The St. John Ambulance Service for South Australia

EMERGENCY CARE and TRANSPORT MANUAL SUPPLEMENT

DAVID FAHE

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TRANSPORT MANUAL SUPPLEMENT

Editor

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Preface

Emergency Care and Transport was published in 1982. Within six months of its publication the Medical Advisory Committee to the St. John Council for South Australia recommended significant changes to Ambulance Officer Training. The necessary information is contained in this Supplement, which will be incorporated into subsequent editions of the Manual.

"Mobile Coronary Care" is a natural sequel to "Cardiovascular Diseases", while "Medical Retrieval Teams" is related to "Reporting to Medical Officers" and "Assistance with Medical Procedures". The chapter on "Paediatrics" includes information peculiar to the care of children, without duplication of information in the Manual of diseases from which children also suffer.

Manual and Supplement together provide the most up-to-date information and techniques of patient care. They should be read in conjunction with each other.

Contents

List of Illustrations

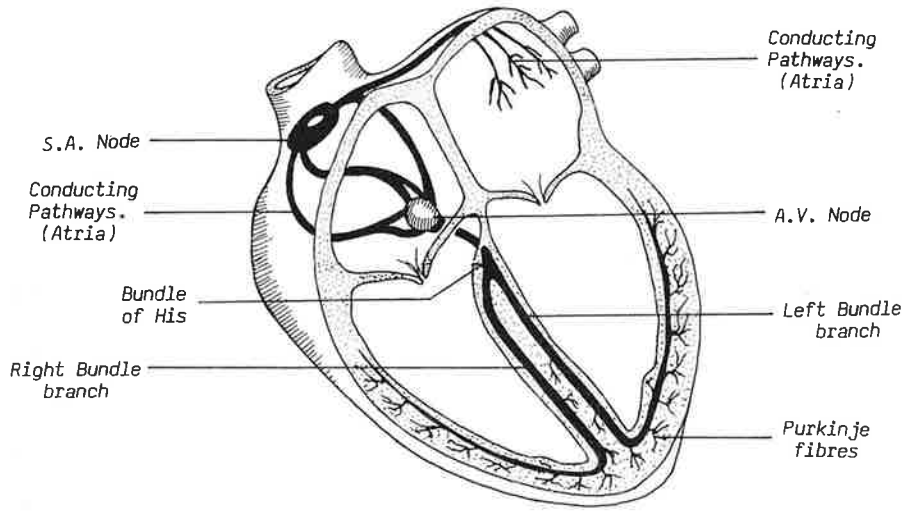
Chapter S.1

Mobile Coronary Care

This chapter expands the chapters "Cardiopulmonary Resuscitation" and "Cardiovascular Diseases" to include detailed information on the conducting system of the heart, normal ECG and interpretation of arrhythmias. This information provides the basis for management of life-threatening arrhythmias by Ambulance Officers, including use of the defibrillator.

THE CONDUCTING SYSTEM OF THE HEART

The conducting system of the heart consists of special groups of cells which provide the electrical excitation and conduction pathways associated with the contraction of the heart (Figure S.1). The heart muscle itself will conduct electrical impulses but not across the atrioventricular junction, which is fibrous tissue.



Figures S.1 Conducting Tissue of the Heart

FUNCTION OF CONDUCTING SYSTEM

Each normal heartbeat is the result of an electrical impulse that originates from the SA node (sinoatrial node), a group of special cells situated in the wall of the right atrium. This tissue normally fires about 60-100 times a minute in rhythmic fashion. Because the SA node controls the heart, it is designated the Pacemaker. Other areas of the heart, e.g. the AV node (atrioventricular node), and Purkinje fibres, have the potential ability to initiate pulses, but they only assume this role under abnormal circumstances. The AV node fires 45-55 times a minute, and the Purkinje fibres 30-40 times a minute. Whenever the SA node is replaced in its normal pacemaking function, it may first be replaced by the AV node, then, if this does not operate, the ventricular pacemaker will beat. Any other area of muscle which takes over the function is called an ectopic pacemaker.

The original impulse is transmitted through the heart via the conduction pathways, and when the impulse reaches the Purkinje fibres, the Purkinje cells are stimulated, and the electrical impulse is conducted through the myocardial cells, making them contract. This electrical process, which causes atrial and ventricular contraction, is called depolarisation. After depolarisation, the muscle cells recover electrical energy. This process is called repolarisation. Under normal circumstances the next impulse from the SA node arrives when repolarisation is complete. The combined periods of stimulation (depolarisation) and recovery (repolarisation) are termed the cardiac cycle.

SUMMARY OF CARDIAC CYCLE

The SA node fires. The impulse is transmitted to the AV node, then via the bundle of His to the left and right bundle branches, to the Purkinje fibres. The Purkinje fibres fire, conducting electricity through the muscle cells. The atria and ventricles contract (depolarisation), the muscle then recovers ready for the next impulse (repolarisation).

RELATIONSHIP OF ECG PATTERNS TO CONDUCTING SYSTEM

ELECTROCARDIOGRAPH

The electrocardiograph is the instrument used to detect and display the electrical activity of the heart. In its simplest form the electrocardiograph consists of a sensitive galvanometer connected by two electrodes and conducting wires to the surface of the body. It measures the strength and direction of electrical current which radiates out from the heart, like a magnetic field (Figures S.2, S.3). Flow in the direction A to B produces a deflection of the needle to the right (positive), and flow in the direction B to A produces a deflection to the left (negative).

By coupling the electrodes to an amplifier and using the amplifier to work a pen on moving paper, it is possible to convert needle deflection into a tracing which can be calibrated (Figure S.4).

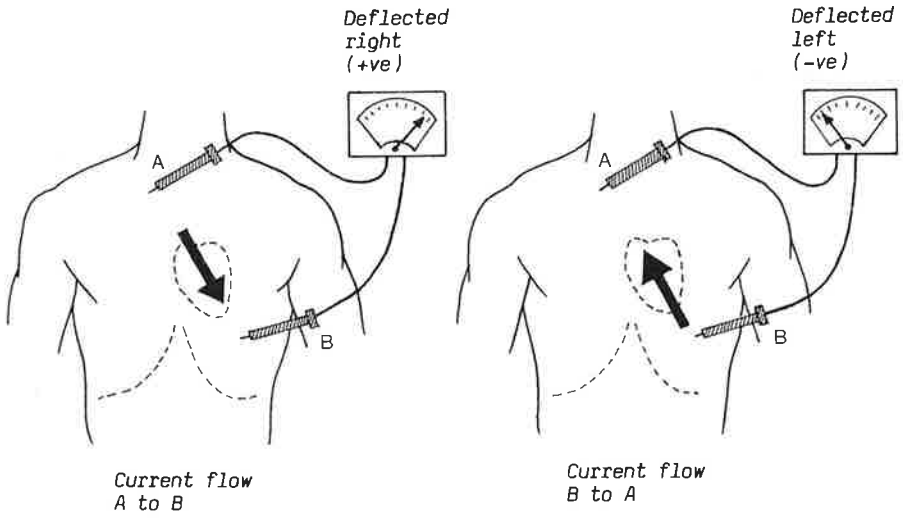
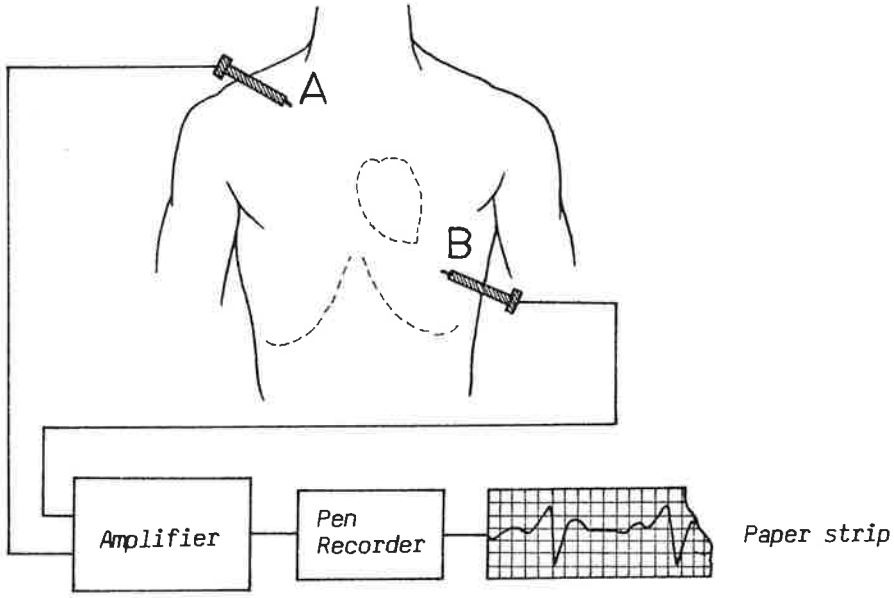


Figure S.2 } *Figure S.3* } *Deflection of galvanometer needle in direction of current flow*

Figure S.4 Electrodes – amplifier – pen recorder – paper strip



Upward deflection of the trace represents a current flow from A to B, and is calibrated in positive millivolts.

Downward deflection of the trace represents a current flow from B to A, and is calibrated in negative millivolts.

A straight line indicates no current flow or no recording.

As well as recording on special paper, the ECG can be displayed on an ECG monitor, a miniature cathode ray tube, sometimes having a memory which can freeze the electronic display. There may be a sound warning when the rate is too low or too high and also a digital readout of heart rate.

Electrode contact is most important for good quality tracing and the disc type electrode maintains good electrical contact.

ELECTROCARDIOGRAM

The electrocardiogram is the recorded trace. A calibrated readout is normally termed an ECG.

It is possible, by varying the location of the electrodes, to record the electrical activity of the heart from different views. In the hospital, it is common to make a recording from 12 different views. This is useful, as it enables the Medical Officer to build up a 3 dimensional picture of the activity, and to locate the area of problem. The ambulance officer will only record the ECG from one view, and that is termed Standard Lead II (Figure S.5).

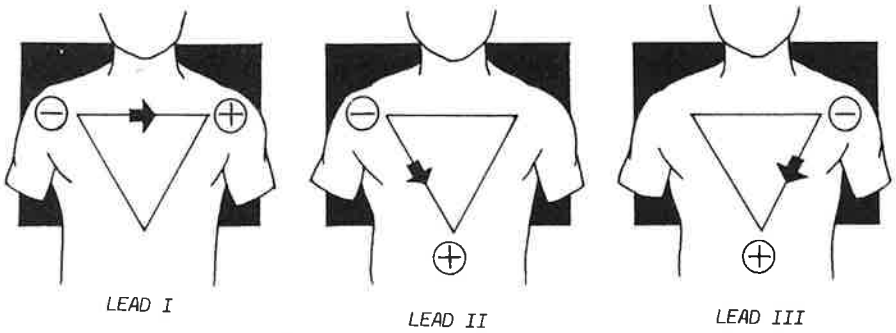


Figure S.5 Illustrating standard leads

It records the activity across the base and apex of the heart. However, by using 3 instead of 2 electrodes, it is possible to switch from a Standard Lead II presentation to a Standard Lead I or III. The Medical Officer or Coronary Care Registered Nurse will initiate any request for an alternative electrical view of the heart.

The electrical activity is recorded on rolls of specially marked graph paper, and/or displayed on a calibrated screen (Figure S.6).

Horizontally, each small square (1 millimeter) represents 0.04 second in time, each large square (5 millimeters) represents 0.2 seconds in time, and five large squares (25 millimeters) represent 1 second in time.

Vertically, each small square represents 0.1 millivolts. Thus, two large squares represent 1 millivolt.

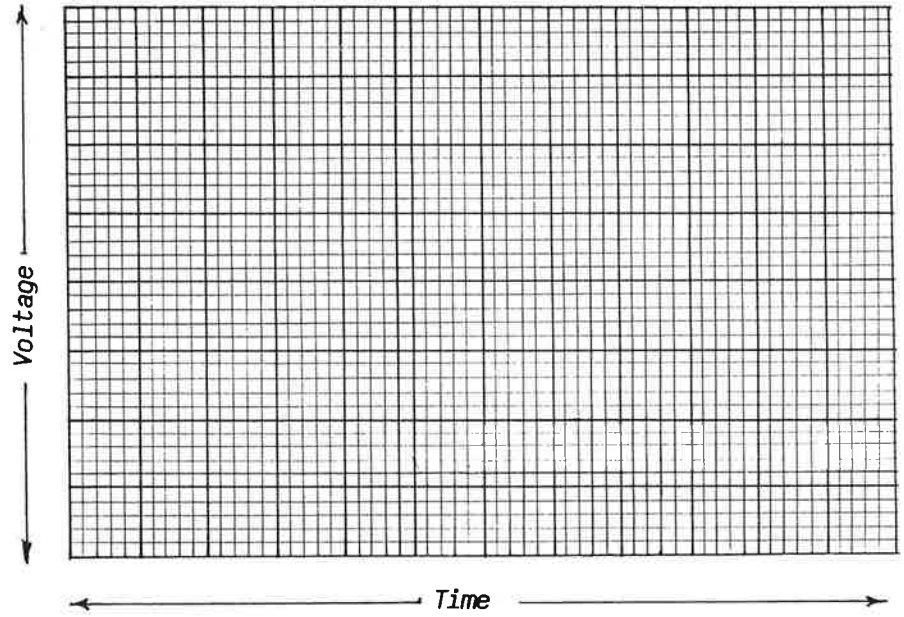


Figure S.6 Illustration of ECG graph paper

WAVE FORMS

The ECG is characterised by 5 separate wave forms, arbitrarily designated P, Q, R, S, and T (Figure S.7).

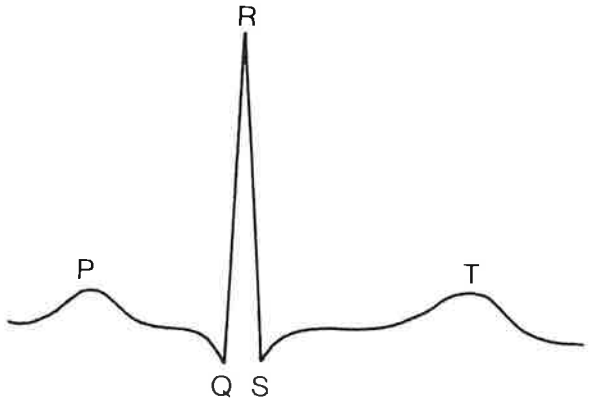


Figure S.7 P-wave, QRS Complex and T-Wave

Each wave form represents separate electrical activity of the cardiac cycle.

Wave form interpretation depends on the relationship of the electrical components to the conducting tissue of the heart (Figures S.8, S.9).

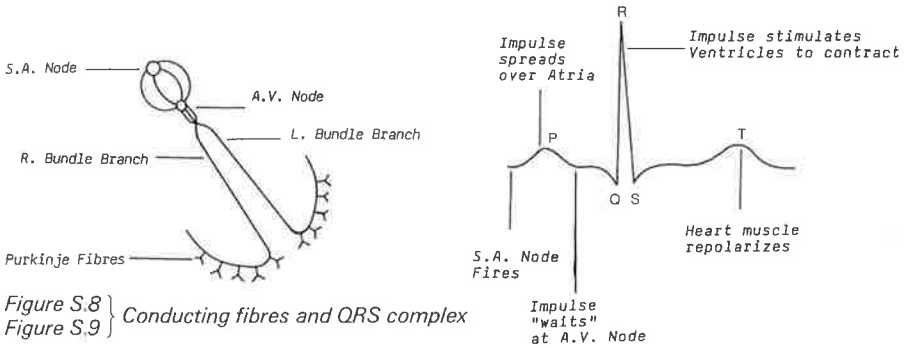


Figure S.8
Figure S.9 } *Conducting fibres and QRS complex*

TIME INTERVALS

The duration of wave form activity is significant, and the Ambulance Officer should know the normal time interval for the P-wave = 0.06-0.10 seconds (1.5-2.5 small squares), the PR interval = 0.12-0.22 seconds (3-5.5 small squares), the QRS complex interval = 0.06-0.10 seconds (1.5-2.5 small squares). The QT interval depends on the pulse rate (number of R-waves present during a 6 second interval are counted and multiplied by 10 = heart rate per minute) (Figure S.10).

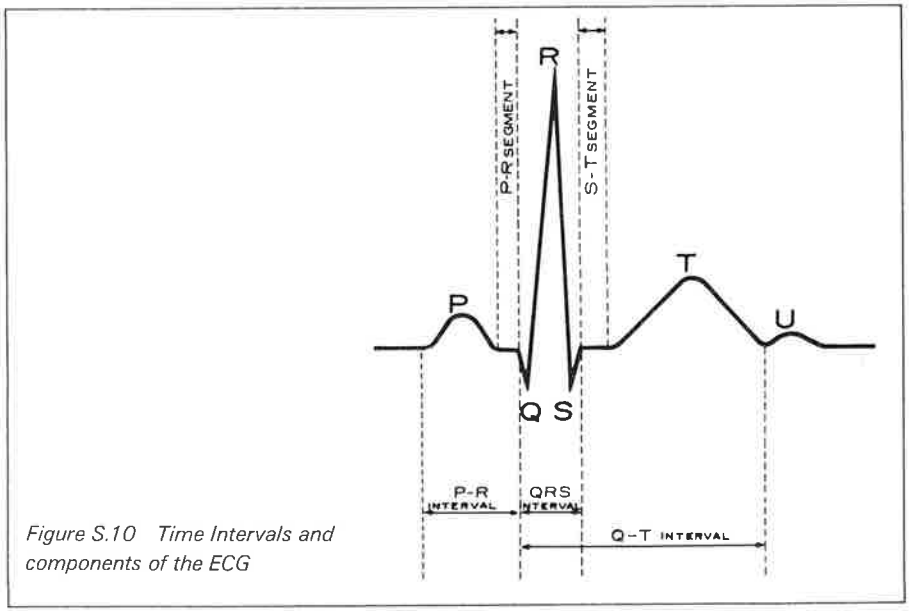


Figure S.10 Time Intervals and components of the ECG

SIGNIFICANCE OF THE ECG

The ECG is a reflection of electrical forces developed within the heart muscle. It does not reflect mechanical activity (the actual physical activity of the heart) but the electrical activity which ultimately generates the mechanical muscle activity.

Its pattern will deviate from normal when there are abnormalities in cellular and extracellular chemical behaviour, in the action of certain drugs or in the state of oxygenation or temperature of the heart muscle. The change recorded may be permanent, transient, or too small to be detected by what is basically a relatively insensitive device.

THE CLINICAL APPEARANCE OF THE PATIENT IS THE MOST IMPORTANT FACTOR THE AMBULANCE OFFICER MUST CONSIDER. THE ECG MERELY ADDS TO THIS INFORMATION.

CORONARY ARTERY DISEASE AND SUDDEN DEATH

Coronary artery disease is associated with sudden death (cardiac arrest) for one or more of the following reasons:

1. Acute myocardial infarction (AMI), causing ventricular fibrillation, ventricular asystole, acute rupture of the heart.
2. Advanced coronary artery disease, without current infarction but with evidence of previous muscle damage. In this instance, death is presumed due to rhythm disturbance.

Of these conditions, the one potentially remediable by the ambulance officer is ventricular fibrillation. One of the purposes of advanced care is to prevent this arrhythmia developing and to treat it should it occur.

CERTAIN FACTS ABOUT SUDDEN CARDIAC DEATH

In studies carried out before coronary care units were introduced, it was found in one autopsy study of men under the age of 40 years, dying of coronary artery disease, that 80% died within 24 hours of the onset of their symptoms, and that 45% died within one hour.

In another study of death due to coronary artery disease occurring in white men between the age of 40 and 64, 67% of deaths occurred within 24 hours or were unwitnessed. Of deaths witnessed, 46% of the sudden deaths and 30% of all deaths occurred within 2 hours. 67% of all deaths (all ages) due to coronary artery disease, occurred outside the hospital.

The overwhelming sudden death mortality from coronary artery disease occurs within the first 15-60 minutes from the onset of pain. It is this group in which advanced techniques in pre-hospital care could potentially have the greatest effect.

THE ABNORMAL ECG

The effect of myocardial ischaemia, injury, and infarction may result in changes to the normal ECG wave form. These changes may be distinctive and allow the

medical officer or registered nurse to diagnose a particular problem and recommend pre-hospital treatment.

The ECG pattern obtained in coronary artery disease depends on the state of the myocardium at the time of recording. The changes will vary, depending on the degree and time course of the process. Myocardial ischaemia is considered to be reversible and is shown by a change in T-waves. Myocardial infarction is irreversible and shown by changes in the QRS complex. Myocardial injury may be reversible but can be the first evidence of infarction. It is shown by changes in the ST segment. When recovery from myocardial infarction is taking place, the ST segment becomes normal. Then the T-wave may become upright again. At the stage of old infarction, the changes in the QRS will persist. These changes are shown in Figure S.11.

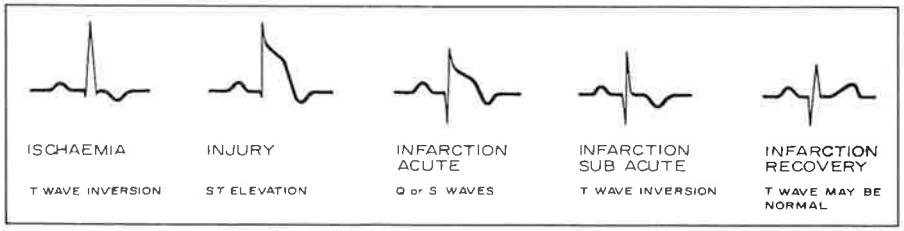


Figure S.11 ECG changes in ischaemia injury and infarction

ISCHAEMIA

In ischaemic muscle, repolarisation is impaired, hence it is the T-wave that will show the change.

INJURY

In injured muscle, the recording electrode will record an elevated ST segment if it is related to the area. From uninjured muscle, a reciprocal depressed ST segment will be recorded.

EVOLUTION OF THE ACUTE INFARCTION PATTERN

Myocardial infarction shows Q or QS waves. The evolution of the infarction pattern will occur in a matter of hours or days. Q-waves may persist indefinitely. The T-waves in acute infarction are symmetrical and deeply inverted and the change is most marked up to 10 days after the event. A normal ECG may be recorded an hour or so after pain first develops.

ARRHYTHMIAS THE AMBULANCE OFFICER NEEDS TO KNOW

The ambulance officer must be able to identify major life-threatening arrhythmias and note any changes of the ECG from previously transmitted information.

Pre-hospital interpretation of ECG wave forms is limited in scope to identifying major arrhythmias and death producing arrhythmias. The method of taking the

pre-hospital ECG (Lead II) and the desire to avoid introducing delay in patient hospitalisation, make inappropriate a detailed ECG analysis.

MAJOR ARRHYTHMIAS

Persistent sinus tachycardia
Bradycardia (when less than 50/minute)
First degree heart block
Second degree heart block
Complete (third degree) heart block
Atrial fibrillation
Supraventricular tachycardia
Premature ventricular contractions
Ventricular tachycardia.

DEATH PRODUCING ARRHYTHMIAS

Ventricular fibrillation
Asystole (ventricular standstill).

WAVE FORMS NOT RELATED TO THE PATIENT

Electrical interference
Muscular movement
Poor or absent electrode contact or lead continuity.

MAJOR ARRHYTHMIAS

PERSISTENT SINUS TACHYCARDIA (Figure S.12)

Rate:	100 beats/minute and over.
Rhythm:	Regular.
Pacemaker Site:	SA node.
P-Waves:	Normal and upright. Sometimes P-wave is incorporated in T-wave and hard to detect.
Cause:	Increased sympathetic tone, pain, raised temperature, oxygen lack, loss of circulating fluid volume, drugs which affect the autonomic nervous system (adrenalin, atropine), anxiety.

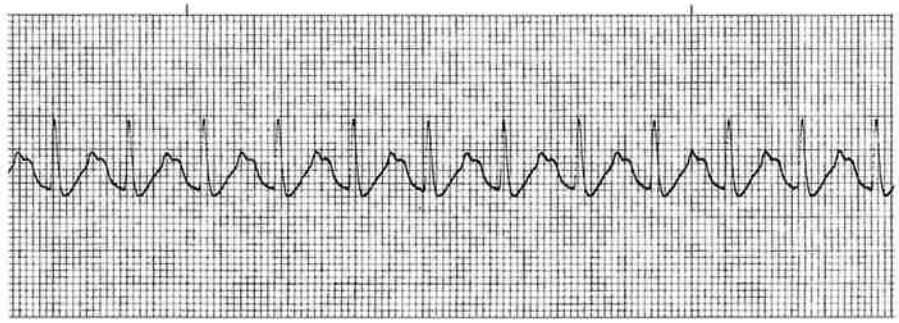


Figure S.12 Sinus tachycardia

BRADYCARDIA (Figure S.13)

Rate: 35 to 55 beats per minute.
Rhythm: Regular or slightly irregular.
Pacemaker Site: If P-waves present, in SA node (sinus bradycardia). If P-waves absent, may indicate pacemaker is in AV nodal area or ventricles.
Cause: Damage to SA node, damage to AV nodal area, hypoxia, drug overdose, (with P-waves) increased parasympathetic tone – some athletes may condition heart to beat at a very slow rate.

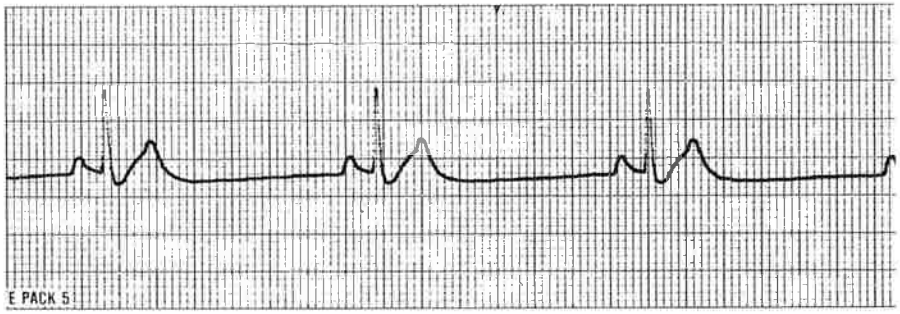


Figure S.13 Sinus bradycardia

ATRIAL FIBRILLATION (Figure S.14)

Rate: May vary, but typically 60-160 uncoordinated ventricular beats per minute. The atria do not contract, but twitch at a very rapid rate (analogous to ventricular fibrillation).
Rhythm: Irregular.
Pacemaker Site: Numerous ectopic pacemakers scattered throughout the atria, the activity of the SA node is suppressed.
f-Waves: Irregular rhythm without P-waves and with narrow QRS complexes and small waves (f-waves) may be seen. f-waves are often of varying amplitudes and shapes.

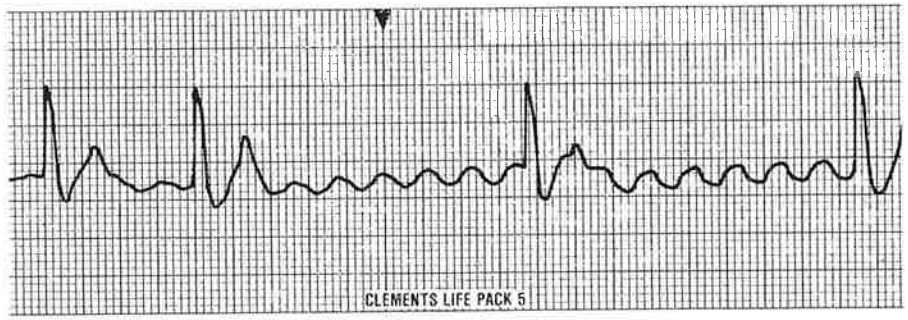


Figure S.14 Atrial fibrillation

Cause: Damage to SA node or atria, hypoxia, sympathetic tone and catecholamines.
Atrial fibrillation may be self-limiting with a relatively slow ventricular rate (e.g. 100-130). The clinical significance depends upon the ventricular rate and the clinical situation.

SUPRAVENTRICULAR TACHYCARDIA (Figure S.15)
(also called Atrial Tachycardia in American text books).

May be paroxysmal (occasional) or sustained.
Rate: Rapid, in excess of 100 beats/minute. Typically 140-160.
Rhythm: Regular.
Pacemaker Site: In AV junction.
P-waves: May be on top of T-waves, and difficult to identify.
Cause: Damage to SA node, damage to AV junction.
Rhythm may be rapid, regular, with normal looking QRS complexes, and, although P-waves may be obscured, they may be identifiable. A rapid ventricular rate may result in reduction of cardiac output and consequent cardiac failure or hypotension. Bundle branch block (QRS aberration) with supraventricular tachycardia, may simulate ventricular tachycardia.

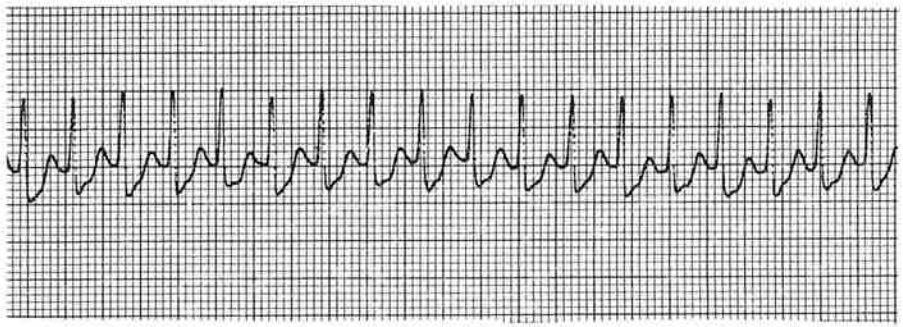


Figure S.15 Supraventricular tachycardia

FIRST DEGREE HEART BLOCK (Figure S.16)

Rate: Normal.
Rhythm: Regular.
Pacemaker Site: SA node. P-waves precede each QRS complex, but PR interval is prolonged, i.e. greater than 0.22 seconds.
Cause: Damage to AV nodal area, causing longer than normal conduction delay, hypoxia, some cardiac drugs, increased parasympathetic tone.

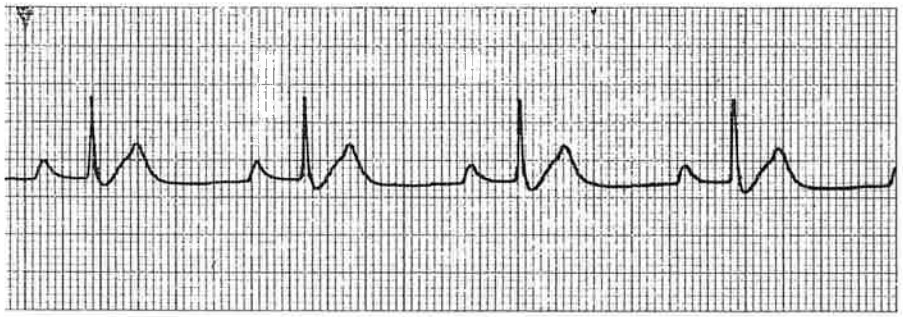


Figure S.16 First degree heart block

SECOND DEGREE HEART BLOCK (Figure S.17)

Rate: Normal or slow.

Rhythm: ECG may have two appearances:

1. Irregular (Wenkebach). There are more P-waves than QRS complexes. P-R interval shows progressive lengthening, until QRS complex fails to appear and the next P-wave leads to conduction. This pattern occurs in cycles.
2. Regular. P-R interval of all conducted beats is constant. There may be two P-waves for each QRS complex (2:1 ratio), or 3 P-waves for each QRS complex (3:1 ratio) or more.

Cause: Ischaemic damage to AV nodal, AV junction, and bundle of His areas (more extensive damage results in regular second degree block) or due to degeneration of the conducting system. SA node produces normal impulses, but some of these are blocked in AV nodal areas. Thus, when a block occurs, the QRS complex fails to appear on the ECG and the ventricles fail to contract.

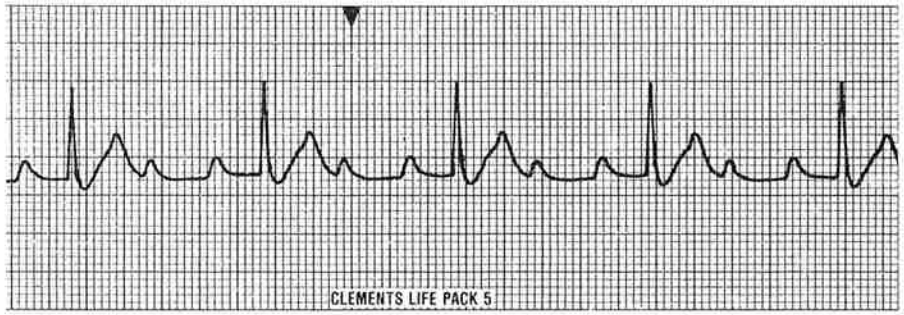


Figure S.17 Second degree heart block

COMPLETE (THIRD DEGREE) HEART BLOCK (Figure S.18)

Rate: Typically ventricular rate is 40 or less.

Rhythm: Regular.

Pacemaker Site: Below AV junction, in Bundle of His, or Purkinje fibres.

P-waves: May be present or absent. There is no relationship between P-waves and QRS complexes. P-R interval is quite variable. QRS complex appears regularly.

Cause: Damage to AV junction, Bundle of His, or Bundle branches following infrarction.
Inherent automaticity of ventricles results in heart beating at a slow rate.

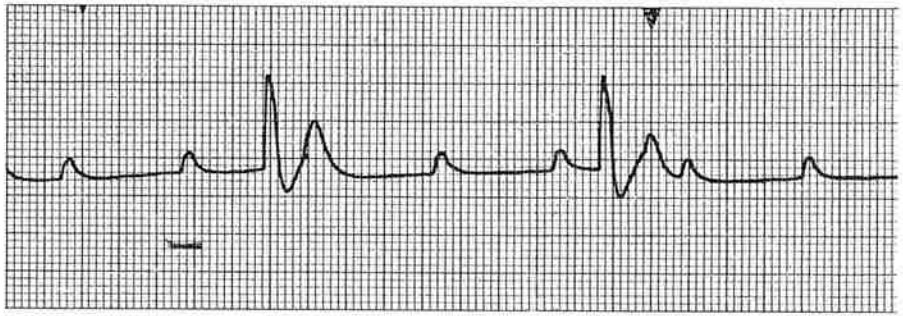


Figure S.18 Complete heart block

PREMATURE VENTRICULAR CONTRACTIONS (PVCs) (Figure S.19)

Rate: Depends on extent and location of injury to the myocardium.

Rhythm: Irregular. A short R-R interval separates premature ventricular contractions (PVCs) from preceding complex. R-R interval following PVC may be prolonged.

Pacemaker Site: Apart from the SA node, ectopic pacemaker sites exist in ventricular His-Purkinje system or in heart muscle. QRS complex is bizarre, distorted, prolonged beyond 0.12 second,

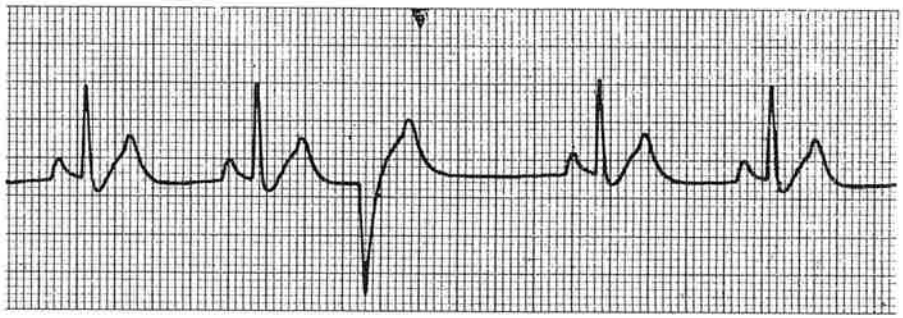


Figure S.19 Premature ventricular contractions

following closely on a normal complex or beat. PVCs may occur regularly, e.g. in pairs, or alternately. PVCs are classified as frequent when more than 6 occur in one minute.

Cause: Irritable focus creating ectopic pacemaker which will stimulate ventricles directly causing premature ventricular contraction. PVC is the most common arrhythmia associated with myocardial infarction and represents myocardial irritability following injury. Patients on drug therapy for heart conditions may suffer digitalis overdose and potassium deficiency (following use of diuretics, e.g. Lasix). This can induce PVCs of less significance than in myocardial infarction.

Infrequent PVCs may not be a serious problem. Frequent PVCs may provoke a serious problem, there being a tendency for PVCs to lead to ventricular tachycardia, when occurring on T-waves, which in turn may lead to ventricular fibrillation.

VENTRICULAR TACHYCARDIA (Figure S.20)

Rate: 140-220 beats/minute.
Rhythm: Slightly irregular.
P-Waves: No readily detectable P-waves, and rapid wide QRS complexes which may not be absolutely regular.
Pacemaker Site: Ectopic pacemaker in ventricular His-Purkinje system. Some authorities define ventricular tachycardia as a series of four or more consecutive PVCs occurring at a rapid rate.
Cause: Damage to ventricles, with irritable focus creating ectopic pacemaker. Blood pressure generally falls after onset of ventricular tachycardia. This is due to the fast rate not enabling the ventricles to adequately fill between contractions and loss of atrial contraction. Patient may have signs of low blood pressure, and inadequate tissue perfusion. Patient generally feels very apprehensive. If not terminated, it may lead to ventricular fibrillation. Ventricular tachycardia sometimes terminates spontaneously.

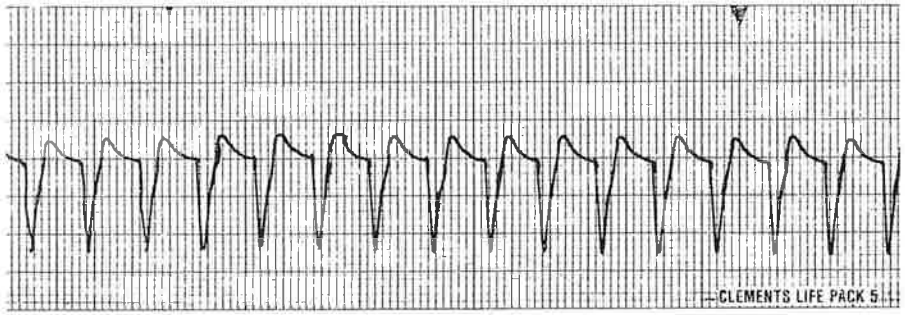


Figure S.20 Ventricular tachycardia

DEATH PRODUCING ARRYTHMIAS

VENTRICULAR FIBRILLATION (Figure S.21)

Rate: 150-300 uncoordinated, non-pumping beats per minute.
Rhythm: Very irregular.
Pacemaker Site: Numerous ectopics scattered throughout ventricles. P-waves present but not recognisable. Defined QRS complexes absent.
Cause: Injury to myocardium leads to irritable tissue and multiple ectopics. Rapidity of stimulation of muscle tissue does not allow recovery, and individual fibres "twitch" but do not contract, and no effective systole occurs. Patient becomes clinically dead moments after the onset of the event. Unless CPR is commenced immediately, biological death will ensue.

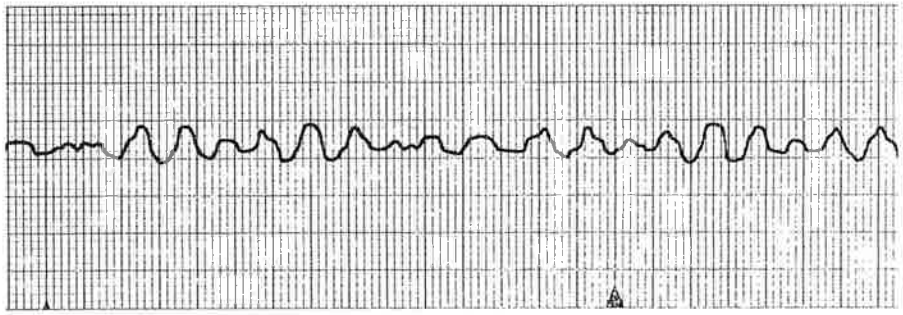


Figure S.21 Ventricular fibrillation

ASYSTOLE (VENTRICULAR STANDSTILL) (Figure S.22)

Rate: Nil.
Rhythm: Nil.
Pacemaker Site: SA node and other pacemaking sites may still operate, but ventricles do not respond. ECG may be "straight line", indicating no electrical or physical activity. ECG may show wave

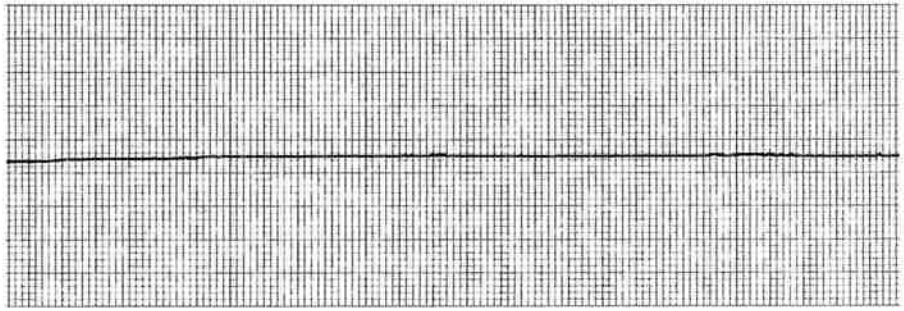


Figure S.22 Asystole

forms, e.g. P-waves, QRS complexes, but patient will be clinically dead, i.e. absent pulse, absent respiration.

Cause: If impulses fail to reach ventricles or if impulse formation ceases, ventricular standstill occurs. The problem may be due to injury to the conduction system and/or hypoxia, which depresses conduction, impulse formation, and myocardial responsiveness to stimulation.

The immediate effect of asystole is clinical death. Unless CPR is commenced immediately, biological death will ensue.

WAVE FORMS NOT RELATED TO PATIENT

Electrical interference, particularly 50 cycle AC mains, may be inducted into the monitoring leads and be recorded in conjunction with the ECG (Figure S.23). The leads should be placed away from the immediate location of fluorescent lights and other mains equipment.

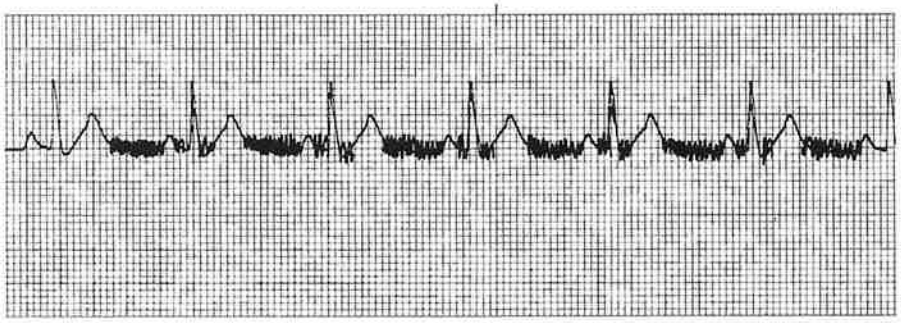


Figure S.23 Electrical interference

Patient motion may produce a "wandering base line" (Figure S.24). Even repiration may produce this phenomenon. Recentre the display by adjusting the "Position" knob.

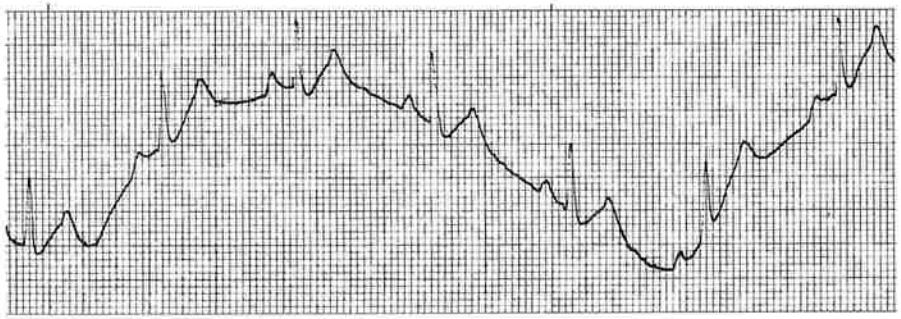


Figure S.24 Wandering base line

Lead failure and inadequate electrode contact may produce a straight line display (Figure S.25). REMEMBER, the presence of a circulation is checked by looking at the patient.

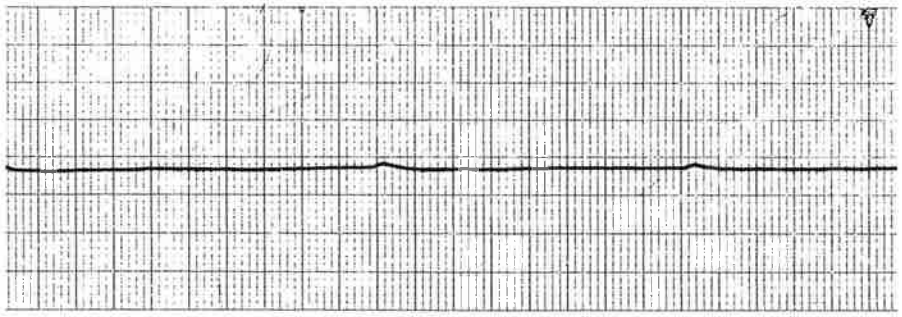


Figure S.25 Straight line display

Skeletal muscular movement produces artifacts when these muscles contract (Figure S.26). Any patient movement may produce this pattern. Filters are built into some monitors to reduce this problem, but it is never entirely eliminated. Rough roads and other in transit movements may assist in the production of these artifacts.

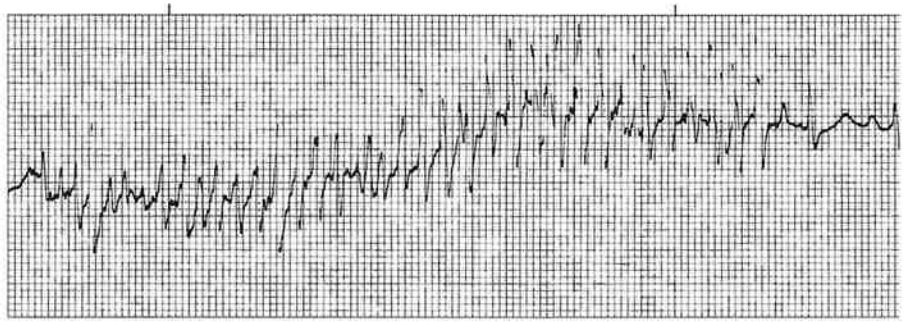


Figure S.26 Muscle artifact

PRACTICAL POINTS IN ECG MONITORING

1. Place the ECG monitor in a convenient location near the patient.
2. Connect the patient monitoring cable to the Lifepak 5 in the appropriate socket.
3. Connect the electrodes to the cable studs.
4. Connect the electrodes to the patient's chest (Figure S.27).
5. Set the cable/paddle selection switch to cable position.
6. Depress the main power switch.

Figure S.27
Placement of ECG electrodes

Figure S.28 Lifepak 5

7. Adjust the ECG size of the cardioscope if the unit has not already been pre-set. Depress the calibration switch and adjust the ECG size to obtain approximately 2 square height of the ECG paper and convenient height on the cardioscope.
8. Have the patient relax as much as possible so that disturbance of the arrhythmia will not occur.
9. Connect the modulator unit to the ECG unit and the portable radio in preparation for transmission of the ECG.
10. Initiate a cardiac consult and provide initial patient information. Await instructions from the Medical Officer as to when (or if) to transmit the ECG.
11. Advise via radio consult that you are about to transmit calibrations, followed by the ECG.
12. Switch the radio telemetry switch to "ON" position, and ECG unit cable/paddle switch to "PADDLES".
13. Depress the calibration switch approximately once per second for 10 seconds.
14. On completion of the calibration transmission,
    (a) return cable/paddle switch to "CABLE" position
    (b) depress paper run switch and allow approximately 6 seconds of the patient's ECG to be transmitted.
15. On completion of the ECG transmission,
    (a) switch paper run switch to "OFF"
    (b) switch radio telemetry switch to "OFF"
    (c) tear off ECG paper strip and record –
        (i) the name of the patient
        (ii) the time the ECG recording was taken
    (d) await confirmation from the Medical Officer via radio as to –
        (i) instructions of patient care
        (ii) repeat ECG transmission.

NOTE

Do NOT contact the Medical Officer via radio on completion of the ECG telemetry, as a voice signal will interfere with the pen recording equipment at the hospital.

PRACTICAL POINTS IN DEFIBRILLATION

1. Place the Lifepak 5 unit in a convenient location within reach of the patient. The second Ambulance Officer is to commence and maintain CPR.
2. Set the cable/paddle switch to "PADDLE" position.
3. Depress the main power switch.
4. Adjust the ECG size control to obtain the patient generated ECG display on the cardioscope.
   Note: If the unit has been calibrated during earlier check, this step may not be necessary.
5. Lubricate the surface of the paddles with conducting jelly.
   Note: This **MUST BE DONE** to ensure –

Figure S.29 Paddles applied

(a) a proper electrical conductivity is achieved:
(b) that the skin is not burnt due to the electrical charge.
Bare the patient's chest.

6. Place the paddles firmly upon the patient's bared chest (Figure S.29).
   (a) Paddle marked "STERNUM" near the patient's right infraclavicular area.
   (b) Paddle marked "APEX" near the lower left sternal edge.
7. Confirm that the oscilloscope shows ventricular fibrillation.
8. Depress the power button on the side of "STERNUM" paddle. The green power indicator light will confirm that the power is on.
9. Set the "ENERGY JOULES" selector on "APEX" paddle to 300 joules.
10. Depress the charge power button on the side of the "APEX" paddle. The red power indicator light will flash while the charge is being raised, and will remain stationary when the required joules rate is achieved.
11. Order safety precautions – *"Stand clear, everyone clear"*.
    Ensure –
    (a) oxygen supply is removed from the patient
    (b) all personnel, including any bystanders, are well clear of the patient and/or stretcher
    (c) no water is in the vicinity of the patient
    (d) the operator is clear of the patient.
12. Depress the discharge buttons simultaneously on the "APEX" and "STERNUM" paddles, then release. Ensure paddles are placed firmly and correctly on the chest.

13. Review the waveform on the cardioscope and the vital signs of the patient.
14. If the patient remains in ventricular fibrillation,
    (a) recommence CPR
    (b) make a medical consult
    (c) **only** if directed by the receiving Medical Officer will the Ambulance Officer reset the joules rate to 400 and repeat steps 10 to 13.
15. If the patient is converted from ventricular fibrillation to normal sinus rhythm or other effective arrhythmia,
    (a) continue to assist respirations with bag mask ventilator and oxygen supply
    (b) initiate Medical Consultation and report action taken
    (c) be prepared to transmit an ECG via the telemetry system and to change the patient from "QUICK LOOK PADDLE" to patient monitoring leads
    (d) await the Medical Officer's instructions, confirm them, continue respiratory assistance as required, load the patient, and transport
    (e) continue monitoring of the ECG during transport. Be alert for recurrence of cardiac arrest, and provide updated information to the Medical Officer as required.

Chapter S.2

Paediatric Emergencies

The special needs of children in the emergency incident can be considered under the following headings:

APPROACH TO THE CHILD PATIENT

The sick or injured child presents many challenges in both assessment and care. The child's perception of his or her problem, his or her world and the Ambulance Officer, may be totally different from the perception of an adult. It is difficult to view the world through the eyes of a child, but this is often the most effective way to understand the child's emotions. Consider what a child may think of –

- being separated from his mother, his home or his favourite toy;
- the ambulance officer and the ambulance, which is to take him away from his family and home;
- the physical pain which may be involved in moving and during transportation.

Children place great importance on particular material things and environmental conditions as they represent a special type of security. Disruption to this security must be both recognised and considered whenever treating a child patient.

The manner in which you approach the child will have much to do with how well you will be able to get along with each other (Figure S.30).

(a) Sitting at the level of the child, rather than towering over him or her or, if possible, sitting next to the child, will reduce the feeling of confrontation;

(b) Take time to develop and maintain eye to eye contact. Even when asking questions of the parents, try and face the child and act as if you are asking the question of him. Talk to the child and not just to the parents and always in a calm and quiet voice.

(c) It is best not to approach or focus on the child with your hands full of equipment. At times it may be better to let the child play with the piece of equipment before using it, as a means of reducing fear. Explanation of what the equipment is or what it does must be in simple terms, e.g., an oxygen face mask may be described as being like the one the pilots or spacemen use to help them breathe.

THE POTENTIALLY POISONED CHILD

Young children between the ages of one and three years are particularly at risk of poisoning. These are the years when children explore but do not understand

Figure S.30 Ambulance Officer and child

danger, and when even a slight lapse of parental supervision may lead to poisoning. Most poisonings to children occur through ingestion of toxic substances. However, overdosage of prescribed medicine, poisoning by inhalation or skin contact, may also occur. Drugs and household products are the most common causes of child poisoning. With older children it is becoming an increasing problem through drug experimentation and suicide.

Poisoning must always be suspected in a child who presents with any one or a combination of the following signs –

- unusual behaviour
- altered conscious state
- vomiting and/or diarrhoea
- cardiorespiratory disturbances.

Any identified poisons **must** be taken with the child to the hospital or Medical Officer.

TEMPERATURE DISTURBANCES AND CONVULSIONS

Pyrexia (fever) in a child will usually be due to an infection. Less common causes may be heat stroke or head injury. The child with an infection causing an extreme

elevation in temperature may convulse, and should elevation in temperature continue for a long period of time, brain damage may result.

Febrile (characterised or relating to fever) convulsions are most common in the under 3 years age group, but can also occur in older children. Common causes of febrile convulsions are systemic infections, ear infections, pneumonia, bronchitis and meningitis.

The convulsing child must have adequate cardiorespiratory function and be placed in the coma position. Airway maintenance must receive particular attention and oxygen should always be given.

If a child is pyrexic, the child's clothing should be removed, and sponging with luke-warm water commenced and continued during transportation to medical aid.

Post-convulsive treatment depends upon the patient's conscious state and the cause of the convulsion.

RESPIRATORY EMERGENCIES

The normal respiratory structure and function of a child is slightly different to that of the adult. A child breathes faster, has slightly different shaped airways, and lower respiratory volumes.

Respiratory emergencies in children may be classified into the following groups:
- congenital or neonatal problems
- upper airways obstruction
- lung disease
- chest trauma
- respiratory failure.

CONGENITAL OR NEONATAL PROBLEMS

These are difficult to diagnose and treat. A neonatal retrieval team will normally treat and transport such patients.

UPPER AIRWAY OBSTRUCTION

A child has a small larynx which may obstruct more easily than an adult's. The most common causes are –
- croup
- inhaled foreign body
- epiglottitis.

When obstruction becomes severe, there will be respiratory distress, stridor, use of accessory muscles of respiration, and indrawing of the intercostal, supraclavicular and suprasternal spaces. Inability to swallow, and dribbling of saliva from the mouth are extremely serious signs.

Any child with respiratory distress and stridor, especially if unable to swallow, must be transported rapidly to hospital. The child should be allowed to posture himself.

Radio communication to hospital is essential.

LUNG DISEASE

Asthma, pneumonia and bronchiolitis occur in children.

CHEST TRAUMA

Pneumothorax and flail chest may occur in children.

RESPIRATORY FAILURE

Respiratory failure, as in the adult, may be secondary to coma, spinal cord damage, neuromuscular paralysis, chest wall damage, airway or lung disease. The single most important point in managing children with a respiratory emergency is that, because of their high metabolic rate, they become hypoxic much more rapidly than adults.

CIRCULATORY PROBLEMS.

Circulatory problems in children may be grouped under the following headings.

CONGENITAL HEART DISEASE

There are many types of congenital heart disease, in which abnormal development of the heart produces abnormal channels of blood flow. For example, a ventricular septal defect (one type of "hole in the heart") allows blood coming from the right atrium into the right ventricle to pass directly into the left ventricle instead of going into the pulmonary circulation. As a result, blood leaving the left ventricle has not been properly oxygenated in the lungs, and the child may be cyanosed even at rest. This is not common, but requires specialised care and transport by a medical retrieval team.

SHOCK

A child has a much faster heart rate, and a smaller blood volume than an adult. Because of this, a child may become shocked rapidly from burns, vomiting, diarrhoea or blood loss.

DEHYDRATION

There are a number of causes of dehydration in children, the most common being diarrhoea and vomiting. Other causes include poor fluid intake, burns and polyuria. The child with dehydration will most likely have been diagnosed previously by a medical officer who may request transport of the child to hospital. The child will usually have thirst, sunken eyes, dry skin, low urine output and hypotension.

The main treatment for dehydration is to replace body fluids, usually by means of intravenous therapy, and to reduce the loss of fluids.

It must be remembered that severe dehydration can cause death, and therefore it is important that medical aid is obtained as early as possible. If a doctor is present, seek his/her advice about any fluid therapy during transport.

UNCONSCIOUSNESS

Common causes of unconsciousness in children are head injury, shock, drugs or poisons, convulsions, meningitis, encephalitis, diabetes and hypoxia. The management criteria are the same as that for adult patients, i.e. ventilation and circulatory assessment and support of airway. The administration of oxygen, control of haemorrhage and rapid evacuation to hospital or medical aid is of the utmost importance in the management of the unconscious child.

THE DYING CHILD

There will be occasions when Ambulance Officers will be in a situation involving a dying child. Usually the situation will be an acute one, requiring rapid assessment, treatment and evacuation to medical aid. It must be realised, however, that in spite of the urgency of the situation, the child's family are also very much involved.

When caring for a terminally ill child during transport, it is important that the Ambulance Officer adopt a confident and responsive attitude towards the child and not one of gloom and despair. The child with a terminal condition may accept the eventuality of death more readily than an adult. However, although the child may know that death is imminent, the subject may not have been discussed between the child and any adult. The Ambulance Officer should be prepared to answer any questions honestly.

Any death is an emotional and distressing time for all concerned, but more so when it is the death of a child. Many people may be involved, from parents, relations, to medical or social team members. A confident efficient approach, together with the right attitude, is a most important part of the Ambulance Officer's role.

SUDDEN INFANT DEATH SYNDROME (SIDS)

Sudden Infant Death Syndrome is a problem that has puzzled medical science for many years. Even now the exact cause is unknown. It can strike at random and without warning. It is most prevalent in infants of between one month and two years. When an Ambulance Officer attends such a case, he is likely to find the parents in a state of emotional turmoil and total disbelief that such a crisis has happened to their child. Attempts to resuscitate and rush the child away from the parents to hospital may leave them totally unprepared for the traumatic experience to follow. This may also have the adverse effect of building up the hopes of the already distressed parents, only to have the world collapse about them when they are advised of the real circumstances.

Most SIDS occur in the early hours of the morning, and the child shows every indication of obvious death upon examination. In such circumstances the family must receive immediate sympathetic attention and should be comforted as best as possible whilst they express their grief. The parents will search for a reason and often tend to blame themselves. Under no circumstances should any accusations be made or implied, but a tactful, sympathetic and understanding approach towards the parents will achieve the best results under such tragic circumstances.

TRAUMA

Injuries are a leading cause of death in children. They may be either accidentally or intentionally inflicted. Small children are most vulnerable to forces which normally would not inflict serious injury to an adult.

What may appear as a relatively small blood loss may, in fact, represent a major amount of the small child's total volume.

Small children will lose body heat quickly and therefore must not be left uncovered for long periods of time, particularly infants.

The child who is shocked, with hypotension and/or tachycardia, is at great risk. Remember that pain and fright are major contributing factors in shock.

Children tolerate burns badly, and a relatively small burn may cause significant fluid loss and shock.

CHILD ABUSE

Battered or abused children are ones who have suffered from deliberately induced injuries, that may lead to serious mental and physical disabilities (Figure S.31).

Instances of child abuse where ambulance transportation is necessary are uncommon in our community, at least relative to child injuries in motor car accidents. However, in 1981/1982, nearly 500 child abuse victims were reported to the Department for Community Welfare in South Australia. It is therefore important for the Ambulance Officer to understand what action to take when confronted with such situations.

The adult (usually the parent) who has abused the child often behaves in an evasive manner, and will offer little, or contradict the information about what happened. Ninety percent of these people have no consistent psychiatric abnormality. They have been overwhelmed, perhaps only for a few moments, by a multiplicity of domestic and other problems. It is important to remember that it is not the responsibility of the Ambulance Officer to either judge the situation or to confront the parent.

Preventive services are obviously important. Crisis Care (see later) provides a telephone service and prompt Social Work attendance at the scenes of domestic upsets. Life-Line, Youth-Line and MBHA all provide telephone services.

What is the role of the Ambulance Officer in all this? The following are suggested.

Be observant. Take mental note of the situation in which you find the child and other members of the family. If the climate is such that you think you may have to give evidence in Court on the matter later, write down the relevant details, but do this unobtrusively and at the completion of the job.

Treat the injuries, using all the Principles of First Aid that you have learned. Do not forget reassurance of the child and of concerned relatives.

Listen to any explanations of the injuries, but do not comment on these and never, never make accusations. Remember that non-verbal communications can be just as clear as verbal ones: indeed, often they are easier to understand. Be on guard against conveying negative attitudes by your actions or facial expressions.

You will have been called to the scene to provide transport for the injured child.

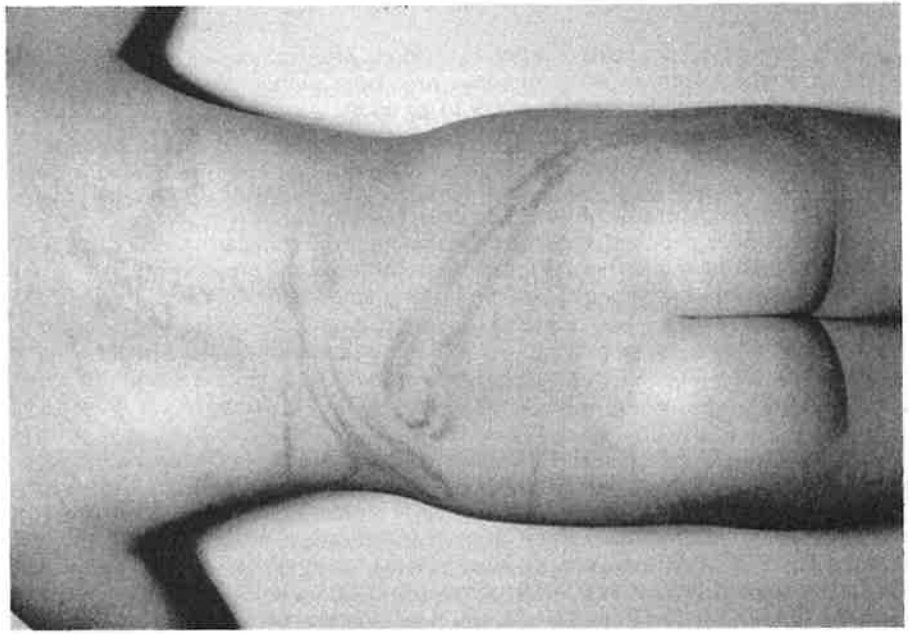
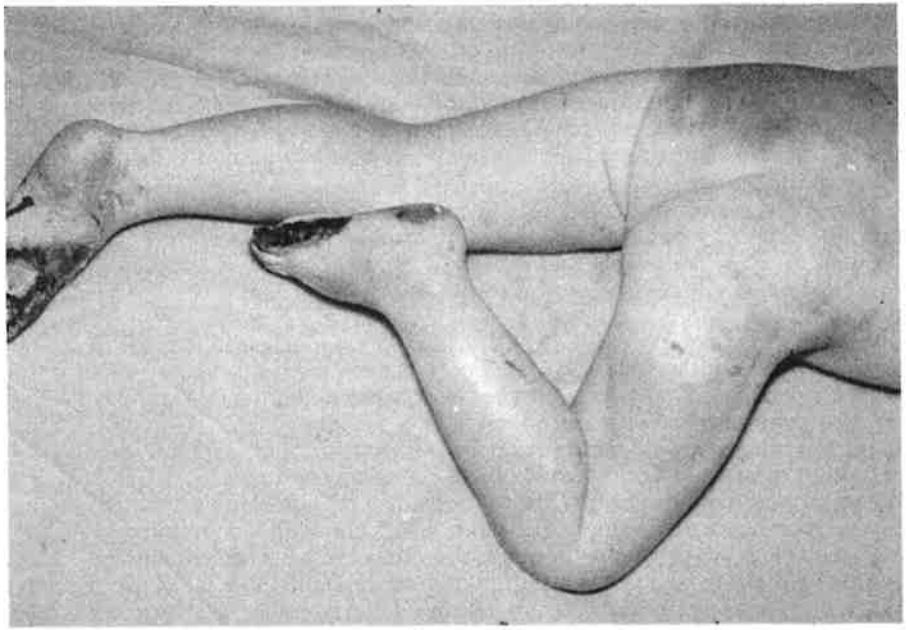


Figure S.31 Child abuse



On occasion there may be resistance from the parents to taking the child to hospital. If this occurs, you may recommend strongly to the parents that the child be taken to hospital, but you have no power to enforce this if the parents do not give permission.

If you sincerely believe the child should be taken to a doctor or hospital but the parents persistently refuse, then contact professional help. In Adelaide this is best done by telephoning the Crisis Care Unit, perhaps via the Radio Room. This Unit is a joint enterprise of the Police Department and the Department for Community Welfare. It consists of 17 social workers who have had experience and training in crisis intervention. They are available 24 hours a day, 7 days a week and, using radio-controlled cars, promptly visit the scenes of domestic upsets. Ambulance Officers should use this service and not act as amateur social workers. Do not be upset if the child is transported subsequently in a Department for Community Welfare car and not in your ambulance. The important point is that the child is receiving protective care.

Finally, do not over-diagnose child abuse, and do not over-react to it. Accidents – genuine accidents – occur much more frequently than does child abuse. Do not go delving inquisitively into family relationships. Your role as Ambulance Officer is to provide First Aid and, where necessary, transport for the injured. This is clearly different from the role of a Police Officer or a Social Worker, or, for that matter, a Judge.

In Adelaide, three major hospitals deal with child abuse problems. They are the Adelaide Children's Hospital, Flinders Medical Centre, and Modbury Hospital. The management programmes with these hospitals are basically the same – the child is admitted for blood tests and x-rays, and the parents are interviewed so that any background social problems can be dealt with.

Chapter S.3

MEDICAL RETRIEVAL TEAMS

There are occasions when a patient's best interests are served by having available to him/her a medical and nursing team with the same facilities as exist in a major hospital. This may be a person with multiple injuries trapped in a vehicle, or a patient in a small hospital with problems beyond the resources of the staff and equipment there. The medical retrieval team can not only resuscitate the patient, but also safely transport him back to a major centre. Local medical officers may resuscitate a patient at a primary care hospital, but not be able to spare staff to escort a patient. During transport, basic life-support procedures, though practised with skill, may be insufficient to combat deterioration from such mishaps as massive haemorrhage, tension pneumothorax, aspiration of gastric contents, or asphyxia from tetanic spasms. In addition, it may be necessary to perform continuous artificial ventilation, give intravenous injections of narcotics, muscle relaxants and antiarrhythmics, to infuse such agents as isoprenaline, to supervise a transvenous pacemaker or to tend pleural drainage systems.

The concept of medical retrieval teams was first introduced as a result of a number of events as early as 1959, in which the major teaching hospitals were involved in the care of patients whose need for intensive care had created problems at smaller hospitals. The retrieval teams were also a source of assistance to a smaller hospital, in cases where a patient collapsed during an operation or required urgent resuscitation.

The expansion of the Air Ambulance Service in 1972 and the introduction of the Emcare Ambulance in 1973, were recognised as major steps forward in transporting the critically ill patient.

In 1974 a request was made to the Director General of Medical Services to further develop long distance clinical consultation, together with the use of aerial and road ambulances as transportation.

The term "Medical Retrieval Team" was derived from the integration of the Ambulance Service facilities with Medical and Nursing staff and their portable intensive care equipment. The retrieval team programme embraces the Royal Adelaide Hospital, the Queen Elizabeth Hospital, Queen Victoria Hospital, Adelaide Children's Hospital, and Flinders Medical Centre.

COMMUNICATIONS

Each hospital has an "urgent line" unlisted phone number known to hospitals and medical practitioners. Delays through switchboard are eliminated, and immediate consultation is available from the Intensive Care Unit or other specialists. Each hospital also has a St. John Ambulance radio, allowing crews to

warn the hospital of the arrival of a "priority red" patient, to discuss problems, and to request a retrieval team.

EQUIPMENT

The retrieval team carries portable intensive care equipment which allows intensive care treatment in the field. This may range from blood transfusion to endotracheal intubation and artificial ventilation, drainage of pneumothorax, cardiac pacing, administration of a variety of drugs (Figure S.32).

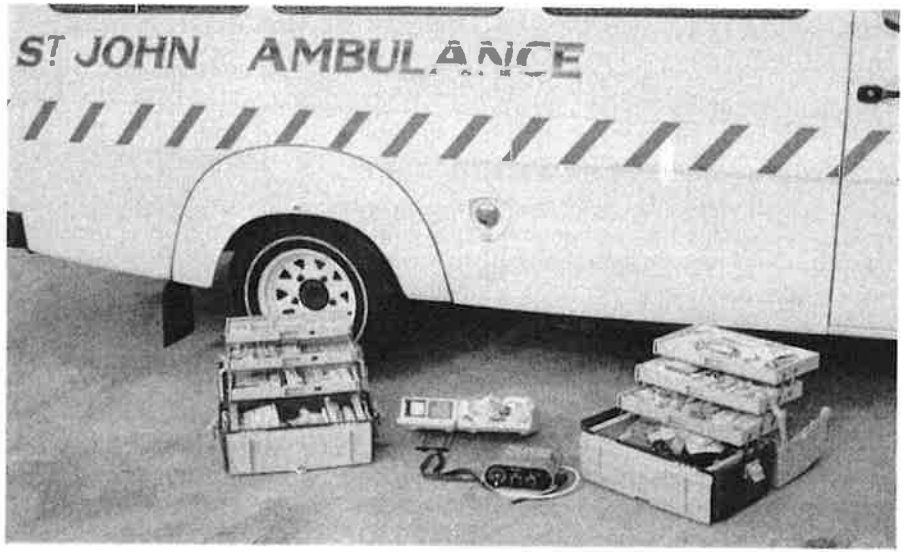


Figure S.32 Retrieval equipment

PERSONNEL

The basic team from the hospital usually consists of a Specialist or Registrar from the Intensive Care Unit, together with another specialist, if appropriate, such as a surgeon or obstetrician, as well as an appropriately trained member of the nursing staff.

ASSESSMENT OF AN EMERGENCY

The term "critically ill" is difficult to define. However, a factor which all such states have in common is acute circulatory or respiratory insufficiency. The success of the retrieval system depends on the early recognition of a severe clinical problem, and early consultation about resuscitation steps and the need for retrieval.

INITIATING A REQUEST

In the majority of cases, a Medical Retrieval Team will notify the Ambulance Service of the requirements to respond to a case. In the metropolitan area, the Ambulance Officer can arrange a Medical Retrieval Team to attend at the scene, especially in cases where there is difficulty in maintaining continuous aid for any severely injured and deteriorating trapped patients at industrial or road accidents, or in areas with difficult terrain, when extrication may be prolonged.

The information required to be relayed to the Medical Retrieval Team is as follows:

1. PRECISE HISTORY OF THE INCIDENT

Location, reason for the delay before being able to transport (trapped in vehicle, machinery or difficult terrain).

2. OUTLINE OF INJURIES OR MEDICAL STATE

Information should be sufficient so that arrangements can be made for the necessary specialists or equipment, e.g. a patient with a limb trapped in heavy machinery may require a surgeon and an anaesthetist to attend.

3. PATIENT'S VITAL SIGNS

The normal signs of conscious state, respiration, circulation and palpatory blood pressure recordings are required.

Country Ambulance Officers should provide as much of the above information as possible to their nearest medical contact, e.g., local hospital or doctor, which will allow the medical authority to provide advice or assistance, as necessary.

Should a Medical Retrieval Team fly into a country area to attend a patient, it may still be necessary for a country crew to transport the patient and team to Adelaide should air evacuation not be advisable because of the patient's condition, or the type of aircraft available.

OBSTETRIC & NEONATAL RETRIEVAL

A pregnant woman may be retrieved before or after delivery because of some complication of pregnancy, such as eclampsia or haemorrhage, or because she is in premature labour. The retrieval team may in some situations include an obstetrician and a midwife.

If delivery of the baby en route is a possibility, they will take appropriate equipment with them.

Neonatal retrieval is becoming more frequent, with the aim of managing premature and other critically ill infants in a major neonatal unit. The retrieval team in this context usually consists of a neonatologist and a neonatal sister, together with a retrieval unit which contains an incubator, respirator, cardiac monitor and intravenous infusion pump, as well as additional boxes.

Figure S.33 Assistance to the team

ASSISTANCE TO THE TEAM

While the Medical Officer and the Nurse will be able to manage the emergency medical care of the patient, they will sometimes need assistance from the Ambulance Officer during the performance of particular procedures such as endotracheal intubation, artificial ventilation, administration of drugs. They will often need assistance in areas in which the Ambulance Officer has more detailed knowledge and experience, such as communications, transport, and use of the ambulance equipment.

Glossary

Amplifier – a device for increasing the size of electric signals.
Artifact – not real, produced by some error.
Bundle of His – main conducting tissue from atrioventricular node down the ventricular septum.
Congenital – something one is born with – e.g. congenital heart disease.
Convulsion – violent muscular contraction of the body.
Defibrillation – the process of electrically shocking the heart to stop ventricular fibrillation.
Depolarisation – process of electrical excitation of muscle cells, causing contraction.
Electrical interference – artificial waveform not originating from the heart.
Electrocardiogram – the recorded trace of electrical activity in the heart.
Electrode – a metal plate or stud fixed to the skin to conduct electric current.
Galvanometer – an instrument for detecting strength and direction of an electric current.
Heart block – arrhythmia due to obstruction to transmission of electrical activity in the conducting system of the heart.
His bundle – see Bundle of His.
Pacemaker – Tissue in the heart which initiates electrical activity and sets heart rate.
Purkinje fibres – muscle fibres in the ventricle wall.
Repolarisation – recovery of muscle cells, ready for depolarisation.
Sinus tachycardia – tachycardia originating in the sino-atrial node.
Supraventricular – above the ventricle, i.e. atrial. Usually supraventricular tachycardia.
Telemetry – transmission of signals to an instrument distant from the site of recording.

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