may hyperventilate because of pain, anxiety, or acidosis. A low carbon dioxide (CO2) gives the diagnosis. Treat only the underlying cause. A somewhat low CO2 is common during CPR because of the artificial respirations.

Hypocalcemia. A deficit of calcium can result from hormone abnormalities, bowel disease, or dietary deficiency. The heart is affected electrically, and cannot contract as strongly, finally becoming more prone to fibrillation. EKG clues are a shortened PR interval with a long ST segment and long T wave. A second "U" wave just after the T wave may be seen--this wave can also be inverted. Treatment (assuming that the patient is in trouble because of it) is calcium by vein. Give about 10 mg per kg for every 1 unit rise desired in serum calcium. Do not treat a low serum calcium unless you think it is affecting the patient's heart.

Hypoglycemia. The brain and heart need sugar to operate. Severe hypoglycemia, an extremely low blood sugar, can cause coma. If the coma is deep enough that the patient stops breathing, cardiac arrest can result. Any patient in undiagnosed coma should get an ampule of dextrose IV (order electrolytes first so you'll know what the original blood sugar was).

Hypokalemia. A lack of potassium in the blood is called hypokalemia. It usually results from diuretics (water pills), but can also occur with hormone problems, or with various causes of dehydration (vomiting, diarrhea). The heart becomes more irritable, and more sensitive to digoxin side effects. The T wave widens, then an extra wave (U) appears after it. Below a level of 2, the ST segment becomes depressed. Treatment of severe hypokalemia (causing cardiac problems) is potassium by vein. Usually this is added into the I.V. fluids. Reorder electrolytes frequently.

Hypotension. Low blood pressure (shock) slowly starves the tissues. As the heart and blood vessels become affected by the hypotension, a vicious circle develops--the heart pumps more poorly and the blood vessels cannot contract to maintain the pressure, so the blood pressure drops further and the heart and blood vessels function even more poorly. Try to treat the CAUSE of the low blood pressure. If low blood pressure results from a rhythm disturbance (either too slow or too fast), then treat that rhythm. Look for any chemical abnormality, and consider the possibility of a drug overdose. If the history hints at fluid loss (dehydration) or blood loss, start replacing lost fluids. Cardiogenic shock is low blood pressure resulting from a severe heart attack (see above). If there is no "fixable" cause (or while waiting for enough fluid to be given IV) support the blood pressure with a DOPAMINE INFUSION. For causes of hypotension, see anaphyllactic shock, cardiogenic shock, dehydration, hemorrhage, hypothermia, narcotic overdose.

Hypothermia. An abnormally low body temperature is called hypothermia. It results from exposure--drunks or addicts out in the cold, drowning victims, newborns exposed to cool air. These victims often seem stiff, cold, and dead. No person with a low body temperature is dead until they are warm and dead. Diagnosis is by rectal temperature (usually below 92) using an electric thermometer. EKG typically shows sinus bradycardia with everything slowed down--prolonged PR, wide QRS, depressed and prolonged ST segment, long T wave. There is hypotension, progressing to acidosis and cardiac arrest. Treatment of hypothermia is "core" warming. The center of the body is warmed using warm NG lavage (or peritoneal dialysis), and warmed air through the ET tube.

Hypovolemia. Low blood volume. See hemorrhage, dehydration.

Irritability. Many problems, including most heart attacks, make the heart prone to abnormal rhythms. If the heart keeps reverting back to V-fib or V-tach, we call this irritability. Think first of any chemical abnormality: acidosis or an electrolyte abnormality may be the cause. If you have not overlooked an obvious cause, then give a lidocaine bolus. Defibrillate if necessary, then draw ABG and lytes. Start a lidocaine drip.

Myocardial infarction. Death of heart tissue from lack of oxygen is called myocardial infarction, or "heart attack." The dead and dying tissue causes irritability (see above) and decreased efficiency of heart pumping. The larger the area of damage, the bigger the problems which it can cause. To prevent ventricular fibrillation, give lidocaine automatically to any heart attack victim.

Narcotic overdose. One automatic response to an unexplained coma is to give a full dose of Naloxone (Narcan). This completely reverses any narcotic effects, without any concern of side effects. Hypotension, shallow respirations, and coma are clues that there might be a narcotic coma. There are no EKG signs. Narcotic coma can progress to cardiac arrest when the dose is high enough to stop the patient from breathing.

Overdose. An oral overdose of medication requires that the stomach be emptied. In a stuporous, comatose, or unstable patient, this means placing an NG tube to suck out any remaining medicine. Specific measures for a particular drug may be required, but the most important first steps are: 1) get control of the patient's airway by placing an ET tube, 2) place an IV, and 3) empty the stomach. Charcoal and laxatives usually follow, but those options are not available in the simulation.

Premature Ventricular Contractions. Occasionally harmless, frequent PVC's occurring in a diseased heart often warn of impending V-fib or V-tach. Usually more than 6 per minute means trouble. Suppress frequent PVC's with lidocaine.

Right bundle branch block. See bundle branch block.

Sinus bradycardia. See bradycardia.

Sinus tachycardia. Sinus tachycardia usually results from overstimulation of the heart. If the blood pressure is normal, leave it alone. Never try to slow sinus tachycardia when the blood pressure is low--the tachycardia is merely a reaction to some other problem, such as hemorrhage or anaphyllactic shock. If the blood pressure is quite high, both the blood pressure and the tachycardia can be treated with a drug like propranolol, but you might want to wait a few minutes until the last dose of epinephrine wears off to

see if the epi is the cause.

Shock. See hypotension.

Ventricular fibrillation. Unorganized electrical activity in the ventricle can result from heart attack, electrolyte abnormality, abnormal acid-base balance, or hypothermia. The heart cannot pump at all. When confronted with ventricular fibrillation, you immediately try defibrillating to see if you can restore a normal rhythm. Fibrillation which resists the shocks is treated first with epinephrine, then with lidocaine. For the exact protocol sequence, see the protocol in "A Simplified Approach". If fibrillation still proves resistant, bretylium is added. Get lab tests and keep trying to defibrillate while waiting. A higher setting gives a better chance of conversion to normal rhythm, so all defibrillations after the first two should be at the maximum setting (4 joules/kg in children). Recurrent V-fib (irritability) should be treated with lidocaine, while you look for any treatable problem such as acidosis which could be causing the irritability.

Ventricular rhythm. If slow and accompanied by hypotension or cardiac arrest, treat it as you would a severe conduction block (see above), while setting up for a pacemaker. If the blood pressure is good, leave the rhythm alone.

Ventricular tachycardia. Caused by factors similar to V-fib, V-tach is a more organized, regular ventricular rhythm which can occasionally give a pulse. Even with a fair blood pressure, V-tach often degenerates into V-fib. Treatment depends on whether the patient is 1)fine, 2)unstable, or 3)pulseless. A patient who is not suffering any harm from the V-tach is treated with lidocaine to try to chemically convert the rhythm. If the patient is unstable (for example, low blood pressure), defibrillate--but at a lower starting dose than for V-fib (see protocol chart in Appendix I). V-tach with NO pulse is treated just like V-fib. Resistant or recurrent V-tach is treated with lidocaine.

APPENDIX E

PROCEDURES AND COMMANDS
Order list, equivalent terms, and explanations

COOLING (COOL, ICE, COLD): A patient with heat stroke (delirious or in coma with rectal temperature above 106) needs rapid cooling. Cooling can be both external (in contrast to the use of heat in hypothermia) or internal and still be effective.

Indications: heat stroke or impending heat stroke

Actions: lowers temperature by 1/4 to 1/2 degree per minute, depending on patient status

Precautions: Be sure to check the temperature frequently and stop the cooling when the temperature nears normal, or you will also get practice at treating hypothermia

SAMPLE ORDERS:

STAT ICE BATH

COLD NASOGASTRIC LAVAGE

D/C COOLING

DEFIBRILLATE (DEFIB, CARDIOVERT, CARDIOVERSION, SHOCK): Defibrillation means giving a brief direct-current shock across the heart. The strength of this shock is measured in joules or watt-seconds (a joule and watt-second are exactly the same thing). The defibrillator is charged, then the shock is given by two paddles. One paddle is placed just above and to the right of the heart, the other placed lower and around to the left. The defibrillator is set at 200 watt-seconds as resuscitation begins. If you want another setting, you must specify. The defibrillator will be at this new setting the next time you order defibrillation. 200 watt-seconds (joules) is the recommended starting setting to defibrillate a normal adult. The stronger the setting, the greater the chances of converting the patient to a normal heart rhythm. In ventricular fibrillation, increase the setting to the maximum if the first two tries are unsucessful. The maximum for our defibrillator is 360. For children, use a setting of 2 to 4 joules per kilogram of weight, rounding up to the nearest multiple of 25.

Indications: V-fib. Also use for V-tach or atrial fib if there is absent pulse or significant hypotension. Worth a try for asystole IF it is in reality very fine V-fib.

Actions: Electrically "fires" all of the heart at once, stopping abnormal "short circuits." Often the heart will then resume a normal rhythm.

Precautions: Excessively high settings will "electrocute" some of the heart muscle.

SAMPLE ORDERS:

DEFIB (will use 200 if no other setting specified previously)

DEFIBRILLATE AT 50 JOULES

SET TO 360 AND SHOCK HIM

ENDOTRACHEAL TUBE (ET TUBE, E.T. TUBE, INTUBATE): You (or the paramedic or anesthesiologist) place a breathing tube down into the patient's trachea. In many situations, you would not want to delay giving important drugs in order to intubate. But as soon as possible, place the ET tube (unless the patient is conscious).

Indications: Intubate any patient in cardiac arrest or coma.

Actions: Prevents aspiration of stomach contents into lungs. Provides better oxygenation of blood. Makes CPR more effective (yes, the program takes that into account, too).

Precautions: Do not delay life-saving actions in order to get the ET tube in.

SAMPLE ORDERS:
PLACE ET TUBE
LET'S INTUBATE HIM NOW
REMOVE E.T. TUBE

HELP (DIAGNOSIS, CHEAT): Gives you the stored diagnosis and teaching points for the patient you are resuscitating. The program will not allow you access to this information until several "minutes" into the resuscitation. You are charged one minute for this information.

SAMPLE ORDERS:
WHAT'S THE DIAGNOSIS
HELP

HISTORY (CHART): You can review the history at any time. You are charged one minute of resuscitation time. This is useful if you've forgotten the patient's weight, or are searching for clues about what's going on.

SAMPLE ORDERS:
CAN I SEE THE CHART AGAIN?
HISTORY

HYPERVENTILATION (HYPERVENTILATING, HYPERVENTILATE): Rapid ventilation of the comatose patient temporarily lowers the acid in the blood stream, as well as supplying increased oxygen and protecting the brain. This will especially make a difference when there is delay getting an IV in place to give bicarbonate. The acid balance returns back to pre-existing values when the hyperventilation is stopped.

Indications: Probably useful for any patient in cardiac arrest, particularly helpful if unable to give bicarbonate.

Actions: Temporarily raises blood pH by blowing off carbon dioxide.

Precautions: Will make a patient with normal pH somewhat alkalotic.

SAMPLE ORDERS:
HYPERVENTILATE
STOP HYPERVENTILATING

IV (I.V., INTRAVENOUS LINE): Medication nurse starts an IV. Occasionally, the IV cannot be easily started. This gives you practice at giving drugs endotracheally. You do not need to keep asking that the IV be started--the med. nurse keeps working at it until it is running, then tells you. The IV is always Dextrose 5% in water (D5W) unless you specify saline or ringer's. If you're running fluids, you can order the IV rate increased or decreased. You can even D/C the IV.

Indications: only route by which most drugs used in resuscitation can be given. Fluid can be given if needed. An IV must be started on every patient.

SAMPLE ORDERS:
PLACE IV
START I.V. WITH LACTATED RINGER'S
TURN UP THE IV

NASOGASTRIC TUBE (NG TUBE, N.G. TUBE): A tube is placed through the nose into the stomach by the team leader or med. nurse. In this simulation, this will be most useful for those patients suspected of drug overdose. The NG lavage removes the remaining drug before it can get into the blood stream.

Indications: This relieves pressure and reduces risk of aspiration if the stomach becomes distended with air. Also useful to suck something out of the stomach (like an overdose of drugs). It can also provide a quick route for warm fluids in hypothermia.

Actions: empties stomach
SAMPLE ORDERS:
PASS AN NG TUBE
NASOGASTRIC TUBE TO SUCTION
D/C NG TUBE

OBSERVE (WATCH, WAIT, NOTHING): If no orders are planned, you may simply hit RETURN without entering anything. Hitting RETURN advances one minute. If you want several minutes to pass while you are waiting for lab or for improvement, you can order a specific number of minutes of observation. There will still be an EKG and vital signs printed out for each minute. The program will override your observation order if the patient's blood pressure or rhythm is bad, lab tests come back, or an IV is started, allowing you to enter new orders. If you want to stop the observation, simply hit any key.

Indications: waiting for lab, waiting until the ICU is ready, waiting to see how a patient improves after treatment.

Actions: advances simulation until specified number of minutes has passed, until blood pressure falls markedly, until lab tests are returned, or until a key is pressed (whichever comes first).

SAMPLE ORDERS:
[RETURN] (hitting return key advances 1 minute)
WAIT 5 MINUTES
OBSERVE 3 MINUTES
WATCH HIM DIE

M.A.S.T. (MAST): Medical anti-shock trousers squeeze the legs and abdomen to help raise the blood pressure. MAST application is especially useful in hypovolemic shock, but there are some arguments for using MAST in cardiac arrest. This is not widely done, and is not part of accepted protocol.

Indications: hypovolemic shock

Actions: gives more effective blood volume to the heart.

Precautions: may precipitate pulmonary edema if fluid volume is normal or increased. Once on, it is dangerous to remove them until blood volume is replaced.

SAMPLE ORDER:
PLACE MAST
D/C MAST

QUIT: see TRANSFER

THUMP: A precordial thump is recommended immediately for a WITNESSED cardiac arrest (no pulse). This involves bashing the victim on the chest with your fist.

SAMPLE ORDER:
PRECORDIAL THUMP

TRANSFER (QUIT): These orders will end the simulation and boot the evaluation program. To TRANSFER, you must have completed at least 20 cycles. QUIT exits the program any time, but you may not get a full critique of your performance. The evaluation program gives you an outcome for your patient, a listing of any problems detected by the computer, and a chance to try the same patient again.

SAMPLE ORDERS:
TRANSFER TO ICU
THIS GUY'S DEAD, LET'S QUIT

WARM (WARMING): A patient who is hypothermic requires "core" warming. To save memory and time, the computer assumes that if you use the word WARM, you are ordering "core" warming (warm NG lavage, warm peritoneal dialysis, warm humidified air via ET tube) and NOT merely warm blankets (which are actually harmful in true hypothermia). So, even though you may get the right effect through the wrong order, order the correct type of warming or your monitor screen will break.

Indications: significant hypothermia (temperature below 94).

Actions: raises rectal temperature by about 1/4 degree per minute if in cardiac arrest, or about 1/2 degree if the patient has a good blood pressure.

Precautions: stop the warming when the temperature is normal.

SAMPLE ORDERS:
CORE WARMING MEASURES
WARM NASOGASTRIC LAVAGE

APPENDIX F

LAB TESTS, TEMPERATURE

Order list, equivalent terms, and explanations

BLOOD GASES (ABG, GAS, ABGS, ABG'S, PH): Arterial blood is tested for pH, oxygen, CO2, bicarbonate, and hemoglobin. The respiratory therapist sticks a needle directly into an artery to get the sample, then runs off to test it. The values are returned to you after five minutes (five program cycles). Normal values, plus the words used to describe abnormalities, are found in the REFERENCE VALUE section. Use ABG to guide your bicarbonate therapy wherever possible (see acidosis under "SOME SPECIFIC PROBLEMS").

DEXTROSTIX (FINGERSTICK GLUCOSE): The nurse sticks a finger, puts a drop of blood on a stick, and tells you what the approximate serum glucose is. It takes one minute. Its advantage over the glucose in the electrolyte panel is that it is back 9 minutes sooner.

ELECTROLYTE PANEL (LYTES, CHEMISTRY, ELECTROLYTES): Blood is drawn from a vein and tested for sodium, potassium, chloride, bicarbonate, glucose, urea nitrogen, and calcium. The test takes ten minutes (ten cycles) to run. The values can be compared to those given in the REFERENCE VALUE table. The significance of any abnormality can be found under "SOME SPECIFIC PROBLEMS." Every patient should have an electrolyte panel drawn. Order the whole panel--do not order a specific electrolyte (serum calcium, for example) or the computer will get confused.

TEMPERATURE (TEMP): Someone will tell you the patient's temperature if you ask. Blood gases may be inaccurate in a cold or feverish patient if someone assumes that the temperature is normal. If the history suggests the possibility of hypothermia or hyperthermia, check the temperature.

SAMPLE ORDERS:
GET A TEMPERATURE
RECTAL TEMP
GET LYTES
DRAW AN ABG
ORDER ELECTROLYTES
DEXTROSTIX

APPENDIX G--PART 1

ORDERING DRUGS

General information: If the drug is to be given as a single injection (bolus), then you must give the computer all the needed information when you enter the order. That means you should give the name of the drug, the dose (in numbers), and the units of measure (CC, MG, AMP). If the drug is to be given endotracheally, you must also specify that. If no route is specified, the program assumes that you want the drug given IV. If you are ordering the drug in pediatric strength, you must also specify that in the order.

If the drug is to be given as an infusion (a constant, steady rate of IV administration), simply state the drug name and specify INFUSION or one of its equivalents (below). Only specific drugs can be ordered as an infusion. After the infusion is set up, you will be asked what rate of drug administration you want (based on a standard mix). To change the rate of an infusion, simply order it increased or decreased, and the medication nurse will ask you what rate of drug infusion you want. To stop an infusion, order it stopped.

If a reasonable order is not being recognized or is being treated differently than you expect, first check your spelling. Make sure that you are using an acceptable word or abbreviation. Check to see if you are using some other word which the computer recognizes as an order.

USEFUL TERMS IN ORDERING DRUGS
(Words within parentheses are equivalent)

Units of measure
- MG (MILLIGRAMS, MILLIGRAM)
- GRAM (G, GRAMS, GM)
- CC (CC'S, ML, MILLILITER, MILLILITERS, C.C.)
- AMP (AMPS, AMPULE, AMPULES)
- MEQ (MILLIEQUIVALENT, MILLIEQUIVALENTS) (Bicarbonate only)
- UNITS (UNIT) (Insulin only)

Routes drugs can be given
- IV (I.V., BY VEIN, INTRAVENOUS)
- ET (ENDOTRACHEAL, ENDOTRACHEALLY, E.T.)
- INFUSION (INFUSE, DRIP, IVAC, PUMP)
- NG (NASOGASTRIC, N.G.) (warm lavage only)

Strengths of medication
- PEDIATRIC (PEDI, SMALL, NEONATAL)
- REGULAR (ADULT, LARGE)

Adjusting dosage
- STOP (DC, D.C., D/C, CANCEL, HOLD)
- DECREASE (DOWN, SLOW)
- INCREASE (UP)

APPENDIX G--PART 2

DRUG LISTING

Order list, equivalent terms, and explanations:

ATROPINE blocks the effects of a specific body chemical and a specific nerve which can slow the heart and increase conduction block. It therefore usually will speed the heart and decrease the blockage in the AV node.

Supplied: AMPULE = 10 CC = 1 MG

Usual dose: adult--0.5 to 1 MG, repeated up to 2 mg total

child--.01 mg/kg, repeated up to three times

May be given ENDOTRACHEALLY.

Indications: bradycardia or high-grade atrioventricular (AV) conduction block, unless blood pressure is good.

Actions: speeds up atrial pacemaker, decreases blockage within AV node.

Precautions: doses lower than those recommended may actually slow the heart further. Increased heart rate may make a diseased heart work harder, resulting in a larger area of heart damage.

SAMPLE ORDER:
ATROPINE .1 MG ET
10 CC ATROPINE

BICARBONATE (BICARB) neutralizes acid. It's used to reverse the acidosis which results from cardiac arrest, but isn't recommended as part of routine resuscitation efforts. Use it for proven severe acidosis on arterial blood gases, or where you strongly suspect severe acidosis due to a long "down" time before CPR was started.

Supplied: AMPULE = 50 CC = 50 MEQ
PEDIATRIC AMPULE = 10 CC = 10 MEQ

Usual dose: 1 MEQ/kg initially (Give this initial dose only if the patient has been in cardiac arrest without CPR for several minutes). You can then give 1/2 MEQ/kg every ten minutes until a blood pressure is achieved, however, you're better off monitoring the need for bicarbonate with blood gases.

Acute replacement dosage:
bicarb = 0.1 x (-base excess) x (weight in kg)

Indications: suspected or proven severe acidosis.

Actions: directly neutralizes acid.

Precautions: if given in excess, alkalosis results, which is very difficult to treat. Use of an immediate dose in a brand-new cardiac arrest will guarantee severe alkalosis. Use ABG to guide therapy.

SAMPLE ORDER:
20 CC OF BICARB IV
BICARBONATE 2 AMPS

BRETYLIUM (BRETYLOL) is useful in resistant V-fib. After use, the heart can often be successfully defibrillated when it could not before. Bretylium also lowers blood pressure, which may be a problem in some patients.

Supplied: AMPULE = 500 MG = 10 CC

Usual dose: 350 mg or 5 mg/kg, repeat at double dose (10 mg/kg) if not effective.

Indications: Ventricular fibrillation resistant to defibrillation. Remember that you still have to defibrillate after giving Bretylium.

Actions: allows easier conversion to sinus rhythm. Also blocks nerves which affect blood vessels, reducing blood pressure somewhat.

Precautions: may exacerbate cardiogenic shock

SAMPLE ORDER:

BRETYLIUM 350 MG

CALCIUM is supplied as calcium chloride. Calcium stimulates the heart, resulting in stronger contractions. It has been shown, however, to do more harm than good when used in cardiac resuscitation. Its uses are: correction of significant hypocalcemia (enough to cause a disturbance of heart rhythm or pumping), and temporary improvement of cardiac disturbances caused by severe hyperkalemia.

Supplied: AMPULE = 10 CC = 1000 MG

Usual dose: .1 cc/kg, repeated once if necessary.

Indications: hypocalcemia which is causing rhythm disturbance, severe hyperkalemia (NO LONGER indicated for electromechanical dissociation (this means a good EKG but no pulse)

Actions: raises the serum calcium, increases the force of cardiac contraction. Counteracts the effects of excess potassium on the conducting system.

Precautions: hypercalcemia may develop. May be detrimental to the ultimate fate of the heart and brain.

SAMPLE ORDER:

CALCIUM 4 CC

1 AMP CALCIUM CHLORIDE

DEXTROSE in this simulation means 50% dextrose. This is a form of sugar. It provides energy for the brain and heart when the blood glucose is low. Although often refered to in the ER as "D50," do not call it "D50" in this simulation, or the nurse will not understand you.

Supplied: AMPULE = 50 CC = 25 GRAMS = 25000 MG

Usual dose: adult--1 amp
child--1 cc/kg

Indications: any undiagnosed coma, suspected hypoglycemia, probably should be used routinely in infants in cardiac arrest.

Actions: raises blood sugar quickly.

Precautions: Although not harmful, electrolytes taken after injection will show a very high blood sugar which could

be confused with diabetes. Draw lab first.
SAMPLE ORDER:
DEXTROSE 25 GRAMS
13 CC DEXTROSE IV STAT

DIAZOXIDE (HYPERSTAT) is used to lower blood pressure. It is a fairly long-lasting drug, and is not to be used except in severe hypertensive emergencies. It is rarely used in a cardiac arrest situation, but is included as an option because it is contained in most "crash carts."
Supplied: AMPULE = 300 MG = 20 CC
Usual dose: 1 to 3 mg/kg, up to a total of 150 mg
Indications: hypertensive crisis
Actions: drops blood pressure quickly
Precautions: may drop blood pressure severely, expecially in patients with sick hearts. Causes a reflexive increase in heart rate.
SAMPLE ORDER:
DIAZOXIDE 100 MG IV

DIGOXIN (LANOXIN) is used to increase the force of the heart's pumping in a person with a sick heart, or to reduce the heart rate of a person in atrial fibrillation by increasing AV block. The drug has substantial hazards but is still widely used because it offers unique benefits. The need for digoxin should be weighed carefully in the cardiac arrest situation.
Supplied: regular--AMPULE = 2 CC = .5 MG
pediatric--AMPULE = 1 CC = .1 MG
Usual dose: start about .005 mg/kg (.25 to .5 in an adult) and titrate up to effect, not to exceed .02 mg/kg
Indications: atrial fibrillation with rapid ventricular rate (consider also verapamil), conversion of PSVT (paroxysmal supraventricular tachycardia) as second-choice drug after VERAPAMIL, heart failure, cautious use in cardiogenic shock
Actions: increases effectiveness of cardiac muscle, partially blocks AV node, some effect on SA node
Precautions: may slow sinus rate. Makes heart more prone to abnormal rhythms. Safe dosage range is very narrow--harmful effects may occur even at usual doses. May produce complete heart block if the AV node is already partially blocked.
SAMPLE ORDER:
.5 CC PEDIATRIC STRENGTH LANOXIN
DIGOXIN .25 MG

DOBUTAMINE (DOBUTREX) increases the heart's contractility similar to dopamine (below), but does not constrict the blood vessels nor raise the blood pressure to the same degree. Used mostly for congestive heart failure in the ICU. Not very useful for cardiogenic shock, but may help in a "borderline" situation where a little extra contractility is desired without the increase in heart work and irritability

that dopamine would cause.

Supplied: must be mixed as infusion. Protocols vary.

Usual dose: start at about 2.5 micrograms/kg/min and increase as needed. Best not to exceed 20 to 30 mcg/kg/min.

Indications: rarely used in the E.R. Limited use where increased heart contraction force is desired.

Actions: stimulates the heart to contract more forcefully.

Precautions: may waste time when dopamine would be more effective. At higher doses, increased heart rate and increased heart irritability occur.

SAMPLE ORDER:

DOBUTAMINE INFUSION

DOPAMINE (INTROPIN) is useful for raising low blood pressure. It stimulates the heart, resulting in a more rapid rate and more forceful contractions. It constricts blood vessels, raising the pressure. These effects increase the heart's need for oxygen (which can increase the severity of a heart attack) and make it more prone to abnormal rhythms. It is usually the first choice drug for all forms of shock.

Supplied: must be mixed as an infusion. Protocols vary from hospital to hospital, but all have charts which show how a specific dosage in mcg/kg/min translates into cc/hour or drops/minute.

Usual dose: begin in the range of 1 to 5 micrograms/kg/min (depending on the severity of shock), and increase until the desired effects are seen. Best not to exceed 30 to 40 mcg/kg/min.

Indications: shock. Fluids should also be given IV if the shock is due to low blood volume.

Actions: stimulates the heart, increasing heart rate, force of contraction, and irritability of the heart. Constricts blood vessels. Raises blood pressure.

Precautions: increases the risk of fibrillation. May increase the severity of a heart attack (but persistantly severe low blood pressure will do more damage).

SAMPLE ORDER:

DOPAMINE DRIP

EPINEPHRINE (EPI, ADRENALINE) stimulates the heart, and constricts blood vessels. It raises blood pressure, increases the heart rate, and increases the heart's irritability. It is used during cardiac arrest because 1) it is an extremely potent cardiac stimulator, and 2) it makes fibrillation more course and easier to convert to sinus rhythm. It is not used routinely to raise blood pressure except in anaphyllactic (allergic) shock. This drug occurs naturally in the body, and is degraded over several minute's time.

Supplied: AMPULE = 10 CC = 1 MG
or custom infusion

Usual dose: adult--1 amp every five minutes until pulse and blood pressure achieved. To sustain beneficial effects,

an infusion of .05 to .1 micrograms/kg/min may be given.
child--.1 cc/kg every five minutes until pulse and B.P.
May be given ENDOTRACHEALLY in bolus form.
Indications: cardiac arrest, anaphyllactic shock.
Actions: potent cardiac stimulant, blood vessel constrictor.
Precautions: stop use when blood pressure obtained. If B.P. falls as Epi wears off, use an epinephrine drip, or dopamine.
SAMPLE ORDER:
EPI 1 AMP
10 CC ADRENALINE ENDOTRACHEALLY
START EPINEPHRINE INFUSION

INSULIN is a natural hormone which moves sugar into cells. The lack of insulin causes diabetes. Too much insulin results in low blood sugar. Only regular (fast acting) insulin is available, and its use is limited to IV bolus in this program (the E.R. doesn't have time to set up those fancy infusions. Leave it to the ICU).
Supplied: drawn up from vial as needed, different strengths per cc, therefore ordered in "UNITS."
Usual dose: .2-.4 UNITS/kg IV bolus, repeated in 10-20 minutes.
Indications: diabetic ketoacidosis, or severe hyperglycemia.
Actions: lowers blood sugar
Precautions: may cause hypoglycemia, lowers potassium somewhat.
SAMPLE ORDER:
10 UNITS INSULIN IV

INSULIN-GLUCOSE (INSULIN/GLUCOSE, GLUCOSE-INSULIN, GLUCOSE/INSULIN) is an infusion which takes advantage of a side effect of insulin, the lowering of serum potassium. A mixture of regular insulin and 10% glucose is run, with rapid lowering of potassium. The order for the mixture must be entered as above rather than as two words.
Supplied: mixed when ordered.
Usual dose: no fixed dose. Just run it and watch the potassium.
Indications: severe hyperkalemia.
Actions: drives potassium into cells.
Precautions: may provoke hypoglycemia, may overshoot and cause abnormally low serum potassium.
SAMPLE ORDER:
INFUSE INSULIN-GLUCOSE MIXTURE
GLUCOSE/INSULIN BY PUMP

ISOPROTERENOL (ISUPREL) is a cardiac stimulant, somewhat similar to epinephrine. It raises the heart rate, reduces any conduction block, and increases the force of contraction. It has little effect on blood vessels. It causes a major

increase in cardiac irritability and oxygen need.

Supplied: mixed as an infusion. Protocols vary, so order in mcg/kg/min.

Usual dose: start around .03 micrograms/kg/min, increase until effects are seen, avoid exceeding .3 mcg/kg/min.

Indications: second choice drug after atropine for refractory bradycardia, high degree AV block.

Actions: cardiac stimulant which affects primarily heart rate and conduction.

Precautions: may increase the size of an infarct. Increases probability of fibrillation.

SAMPLE ORDER:
ISUPREL DRIP

LIDOCAINE (XYLOCAINE) is a local anesthetic which is also useful in treating abnormal heart rhythms. Of course, if the patient is in V-fib, a shock must still be given after the drug to restore a normal rhythm. Blood concentrations of lidocaine fall off over about 20 minutes, so a second bolus and/or an infusion is necessary. Lidocaine is also valuable in preventing abnormal rhythms before one has ever occurred. Many experts recommend giving lidocaine routinely to any patient who has had a heart attack. You will probably come out ahead in this simulation if you do so. A bolus of lidocaine should always be followed by a lidocaine drip to keep the level from falling.

Supplied: AMPULE = 5 CC = 100 MG

Usual dose: adult--75 mg bolus. For irritability, repeat doses of 0.5 mg/kg given up to 3 mg/kg. Follow with drip of 2 to 4 mg/min. (If the patient is in trouble, don't waste your "minute" starting the drip right after the bolus--do more important things, then remember to start the drip in a few minutes)

child--1 mg/kg bolus. Cardiac irritability in a child is almost always due to acidosis or electrolyte abnormality, but if a drip is required, use .01 mg/kg/min.

Effective ENDOTRACHEALLY.

Indications: recurrent or resistant V-tach or V-fib, treatment of cardiac irritability. Prevention of fibrillation in heart attack patients.

Actions: reduces risk of rhythm disturbance.

Precautions: excess doses can cause low blood pressure, seizures. Bolus will wear off unless followed by a drip.

SAMPLE ORDER:
LIDOCAINE 75 MG BOLUS
START LIDOCAINE DRIP

MORPHINE is a potent narcotic used to relieve the pain of a heart attack. It tends to lower the likelihood of fibrillation and reduce the ultimate amount of cardiac damage in an uncomplicated heart attack. It also lowers blood pressure, and therefore should not routinely be used in a patient in shock or post-cardiac arrest. By causing blood to pool in the veins, this blood pressure-lowering effect can be

helpful if the patient is in pulmonary edema (lungs full of water because of a failing heart).

Supplied: order in MG

Usual dose: 6 to 10 MG for an adult, (start about .1 mg/kg for children) may be increased as necessary.

Indications: Pulmonary edema, pain of myocardial infarction.

Actions: Relaxes walls of blood vessels, lowering blood pressure, reducing the "work" of the heart, depresses the central nervous system.

Precautions: may cause shock in certain patients, may cause stupor or coma in high doses. Brain effects of morphine can be reversed with NARCAN.

SAMPLE ORDER:
MORPHINE 10 MG I.V.

NALOXONE (NARCAN) reverses the effects of narcotics, without any harmful effects of its own.

Supplied: regular--AMPULE = 1 CC = .4 MG
neonatal--AMPULE = 2 CC = .04 MG

Usual dose: adult or child--2 amps. If Darvon (propoxyphene) is suspected, up to 10 amps may be given.
infant--.01 mg/kg.

May be given ENDOTRACHEALLY.

Indications: known narcotic overdose, any undiagnosed coma or delirium.

Actions: directly antagonizes narcotics.

Precautions: none.

SAMPLE ORDER:
NARCAN 2 AMPULES

POTASSIUM (KCL) is a body electrolyte. Severe lack of potassium can upset the heart's electrical system. Only when the lack of potassium is causing rhythm disturbances should potassium be given by a fairly rapid IV infusion. When the EKG disturbance clears, the potassium should be stopped or slowed while awaiting electrolytes.

Supplied: Ordered in MEQ, added to I.V. fluid.

Usual dose: never more rapid than 1 MEQ per minute for an adult. Usually 20-40 MEQ added per liter I.V. fluid is safe. Higher concentrations require close monitoring.

Indications: severe hypokalemia with impending rhythm disturbance.

Actions: raises blood potassium.

Precautions: rapid infusions are extremely hazardous--may overshoot and cause hyperkalemia. Rapid injection can cause cardiac arrest.

SAMPLE ORDER:
ADD POTASSIUM TO IV
KCL INFUSION

PROPRANOLOL (INDERAL) does the opposite of isoproterenol. It slows the heart, slightly increases conduction block, and decreases the force of contraction. It is almost never used

in cardiac arrest. Its primary use is for lowering blood pressure and heart rate. It is sometimes helpful in controlling the rapid heart rate of atrial fibrillation.

Supplied: AMPULE = 1 CC = 1 MG

Usual dose: adult--1 mg repeated up to a total dose of 5 mg if necessary.

child--.01 mg/kg, repeated x 4 if required.

Indications: rapid lowering of blood pressure or heart rate. Second-line drug to control the rate in atrial fibrillation.

Actions: blocks stimulation of the heart, increases AV block.

Precautions: avoid if possible in cardiac arrest situations.

SAMPLE ORDER:
INDERAL 1 MG

SALINE (NS, N.S., RINGERS, RINGER'S) is a volume expander to increase blood volume. Although different in composition, saline and ringer's are treated the same in this simulation.

Supplied: IV bottles, ordered as an infusion.

Usual dose: if the patient is truly volume depleted (for example severe hemorrhage) with hypotension, a rate of 2000 to 4000 cc/hr (50-80 cc/kg/hr) until the blood pressure responds is not unreasonable. For the cardiac arrest patient whom you suspect to have slight hypotension because of low blood volume, give about 500 cc over an hour while watching the blood pressure, and watching for complications.

Indications: initial support of hemorrhage with shock, hypovolemia due to fluid loss.

Actions: expands blood volume.

Precautions: excess fluids in a patient with a major heart attack can flood the lungs with water.

SAMPLE ORDER:
SALINE INFUSION
START IV NS

VERAPAMIL (CALAN, ISOPTIN) has complex actions. Its primary use is to treat abnormal, rapid atrial rhythms (such as paroxysmal atrial tachycardia). It decreases heart rate when in sinus rhythm, increases AV block, and may lower blood pressure somewhat. There is evidence that it may protect the heart and brain from oxygen lack. It is rarely used in a cardiac arrest situation.

Supplied:

Usual dose: adult--5 mg, repeated at 10 mg if no effect.

Indications: paroxysmal atrial tachycardia. Decreases the ventricular rate in atrial fibrillation.

Actions: increases AV block, decreases sinus rate, relaxes blood vessels.

Precautions: may predispose to bradycardia and hypotension. Absolutely not to be given with Propranolol.

SAMPLE ORDER:
VERAPAMIL 5 MG

APPENDIX H

REFERENCE VALUES FOR THIS SIMULATION

VITAL SIGNS

above 150 severe tachycardia
above 100 tachycardia
Pulse: NORMAL 60-100
below 60 bradycardia
below 45 severe bradycardia

severe hypertension above 160/110
hypertension greater than 140/90
Blood pressure: NORMAL 120/80, range 140/90 to 100/70
hypotension less than 100/70
severe hypotension below 60/20

above 106 hyperthermia (heatstroke)
Temperature: NORMAL 98.6
below 94 hypothermia
below 89 severe hypothermia

ARTERIAL BLOOD GASES

severe acidosis below 6.9
moderate acidosis below 7.2
mild acidosis below 7.35
pH: NORMAL 7.35 to 7.45
alkalosis above 7.45
severe alkalosis above 7.6

Oxygen (O2): NORMAL above 70 (higher on 100% O2)
hypoxemia below 70
severe hypoxemia below 50

inadequate respirations above 40
Carbon dioxide (CO2): NORMAL 35-40
hyperventilation below 35

severe alkalosis above 45
alkalosis above 30
Bicarbonate (HCO3-): NORMAL 24-28
acidosis below normal
moderate acidosis below 15
severe acidosis below 5 .

above 15 concentrated blood/dehydration
Hemoglobin (Hgb): NORMAL 12-15
below 12 anemia
below 9 severe anemia

ELECTROLYTES

Sodium (Na): NORMAL 134-144

above 7.5 severe hyperkalemia
above 6.5 moderate hyperkalemia
above 5 hyperkalemia
Potassium (K): NORMAL 3.5-5
below 3.5 hypokalemia
below 2.5 moderate hypokalemia
below 1.9 severe hypokalemia

Chloride (Cl): NORMAL 80-100

Bicarbonate (HCO3): see above under ABG

above 20 kidney failure or dehydration
Blood urea nitrogen (BUN):NORMAL 5-20

above 250 severe hyperglycemia (diabetes)
mild hyperglycemia expected with stress or IV
Glucose (Glu): NORMAL 70-100
below 70 mild hypoglycemia
below 40 moderate hypoglycemia
below 20 severe hypoglycemia

above 17 severe hypercalcemia
above 14 moderate hypercalcemia
above 10 hypercalcemia
Calcium (Ca): NORMAL 8-10
below 8 hypocalcemia
below 5 moderate hypocalcemia
below 3 severe hypocalcemia

APPENDIX I

A SIMPLIFIED APPROACH
Part I: Rhythm too fast

DIAGNOSE CARDIAC ARREST by absent pulse and respirations
(note V-tach WITH pulse is treated differently!)

↓

Witnessed arrest? try immediate precordial thump

↓

RHYTHM TOO SLOW, OR TOO FAST?

↓ TOO FAST (V-fib, V-tach)

→ TOO SLOW? next page

↓

Defibrillate immediately 200 joules (child 2 j/kg)
No change?
Defibrillate again, 200-300 joules
No change?
Defibrillate at 360 joules (child 4 j/kg)

↓

Start I.V. (intubate if ANY delay)
Epinephrine 1 mg (child .01 mg/kg)
(may give endotracheally if no IV)
Intubate (if possible and not already done)
Defibrillate 360 joules
No change?

↓

Lidocaine 1 mg/kg (may give endotracheally if no IV)
Defibrillate 360 joules (child 4 j/kg)
No change?

↓

Bretylium 5 mg/kg IV
IF UNWITNESSED, consider bicarbonate 1 mEq/kg IV
Defibrillate 360 joules
No change?

↓

Bretylium 10 mg/kg IV
Defibrillate 360 joules
No effect?

↓

Continue efforts
Epinephrine 1 mg (child .01 mg/kg) every 5 minutes
Repeat lidocaine or bretylium
Keep trying to defibrillate
Await results of ABG, lytes

Part II--Rhythm too slow

DIAGNOSE CARDIAC ARREST (absent pulse and respirations)
Diagnose asystole, block, or bradycardia
(Note bradycardia WITH pulse is treated differently!)

Start IV (intubate if IV delayed)
Epinephrine 1 mg (child .01 mg/kg)
(may be given endotracheally if necessary)

↓

Intubate (if possible and not already done)

↓

PULSE IS STILL TOO SLOW?
(asystole, bradycardia, block)

↓

Atropine 1 mg (child .01 mg/kg)
(may be given endotracheally if necessary)

↓

No effect?
Repeat Atropine up to 2 mg (child, 3 doses)

↓

IF UNWITNESSED, consider bicarbonate 1 mEq/kg IV

↓

Epinephrine 1 ampule (child 0.1 cc/kg) every five minutes
Consider defibrillating (possible fine V-fib)

↓

Await results of ABG, lytes
Consider epinephrine drip .05-1 mcg/kg/min
Consider isoproterenol drip .03 to .2 mcg/kg/min
Set up for pacemaker

Part III--V-tach with pulse

Unstable vs. Stable

Stable?

↓

Start IV
Lidocaine 1 mg /kg

↓

Lidocaine 0.5 mg/kg every 8 minutes
until V-tach resolves, or total 3 mg/kg given

↓

Procainamide 20 mg/min, up to 1000 mg
No effect?

↓

Cardioversion

Unstable

(chest pain, dyspnea, hypotension, congestive heart failure, ischemia, or infarction)

↓

Start IV
Sedation if not hypotensive or unconscious

↓

Cardiovert 50 joules
No change?

↓

Cardiovert 100 joules
No change?

↓

Cardiovert 200 joules
No change?

↓

Cardiovert 360 joules

↓

If recurrent or resistant
Lidocaine 1 mg/kg
Cardiovert

↓

Bretylium (if hypotensive or unconscious)
Procainamide (all others)

Part IV--PSVT
(Paroxysmal Supraventricular Tachycardia)

Stable vs. unstable
Unstable: Synchronized cardioversion, start 75-100 joules and increase similar to V-tach. If unsuccessful, add Verapamil and cardiovert again.

Stable
↓
Vagal maneuvers
↓
Verapamil 5 mg IV
No change in 15 minutes?
↓
Verapamil 10 mg IV
No change in 15 minutes?
↓
Consider:
Digoxin 0.25 mg up to 1 mg IV
Cardioversion
Overdrive pacing

Part V--Suppressing PVC's

Treatable cause?
(potassium abnormality, digoxin toxicity, bradycardia, acidosis, drugs)
↓
Lidocaine 1 mg/kg IV
Not suppressed?
↓
Lidocaine 0.5 mg/kg every 2-5 minutes until response or 3 mg/kg given
Not suppressed?
↓
Procainamide 20 mg/min until effective or 1000 mg given
Not suppressed?
↓
Bretylium 5 to 10 mg/kg

PVC's resolved after:
Lidocaine 1 mg/kg --> lidocaine drip 2 mg/min
Lidocaine 1-2 mg/kg --> lidocaine drip 3 mg/min
Lidocaine 2-3 mg/kg --> lidocaine drip 4 mg/min
Procainamide --> procainamide drip 1-4 mg/min
Bretylium --> bretylium drip 2 mg/min

Part VI--Bradycardia w. pulse

No signs or symptoms?
2nd degree type II or 3rd degree --> pacemaker
Others --> observe

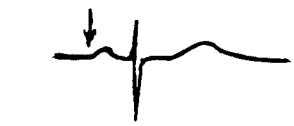
Signs or symptoms present?
↓
Start I.V.
↓
Atropine 0.5 to 1 mg (child .01 mg/kg)
Not improved?
↓
Atropine repeat up to 2 mg
Not improved
↓
CONSIDER:
Isoproterenol drip .03 to .2 mic/kg/min
Epinephrine drip .05 to .1 mic/kg/min
External pacemaker
↓
Transvenous pacemaker

- - -

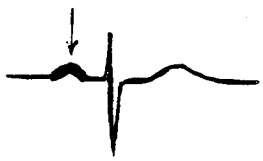
AFTER RESOLUTION OF SIGNS/SYMPTOMS

2nd degree type II or 3rd degree --> pacemaker
others --> observe

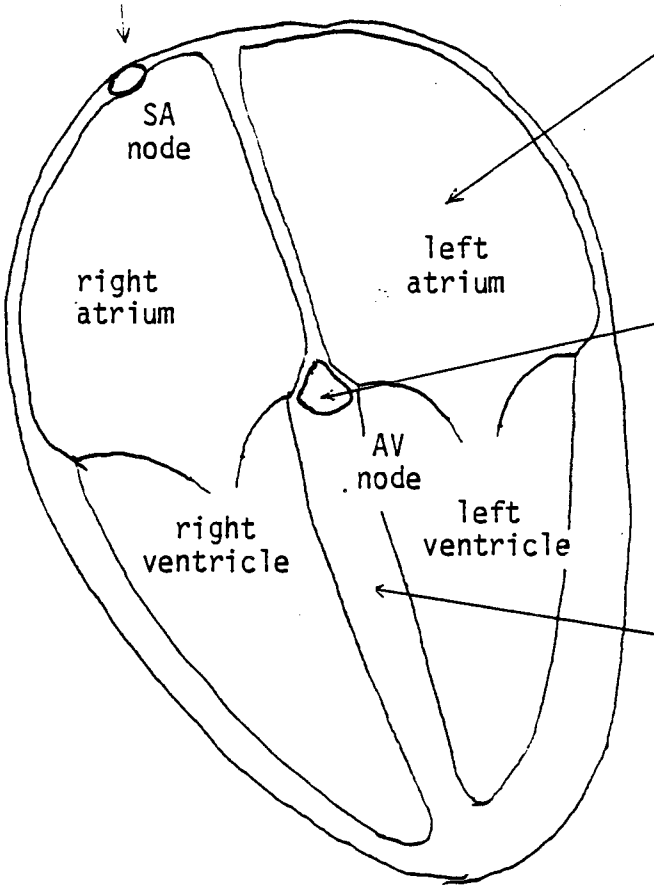
UNDERSTANDING THE ELECTROCARDIOGRAM

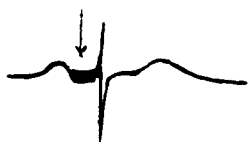


1. Sinoatrial (SA) node fires. (not seen on EKG)

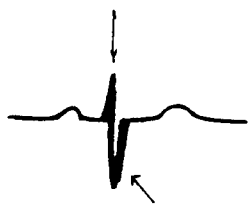


2. Impulse spreads over atrium, causing P wave.

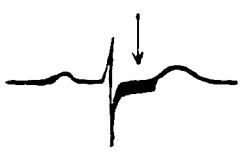




3. Inpulse delayed in atrioventricular (AV) node, causing PR interval. Atrium is contracting.



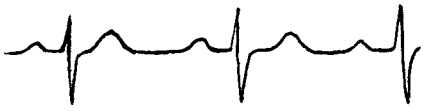
4. Impulse conducted rapidly over ventricle, creating QRS complex.



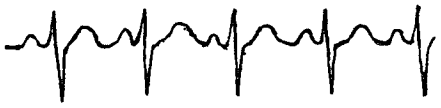
5. Heart is contracting during the ST segment. No current is flowing unless the heart is injured.

6. The heart electrically recharges itself, creating the T wave.

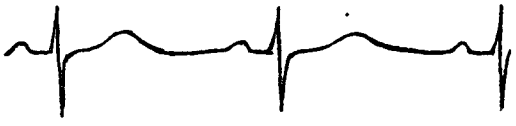
SAMPLE ELECTROCARDIOGRAMS
Part 1: Rhythms



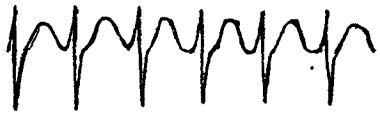
SINUS RHYTHM: Every QRS preceded by a P wave, rate 60 to 100 normally.



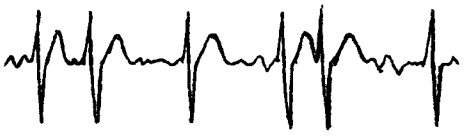
SINUS TACHYCARDIA: Every QRS preceded by a P wave, rate over 100.



SINUS BRADYCARDIA: P wave before every QRS, rate less than 60.



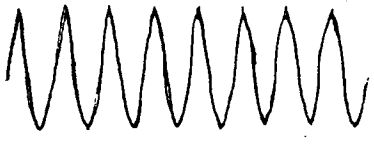
ATRIAL TACHYCARDIA: Regular rhythm, rate 130 to 180, no P waves seen, QRS is narrow.



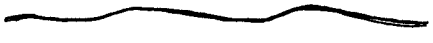
ATRIAL FIBRILLATION: irregularly spaced QRS complexes, 'wiggling' baseline, no P waves. Rate varies with AV block.

VENTRICULAR FIBRILLATION, coarse: Erratic, wide swings of electrical activity, irregular, no pulse.

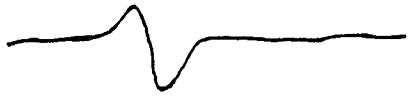
VENTRICULAR FIBRILLATION, fine: Erratic, irregular 'wiggling' EKG, with no QRS, no pulse.



VENTRICULAR TACHYCARDIA: Perfectly regular tachycardia, rate above 200, wide QRS, may cause a pulse.

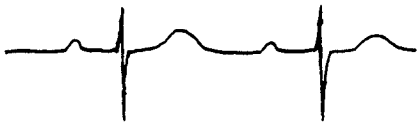


ASYSTOLE: No electrical activity at all, except for slight waving of the baseline.

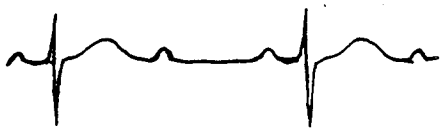


AGONAL RHYTHM: Very slow, wide QRS complexes, without P waves, often without T waves. No pulse.

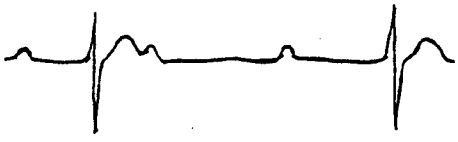
SAMPLE ELECTROCARDIOGRAMS
Part 1: Rhythms (continued)



FIRST DEGREE ATRIOVENTRICULAR BLOCK: Regular sinus rhythm with every P wave causing a QRS after a long PR interval.



SECOND DEGREE ATRIOVENTRICULAR BLOCK: Some P waves are blocked out from the ventricle, leaving a P without a QRS.

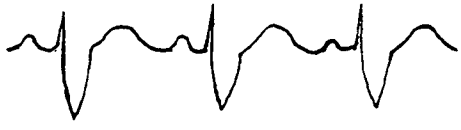


THIRD DEGREE ATRIOVENTRICULAR BLOCK: All P waves are blocked, with the QRS complexes unrelated to the P waves.

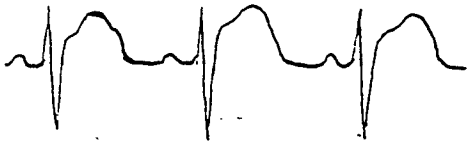
VENTRICULAR RHYTHM: Rhythm is paced entirely from the ventricle, with no P waves seen at all.

Part 2: Specific Problems

RIGHT BUNDLE BRANCH BLOCK: Conduction delayed to the right. Widened QRS with second upward peak.



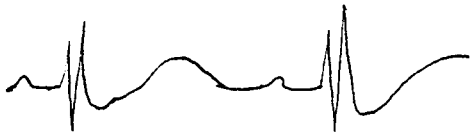
LEFT BUNDLE BRANCH BLOCK: Conduction delayed to the left. Widened QRS with broad, deep S wave.



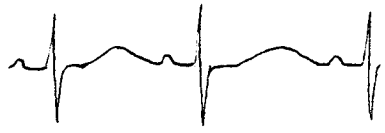
HEART ATTACK: EKG may be normal, or ST segment elevation or depression, or abnormal shape of T wave.

SEVERE HEART ATTACK: QRS may be wide, elevated ST segment, possible loss of the R wave.

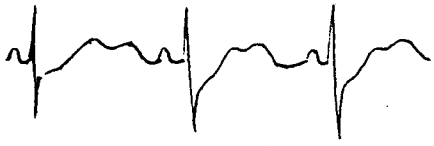
SAMPLE ELECTROCARDIOGRAMS
Part 2: Problems (continued)



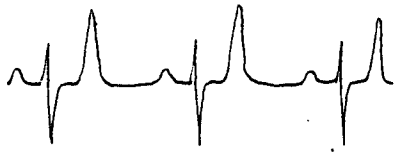
HYPOTHERMIA: ALL intervals prolonged, ST segment depressed, long ST and T wave, often right bundle branch block.



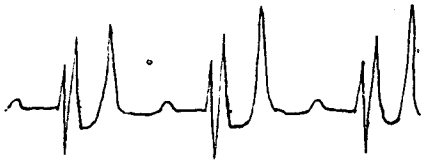
HYPOKALEMIA: Prolonged T wave, possible U wave.



SEVERE HYPOKALEMIA: ST depression, prominent U wave, PR interval fairly short.

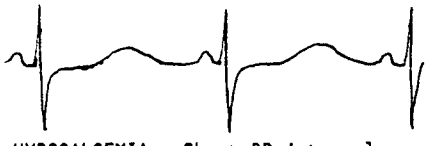


HYPERKALEMIA: Tall, peaked T wave.

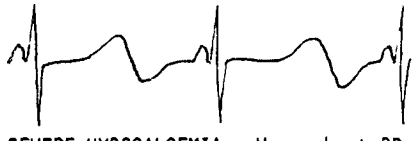


MODERATE HYPERKALEMIA: Long PR, wide QRS, ST depression, tall peaked T wave.

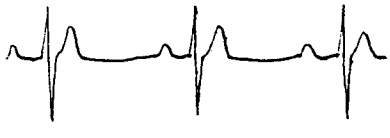
SEVERE HYPERKALEMIA: Disappearance of P wave, wider QRS, may slur into tall T wave.



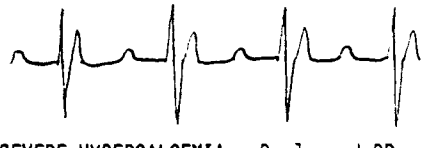
HYPOCALCEMIA: Short PR interval, prolonged ST segment, wide T wave, possible U wave.



SEVERE HYPOCALCEMIA: Very short PR, prolonged ST, very wide T, possible inverted U wave.



HYPERCALCEMIA: Short ST segment, short T wave.



SEVERE HYPERCALCEMIA: Prolonged PR, short ST, short T wave. Ususally tachycardia is present.

APPENDIX K

GLOSSARY

...brief definitions with a pronunciation guide...

acidosis (ass-id-OH-siss), excess acid in body

agonal (A-gun-uhl), slow useless rhythm indicating a dying heart

alkalosis (al-ka-LOH-siss), excess bicarbonate in body

ampule (AM-pule), single-use container of drug, often a pre-filled syringe

anemia (uh-NEEM-ee-uh), deficient in blood or hemoglobin

asystole (ay-SISS-toll-ee), absense of electrical activity

atrial (AY-tree-uhl), pertaining to the upper heart chamber

atropine (A-troh-peen), cardiac drug

bicarb (BY-karb), short for bicarbonate

bicarbonate (by-CAR-bun-uht or by-CAR-bun-ATE), alkaline chemical in blood

bradycardia (brad-i-CAR-dee-uh or bray-dih-CAR-dee-uh), abnormally slow heart rhythm

bretylium (bre-TILL-ee-um), cardiac drug

CPR, cardio-pulmonary-resuscitation

calcium (KAL-see-um), chemical in blood and bones

cardiac (CAR-dee-ack), pertaining to the heart

cardiogenic (CAR-dee-oh-JENN-ik), caused by a heart condition

chloride (KLOR-ide), blood chemical

coma (KOH-muh), unconscious and not responding to pain

defibrillate (dee-FIB-rill-ate), shocking the heart to restore normal rhythm

dehydration (DEE-hy-DRAY-shun), body fluid deficit

dextrose (DEX-trohss), a type of sugar injected IV

diabetes (DIE-a-BEET-iss), abnormal sugar metabolism due to lack of insulin

diabetic (DIE-a-BET-ik), condition of, or person with, diabetes

diazoxide (dy-a-ZOX-ide), blood pressure drug

digoxin (di-JOX-in), cardiac drug

dobutamine (doh-BUTE-a-meen), cardiac stimulant drug

dopamine (DOH-puh-meen), cardiac stimulant and blood pressure drug

electrolytes (ee-LEKT-row-lights), chemicals (ions) in the blood

endotracheal (EN-doh-TRAY-kee-uhl), into the trachea

epi (EH-pee), short for epinephrine

epinephrine (e-pi-NEF-rin), cardiac stimulant drug

fibrillation (FIB-rill-AY-shun), erratic unorganized electrical activity

glucose (GLUE-kohss), blood sugar

hemoglobin (HEE-moh-glow-bin), pigment in blood which carries oxygen

hemolysis (hee-MAW-luh-siss), red blood cells bursting

hemorrhage (HEM-or-rij), bleeding

hypercalcemia (HY-per-kal-SEEM-ee-uh), excess calcium in blood

hyperglycemia (HY-per-GLY-SEEM-ee-uh), excess sugar (glucose) in blood

hyperkalemia (HY-per-kay-LEEM-ee-uh), excess potassium in blood

hypertension (HY-per-ten-shun), abnormally high blood pressure

hyperthermia (HY-per-THERM-ee-uh), body too hot, heatstroke

hypocalcemia (hy-POH-kal-SEEM-ee-uh), abnormally low calcium in blood

hypoglycemia (hy-POH-gly-SEEM-ee-uh), abnormally low blood sugar

hypokalemia (hy-POH-kay-LEEM-ee-uh), abnormally low blood potassium

hypotension (HY-poh-ten-shun), abnormally low blood pressure, shock

hypothermia (hy-po-THERM-ee-uh), low body temperature

hypovolemia (hy-po-vohl-EEM-ee-uh), low blood volume

hypoxemia (hy-pox-EEM-ee-uh), low blood oxygen

infarction (in-FARK-shun), death of tissue due to lack of oxygen

infusion (in-FUZJ-un), steady flow of drug into the patient

insulin (IN-suhl-in), sugar-lowering drug

intravenous (in-truh-VEE-nus), by vein

isoproterenol (IE-soh-proh-TER-en-awl), cardiac stimulant drug

ketoacidosis (KEE-toh-ASS-id-OH-siss), excess acid plus ketones, diabetes

kilogram (KILL-a-gram), 2.2 pounds

lavage (luh-VAWJ as in corsage or triage), flushing fluid in and out

lidocaine (LIE-doh-cane), cardiac irritability drug

milliequivalent (MILL-i-ee-QUIV-uh-lent), unit of ionic activity

milligram (MILL-i-gram), unit of weight, 1/1000 gram

milliliter (MILL-i-LEE-ter), unit of volume, 1 cc, 1/1000 liter

morphine (MORE-feen), narcotic

myocardial (my-oh-CARD-ee-uhl), pertaining to the heart muscle

naloxone (nal-OX-ohn), narcotic antidote

nasogastric (NAY-zoh-GAS-trick), through the nose into the stomach

neurological (NUHR-uh-LOJ-i-kuhl), pertaining to the brain or nervous system

PVC's (pee-vee-sees) premature ventricular contractions

potassium (poh-TASS-ee-um), blood chemical

propranolol (proh-PRAN-uh-loll), cardiac blocking drug

pulmonary (PULL-mun-air-ee), pertaining to the lungs

resuscitation (ree-suss-i-TAY-shun), efforts at restoring life

ringer's (RING-erz), altered salt solution to expand blood volume

saline (SAY-leen), salt solution to expand blood volume

shock (shock), sufficiently low blood pressure to cause damage

sinus (SINE-us), referring to place where normal rhythm originates

tachycardia (tack-i-CAR-dee-uh), abnormally rapid heart rate

triage (TREE-awj as in corsage), deciding who needs treatment first

urea (you-REE-uh), chemical measured in BUN

ventricle (VENN-trick-uhl), lower heart chamber

ventricular (venn-TRICK-you-ler), pertaining to the lower heart chamber

verapamil (ver-AP-uh-mil), cardiac drug

CARDIAC ARREST! FLOWSHEET

Sample--This page may be copied

Date:_____ Time:_____ I.V.:_____ ET tube:_____
Patient description:_____
Pertinent history:_____
Age:_____ Weight:_____ Estimated time of arrest:_____

Time	Pulse	B.P.	Resp	Neuro	Orders/lab values/notes

CARDIAC ARREST! FLOWSHEET

Date:_____ Time:_____ I.V.:_____ ET tube:_____
Patient description:_____
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Age:_____ Weight:_____ Estimated time of arrest:_____

Time	Pulse	B.P.	Resp	Neuro	Orders/lab values/notes