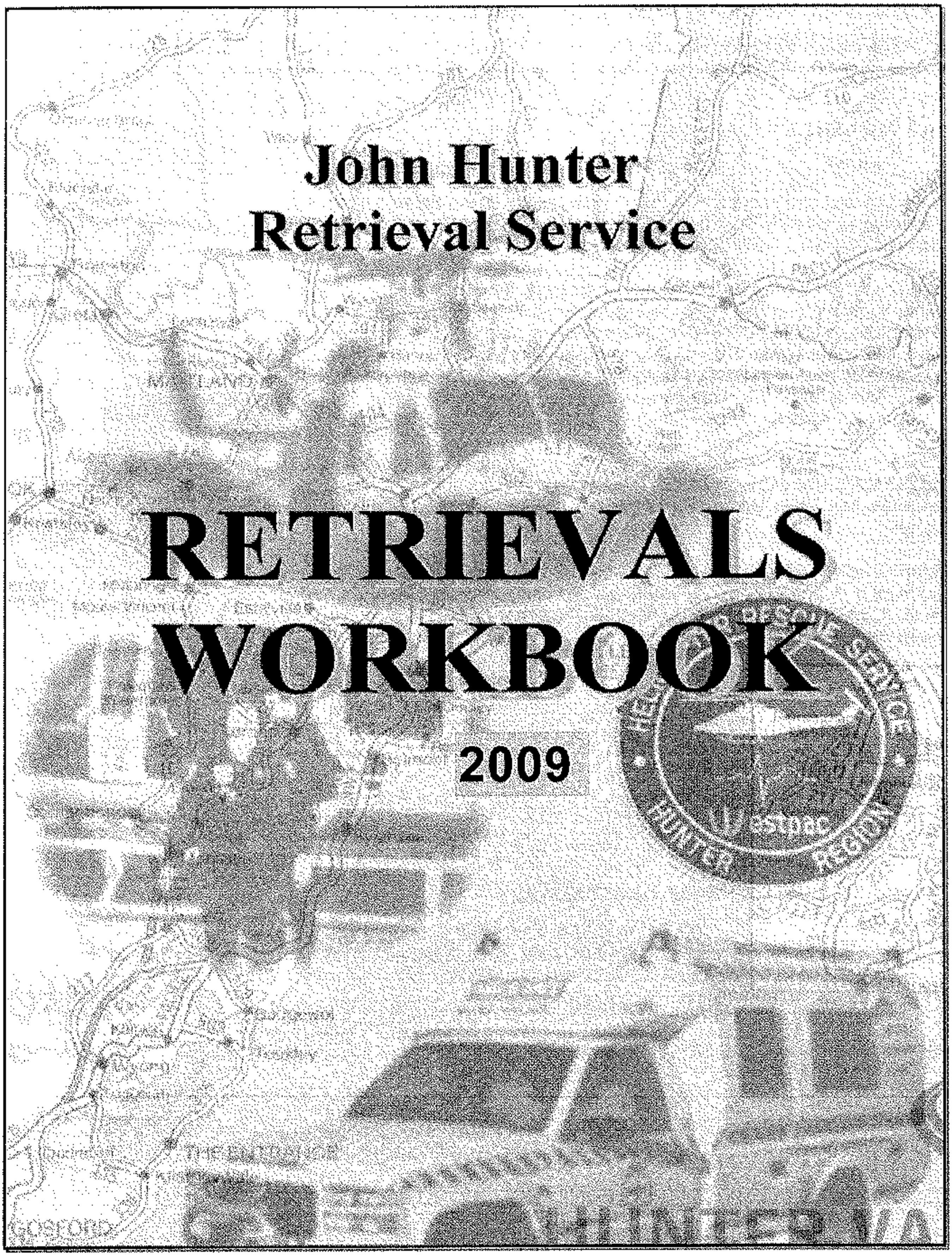
John Hunter Retrieval Service

RETRIEVALS WORKBOOK

2009



INTRODUCTION

The John Hunter Retrieval Service provides highly skilled teams specialising in the transport of critically ill patients between health services both within the Hunter Region and across NSW, utilising road, fixed wing and rotor wing transport modes.

The aim of this workbook is to provide a resource for team members concerning the skills, knowledge and safety procedures specific to the transport environments most frequently encountered. A current high level of skill and knowledge regarding the care and management of critically ill adults and children in the hospital based, intensive care environment, is assumed. Also assumed is competency in the safe operation and assembly of all medical equipment used in the transport of critically ill patients within the John Hunter Intensive Care Unit.

This workbook is not a complete reference on the subject of patient transport and further reading of current literature is essential. For this purpose a list of suggested readings has been included, and articles compiled in the 'Retrievals Resource Folder'.

Short review questions are included at the end of many sections and must be completed. A scenario based simulation workshop must be attended and all staff must complete satisfactorily performed 'buddy' retrieval before embarking on independent retrieval work.

The John Hunter Retrieval Service Education Group.

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NURSING ELIGIBILITY FOR EXTERNAL RETRIEVALS

To be eligible to conduct external retrievals, nurses must fulfill the following criteria

- A. RN with a post basic ICU certificate
- B. At least 3 months post certificate experience in JHH ICU.
- C. **Or** CNS in ICU.
- D. Current member of full time or part time staff of the JHH ICU.
- E. Must have currency of annual helicopter safety brief.
- F. Must have currency of ALS accreditation.
- G. Staff new to retrieval work must complete at least one supervised 'buddy' retrieval.

I. Staff are encouraged to complete the Retrieval Workbook. Successful completion will be recorded in the Staff database.

II. To be eligible, nurses must agree to participate in **all** retrievals. (ie air/road, adult/paediatric).

III. Eligible nurses may **elect** to be removed from the eligibility list at any time by applying in writing to the ICU NUM.

IV. All team members should display dedication to providing a high clinical and professional standard of practice.

V. All team members are expected to be familiar with, and competent in the use of all equipment used on retrievals.

VI. Medical exclusions include the following
   - A. Pregnancy greater than 26 weeks.
   - B. Middle ear disease.
   - C. Severe proneness to motion sickness.

ICU Course Participants

Students may only participate in retrievals in a supernumerary capacity after completion of retrieval presentation and management term.

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PROFESSIONAL ISSUES

Crew Resource Management

"Flight nursing practice is collaborative" (Holleran, 1996,6).
The retrieval nurse comprises part of a team that includes the doctor as a partner, pilot, non-medical crew, and all other persons who participate in the retrieval of the patient from a referring institution.

The concept of *Crew resource Management* encompasses the relationships between team members, each with their own specialised roles to play but with the ability to work in combination to facilitate the successful and safe outcome of the medical retrieval mission. Statistics suggest that 70% of accidents or incidents that occur in the transport environment are caused by crew or team members failing to work together effectively (Campbell and Bagshaw, 1994). Studies show that problems arising in transit often have little to do with the technical aspects in operation of the aircraft, but result from ineffective communication, poor decision making, inadequate problem solving and faulty judgement.

Each member of the flight crew, including the medical team, carries out integrated functions and delegated duties. This involves coordinated teamwork in the exchange of information, and the reliance on information given to be accurate.

Whilst the pilot and non-medical crewmen are not directly responsible for patient maintenance and safety, and medical crew have little to do with maintenance of the aircraft, the overall safety and success of the mission is reliant on all team members performing their individual and specialised tasks competently and in concert with each other

The pilot is *captain* of the team in all aeromedical retrievals and has the overall responsibility for all flight crewmembers and mission safety.
Individual team member level of skill and competency, an appropriate and professional attitude, and co-operation is mandatory to the safe execution and completion of all aeromedical missions.
Individual team members are responsible not only for assuring exemplary personal performance, but also contribute to the safe completion of the medical retrieval in all aspects.

Good communication skills in the conveyance of relevant and accurate information, respect for the roles and function of other team members, the ability to work within an integrated and multifaceted team, and personal responsibility for the maintenance of one's knowledge and skills level to the aviation medical environment, all contribute to the nurse assimilating into a successful crew resource environment.

The Team

The retrieval service offered by the John Hunter Hospital involves the co-ordination and effort of all professionals involved in the patients care from the time they arrive at the referring hospital.

This includes the medical and nursing staff at the referring hospital, the ambulance crew or flight crew, the medical and nursing staff from the JHH ICU, the consulting Intensivist or fellow from the JHH ICU, and the ancillary staff (wardsmen, ward clerks, security officers, etc) all of whose efforts are essential to the smooth, rapid and safe completion of each mission.

Therefore, it is the team's responsibility to support, educate and encourage all staff in the execution of their duties, working with them to achieve a common goal.

Staff at peripheral hospitals, frequently work in less than ideal conditions. Also, they are not as familiar with critical care technology and the concepts of transport preparation of the critically ill patient.

It is therefore, extremely important to support, encourage and include these staff in the team approach to stabilising the patient prior to leaving their hospital.

ANATOMY AND PHYSIOLOGY OF ALTITUDE AND MOTION

- Knowledge of the earth's atmosphere and awareness of the effects that altitude can have on human physiology, provides an essential foundation for the adaptations and interventions necessary for optimal patient care in the air medical environment.

Composition of the Atmosphere

- The atmosphere consists of a mixture of gases. Suspended within these gases are tiny particles of dust and smoke. Water is also present in vapour, liquid and solid forms.
- The atmosphere can be characterised by layers within the atmosphere, or physiological zones that predict the effects of altitude on the human body.
- Atmospheric pressure or barometric pressure is the force or weight exerted by the atmosphere at any given point. 1 atmosphere pressure (atmos) = 760 mmHg.

Composition of Dry Air

Table 1. The concentrations of gases in the atmosphere.

GAS	PRESSURE (mmHg)	PERCENT
Nitrogen	593.408	78.08
Oxygen	159.22	20.95
Argon	7.144	0.94
Carbon-dioxide	0.288	0.03
Hydrogen	0.076	0.01
Neon	0.013	0.0018
Helium	0.003	0.00015

- The concentration of oxygen remains relatively constant at 21% up to altitudes of 70,000 feet (21km). This is also true for the other gases with the exception of ozone, water vapour and some variability of carbon-dioxide.
- HOWEVER, the availability of oxygen diminishes as the altitude increases because O_2 molecules as well as others become more widely dispersed as altitude increases.

Atmospheric Ozone

- Ozone molecules consist of 3 atoms of oxygen (O_3). Most ozone in the stratosphere forms as a result of processes that include the absorption of ultra-violet radiation.
- The concentration of ozone varies with altitude, latitude and time due to the circulation of the atmosphere around the earth.
- The presence of ozone in the atmosphere is essential for human existence on earth because of its ability to absorb ultra-violet radiation from the sun.

Water Vapour in the Atmosphere

- The atmosphere contains some water vapour, but the amount varies. Water vapour enters the atmosphere from the earth's surface chiefly by evaporation from water surfaces, and transpiration from plant life. It changes into liquid and solid states, and returns to the earth's surface as dew, rain, hail or snow.

- In general, the concentration of water vapour in the atmosphere decreases with altitude.

Carbon-dioxide

- CO_2 enters the atmosphere by processes such as human, animal and plant respiration, decomposition of dead organic matter, and burning of materials including volcanoes. Plant life removes a large proportion of CO_2 from the atmosphere during photosynthesis.
- 99% of the earth's CO_2 is dissolved in the waters of the oceans.
- The solubility of CO_2 varies with temperature.
- The concentration of CO_2 near the ground is variable depending on car emissions and nearness to industrial areas, etc.

Vertical Divisions of the Atmosphere

- The atmosphere is divided into four divisions- troposphere, stratosphere, mesosphere and thermosphere. Divisions are based on mean temperature variation with altitude.

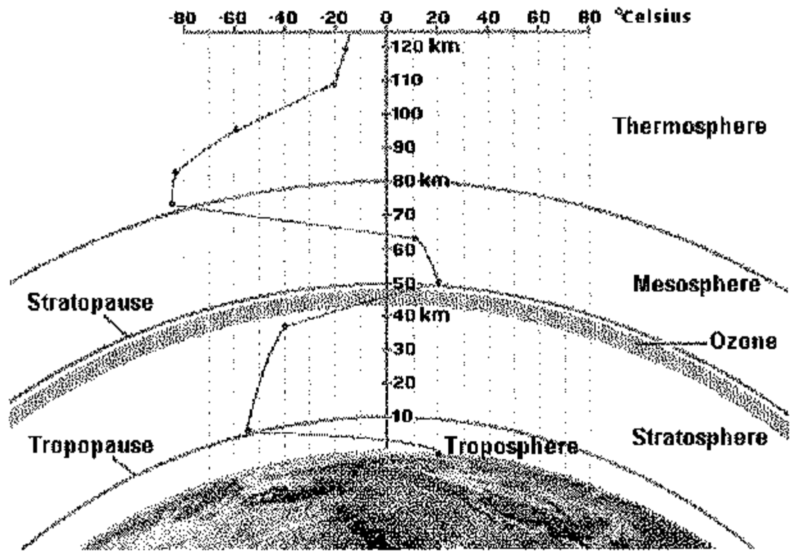


Figure 1. Vertical divisions of the atmosphere, *Microsoft 1997.*

- The high temperatures that occur near the earth's surface are associated with the absorption of radiation from the sun. Most radiation is absorbed by the earth's surface and so the troposphere is heated from below.
- By contrast, the heat source in the upper stratosphere is in its upper levels where ozone absorbs ultra-violet radiation. The higher temperatures near the stratopause indicate that the atmospheric particles are moving at higher speeds, however the density of the atmosphere is lower at these levels.

- The number of atmospheric particles involved is very much greater near the earth's surface, hence the heat energy of the atmosphere is largely concentrated in the lower troposphere.
- The pressure exerted by the atmospheric gases at any altitude depends on the molecular weight of the particles above unit area at that level.
- Atmospheric pressure at mean sea level is approximately 1,000 mb (760 mmHg). The stratopause pressure is only about 1 mb, indicating that approximately 1/1000 of the mass of the atmosphere lies above 50km. At higher altitudes the density becomes even less.

The Troposphere

- The lowest region of the atmosphere is called the troposphere and extends to an altitude of approximately 35,000 ft. Usually the temperature decreases with altitude in the troposphere, but in some parts there may be a shallow layer in which the temperature increases with altitude. Such a layer is called a temperature inversion.
- The top of the troposphere is called the tropopause. Its altitude varies over the earth's surface and is not continuous. A tropical tropopause exists in low latitudes (near the equator) at an altitude of approximately 30,000 ft (9.1 km). At higher latitudes a polar tropopause exists at about 6,000 ft (1.8 km).
- Between these two regions there is a sloping middle latitude tropopause with breaks occurring in the vicinity of jet streams. Multiple and overlapping tropopauses may therefore occur in the middle latitudes, and rapid changes in the temperature and altitude of the tropopause may occur in any locality.
- Within the troposphere, the temperature will decrease 2 degrees Celsius for every 1,000 ft (305 m) increase in altitude.
- The moving weather systems and associated cloud systems that effect our lives are mostly confined to the troposphere. As these systems change, the characteristics of the tropopause vary in time and place.
- Helicopter transport is confined within the troposphere.
- The steady decrease of temperature with altitude in the troposphere continues until the tropopause is reached. Because the height of the tropopause is greater over the equator, the lowest temperatures in the atmosphere occur in the vicinity of the equatorial tropopause.
- The troposphere contains the greater part of the mass of the atmosphere. It is characterised by marked vertical air movements, appreciable water vapour content, cloud and weather.

Physiological Zones of the Atmosphere

- The physiological efficient zone extends from sea level to approximately 12,000 ft above sea level. Within this zone, the barometric pressure decreases from 760 mmHg to 483 mmHg.
- This is the most acceptable zone for normal human physiological functioning, unless an individual acclimatises to a higher altitude or supplemental oxygen is used.
- From 12,000 - 50,000 ft is the physiological deficient zone. Barometric pressure drops from 483 mmHg to 87 mmHg. Normal physiological functioning is greatly impaired at the upper limits of this zone if there are no appropriate interventions.

- Most commercial and private aviation occurs within the physiological deficient zone. The implications for patient transportation within this zone are limited to fixed wing aircraft with cabin pressurisation capabilities.

All helicopter retrievals occur within the troposphere, below 10,000 ft.

Flight Physiology

- Air medical transports must be executed safely. To facilitate safe transportation of the patient, the nurse must be familiar with the effects of altitude and flight on human functioning. An understanding of the concepts of flight physiology assists the nurse to provide a basis on which all interventions are centred to ensure a safe medical air retrieval for the critically ill patient. Such concepts include the physical gas laws and the way they relate to the stresses of flight.

The Gas Laws

- An understanding of altitude physiology begins with understanding the gas laws, the primary concern of which is to describe the relationships between the variables of temperature, pressure, volume and mass of gases.
- Changes in these variables become particularly important during ascent and descent.

Temperature

- Kelvin (K) refers to the level of energy of a gas sample.
- Celsius and Fahrenheit refer to the absolute temperature of a gas sample.

Pressure

- Is defined as absolute or total pressure and is conventionally expressed in atmospheres (torr), as a given column of Mercury in millimetres (mmHg), or of water balancing the pressure in centimetres (cmH_2O).

Volume

- Is expressed in cubic units such as cubic meters (m3), cubic centimetres (cc), or in litres (L).

Mass

- Relative mass of gas or number of molecules (or ions) expressed in gram molecules ie/ the molecular weight of the substance in grams.

Boyle's Law

- When the temperature remains constant, the volume of a given mass of gas varies inversely to its pressure. Thus at a constant temperature, the volume of a gas is inversely proportional to the pressure, ie as an aircraft ascends to altitude and the ambient pressure decreases, the volume of gas within an enclosed space will expand. As the aircraft descends, the volume of gas will contract.
- Boyle's Law can effect any medical equipment or body cavity that has an enclosed air space. Intravenous flow rates, the pressure in a MAST suit, the volume in an endotracheal cuff will all be altered. Body cavities that can be affected include the stomach, intestines, middle ear, sinuses and closed pneumothorax.

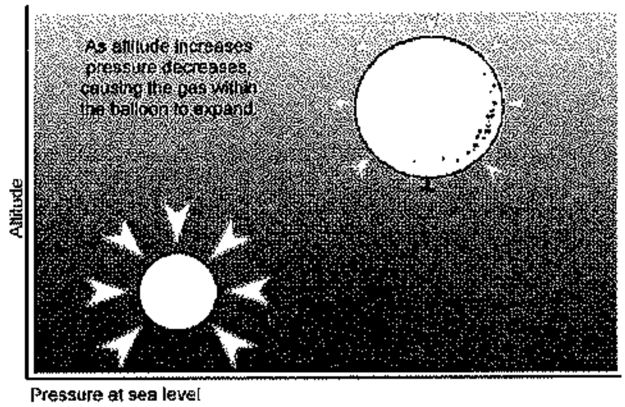


Figure 2. The effects of changing altitude on the gas within a balloon according to Boyle's Law, *Flight Physiology, Blumen and Dunne, 1992.*

Dalton's Law

- The total pressure in a mixture of gases, is the sum of the partial pressures of the individual gases within that mixture. Gases in a mixture exert a pressure equivalent to the pressure each would exert if present alone in the volume of the total mixture.
- This means that each gas present in a mixture exerts a partial pressure equal to the percentage in concentration (by volume) multiplied by the total pressure. As atmospheric pressure (barometric pressure) decreases on ascent to altitude, the partial pressure of each gas in ambient air will decrease.
- The decrease in partial pressures of gases at altitude has important considerations for oxygen delivery to the body. A pressure differential is required for O_2 to cross the alveoli into the bloodstream. As a result of a decreased partial pressure of O_2 in inspired air, less O_2 is transferred to the body.

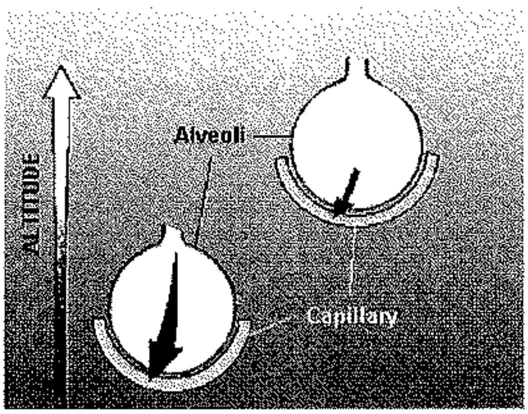


Figure 3. The effect of altitude on gas exchange in the alveoli according to Dalton's Law, *Flight Physiology, Blumen and Dunne, 1992.*

Henry's Law

- Deals with the solubility of gases in liquids. This law states that the quantity of gas dissolved in 1 cm of a liquid is proportional to the partial pressure of the gas in contact with the liquid. The absolute amount of gas dissolved in liquid under conditions of equilibrium, is dependent on the solubility of the gas, the temperature, in addition to the partial pressure of the gas, eg when a bottle of carbonated soft drink is opened after being shaken, the gas is released to the atmosphere. The soft drink was bottled with an equilibrium established between the liquid and the gas within the bottle. When the bottle is opened, the equilibrium of the gas above the liquid is altered thus releasing the bubbles of gas within the soda.

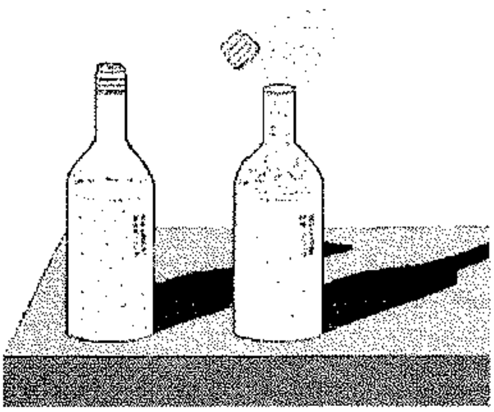
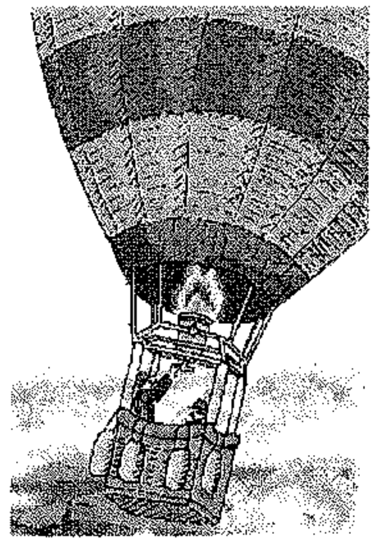


Figure 4. The effects of pressure changes on dissolved gases according to Henry's Law, *Flight Physiology, Blumen and Dunne, 1992.*

Graham's Law

- States that the rate of diffusion of a gas through liquid is directly related to the solubility of the gas, and inversely proportional to the square root of its density or gram molecular weight. This means that gases will diffuse from an area of higher pressure or concentration to an area of lower pressure, eg simple diffusion, or gas exchange at cellular level.

Stresses of Flight.



- Aspects related to altitude and flight physiology provide air medical crew with many challenges. It must be remembered that the normal physiological responses to a changing altitude are further complicated when transporting an already compromised patient.
- The term stresses of flight is commonly used to identify the conditions and physiological effects that the air transport environment may place on the patient and flight crew alike. In addition to these stresses, there are a series of self imposed stresses that influence crew performance, patient outcome and overall safety of the retrieval.
- A background knowledge of the atmosphere, the physical gas laws and cabin pressurisation, helps to illustrate how the human body responds to atmospheric changes and begins to explain several of the stresses of flight. Awareness of the effects of altitude on human physiology will provide an essential foundation for the adaptations necessary for optimal patient care in the air medical environment.
- It is also important to appreciate the link between stress and work performance.
- Stress results from a perceived imbalance between a demand and the ability to meet that demand. Stress can cause fatigue and sub-optimal work performance. An understanding of the stresses of flight may prevent or alleviate stress related complications during either helicopter or fixed wing medical retrievals.
- There are two types of stress associated with the aviation environment- they are the stresses of flight, and self imposed stress. These stresses are cumulative and may lead to significant personal compromise, potentially endangering all occupants of the aircraft.
- The Air Medical Crew National Standards Curriculum (USA) identifies 9 stresses of flight- barometric pressure, hypoxia, thermal stress, dehydration, noise, vibration, gravitational forces, third spacing and fatigue.

Barometric Pressure

- The effects of changing altitude during air medical retrieval are directly related to the physical gas laws. The impact of barometric changes can effect the medical crew, patient and the equipment alike.
- There are 3 mechanisms by which barometric pressure effects the body.

Trapped Gases

- As altitude increases the volume of a gas also increases (Boyle's Law).
- If these gases are trapped within a body cavity the result of this expansion is increased pressure, distension, compression of adjacent structures and infrequently rupture.
- Injuries that are a direct result of the mechanical effects of a pressure differential are referred to as barotrauma.
- The expansion of trapped gases within body cavities can effect any part of the body that contains gas. Gas can be trapped as a result of trauma, illness or medical procedures.
- When assessing a patient prior to aeromedical transport, it is therefore important to identify any trapped gases and consider measures to decompress these gases.
- If the gas can not be decompressed and poses a threat to the patient's condition the flight crew should be consulted about a low level flight plan for the return flight.
- Trapped gases can also effect the crew. This is especially true in regards to inner ear and gastrointestinal gas.

Common Trapped Gas Scenarios

- **Head Injuries:** Any traumatic head injury can result in gas becoming trapped within the skull (aerocele). Any amount of gas trapped within the skull or brain tissue will expand up to twice its normal volume at the altitudes used in helicopter transport.
- **Penetrating eye injuries:** Penetrating eye injuries can result in gas being trapped within or behind the eye. At altitude this may be enough to cause further injury.
- **Sinusitis:** Blocked sinuses due to URTI or other conditions may cause severe discomfort and increase the likelihood of sensory disturbances during flight. The use of a nasal spray may provide relief if the condition is not severe. Crew members with sinusitis should avoid aeromedical missions.
- **Aerodentalgia:** Small pockets of gas trapped beneath fillings or in dental cavities can expand causing severe pain or dislodgment of fillings.
- **Middle and Inner Ear Disturbances:** Otitis media and other inner ear conditions can cause gases to be trapped within the inner ear. If the pressure within the inner ear can not be equalised with the ambient atmospheric pressure severe pain and sensory disturbances are likely to occur. Relief may be achieved by thrusting the jaw forward, swallowing or a valsalva manoeuvre.

- **Pneumothorax or Thoracic Trauma/Surgery:** Gas trapped within the pleural space will expand at altitude and may progress to a tension pneumothorax. Intercostal catheters should be considered for all pneumothoraces.
- **Tension Pneumothorax:** All tension pneumothoraces should be decompressed with an intercostal catheter prior to aeromedical transport.
- **Pneumopericardium:** The aeromedical transport of any patient with trapped gas within the pericardium or retrosternal gas should be carefully considered.
- **Recent Abdominal Surgery or Trauma:** Gas can easily become trapped within the abdominal cavity during abdominal surgery. Expansion of this gas at altitude can cause severe discomfort and pain, as well as compromising respiratory function.
- **Recent Gastrointestinal Surgery/Ileus:** Gas can accumulate in an inactive bowel or be introduced into the bowel, especially following surgery or trauma. All patients in this category should be transported with a nasogastric tube in the correct position on free drainage. Check the N/G tube for patency and empty the stomach of gas and fluid prior to departure.
  In severe cases hypotension, severe pain, vasovagal response and respiratory failure can result.
  Flight crew should avoid carbonated drinks and large meals prior to flight.
- **Traumatised Tissues:** Any traumatised tissue, including recent suture lines, can trap small amounts of gas. This may cause anxiety, discomfort and pain at altitude.
- **Intubation:** During intubation and IPPV, gas is frequently forced into the stomach and oesophagus. All intubated patients should, therefore, have a vented N/G tube insitu for any transport.
- **Equipment:** air enclosed within a confined space in any piece of equipment will also be subject to the effects of barometric pressure.
  - ETT cuffs will also be affected by changes in altitude if filled with air, and should be evaluated to prevent balloon rupture or excessive pressure on the tracheal wall during ascent or excessive leak on descent.
  - The air in intravenous fluid containers will also expand on ascent resulting in an increase in flow rate (for this reason collapsible bags are used, not bottles). On descent the flow rate will slow as air volume is decreased.
  - MAST suits and pneumatic splints will also be effected pressure changes, and at altitude, a compartment syndrome may develop with distal circulation being compromised.

Evolved Gases

- When atmospheric pressure is reduced, gases dissolved in a fluid are released from that fluid into a gaseous form (Henry's Law).
- Most evolved gas problems that occur in the human body result from the release of nitrogen from body fluids and tissues following rapid decompression during scuba diving (the Bends).
- When transporting any patient suffering from a decompression illness a low level flight plan should be strongly considered.

Tissue Concentration of Gases

- The third mechanism applies to barometric pressure changes in the under water environment, and addresses abnormal tissue concentrations of various gases.

Cabin Altitude

- The first protection against the influences of a changing altitude on occupant physiological functioning is the creation of an artificial atmosphere or cabin altitude.
- In a pressurised fixed wing aircraft, compressed air is pumped into the cabin to maintain a cabin altitude significantly less than flight altitude.
- In most pressurised aircraft a cabin altitude of approximately 8,000 ft can be achieved while flying at an actual altitude of over 40,000 ft.

The Bell 412 and Longranger do not have pressurised cabins.

Hypoxia

- Hypoxia represents an oxygen deficiency in body tissues sufficient to cause impairment in physiological functioning. Hypoxia can be described according to it's aetiology

Hypoxic Hypoxia

- is caused by inadequate gas exchange at the alveolar / capillary membrane. The combined effects of the physical gas laws explain the aetiology of this type of hypoxia at altitude.
- An inadequate supply of oxygen to the blood results in oxygen deficiency to the tissues.
- Common causes include an airway obstruction, V/Q mismatch or an inadequate oxygen partial pressure in inspired air.

Occupants of unpressurized aircraft above 10,000 ft will be hypoxic. Hypoxia may occur below 10,000 ft in susceptible individuals.

- Hypoxic hypoxia is the most common and most serious cause of hypoxia encountered at altitude. It may become most apparent at an altitude above 10,000 ft. If there is no compensatory mechanism or treatment, blood oxygen saturation will drop precipitously.
- A sea level oxygen saturation of 98% will drop to 87% at 10,000 ft, and at 22,000 ft it will be 60%.

Anaemic Hypoxia

- a reduction in the oxygen carrying capacity of the blood may also be termed anaemic hypoxia.
- Blood loss, anaemia, drugs, smoking and carbon- monoxide poisoning are common causes.

Stagnant Hypoxia

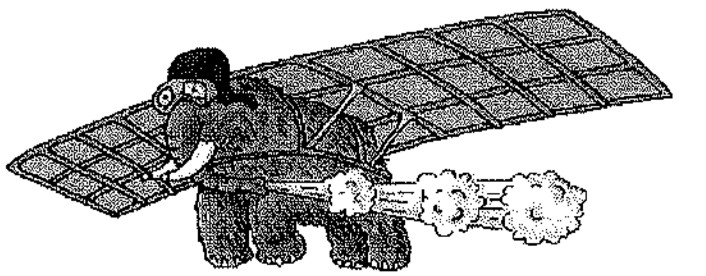
- results from poor circulation in the body causing an oxygen deficiency to the tissues.
- Inadequate cardiac output that cannot meet tissue requirements, occlusion of a blood vessel, venous pooling, arterial spasm and periods of positive pressure ventilation are all contributing states.

Histotoxic Hypoxia

- occurs when there is adequate oxygen delivery, but the body tissues are unable to utilise the available oxygen. Carbon-monoxide and cyanide poisoning, alcohol ingestion and narcotics may result in this form of hypoxia.

- During an air medical retrieval, the most threatening factor of hypoxia is it's insidious nature. The pilot and medical crew are also susceptible to hypoxia, however the onset and symptoms may vary with the individual.

- Many factors predispose an individual to hypoxia at altitude. Pre-existing medical illness will be exacerbated at altitude including pneumonia, CAL, acute asthma, pneumothorax, heart failure, shock and blood loss.
- Several social factors also play a role on one's susceptibility. Physical fitness, metabolic rate, obesity, diet, nutrition, emotions and fatigue all influence an individual's threshold for hypoxia.
- Alcohol ingestion may promote histotoxic hypoxia, and smoking produces carbon-monoxide reducing the blood's capacity to bind with oxygen.
- An increase in rate and depth of ventilation is the initial respiratory response to hypoxia.
- The response may be minimal until an altitude of approximately 8,000 ft, where an arterial oxygen saturation drops to about 93%. The maximum response occurs at 22,000 ft.
- At this elevation the minute volume will double. A change in tidal volume is the primary reason for this rather than an increase in respiratory rate.
- An important consideration during air medical transport is the medications that a patient may be given. CNS depressants may inhibit the respiratory response to hypoxia that normally occurs at altitude. This emphasises the need to recognise the early symptoms of hypoxia, to properly monitor the patient, and to aggressively treat patients who are already hypoxic.



- A common threshold for the onset of cerebral hypoxia is a PaO_2 of 50-60 mmHg.
- Lower oxygen partial pressures may also be associated with hypoxic effects based on an individual's predisposing medical condition, social factors, physical condition and activity level.
- The brain and the eyes will be affected significantly due to the high oxygen requirements of theses 2 organs. Initial CNS signs and symptoms include - hyperactivity, restlessness, excitation, talkativeness and euphoria.
- As CNS hypoxia persists, a patient or crew member will exhibit worsening mental confusion, impaired judgement, decreased attention span, impaired memory, depression, worsening visual depth and perception, inability to interpret other sensory input and finally unconsciousness.
  1. The cardiovascular response to hypoxia may be observed in 2 stages.
  2. An initial increase in cardiac output by escalation in heart rate and selective vaso-constriction. This response will begin at about 4,000 ft in altitude. As a result of the increase in cardiac activity the cardiovascular system will require more oxygen.
- If hypoxia is left untreated, the myocardium which is already hypoxic, will then respond with a decreased heart rate, hypotension and arrhythmias.

Noise

- Noise and vibration are inherent and troublesome facts of air medical transports. Noise is not only annoying, but causes speech interference and promotes hearing loss. Excessive noise can also interfere with and complicate patient care.
- During air transport it is impossible to auscultate the lungs or blood pressure.
- Inadequate communication between the medical team and an awake patient may interfere with the detection in changes of symptoms or condition.
- The crew must rely on other means to monitor and assess the patient's condition.
- Close observation for alteration in the patient's respiratory rate, chest expansion, level of consciousness, agitation and abdominal distension may indicate a change in the patient's condition.
- Blood pressure may be monitored through invasive or non-invasive means.
- Pulse oximetry provides valuable information about the patient's oxygenation and respiratory status, and CO_2 detectors may be helpful in assessing the ventilated patient's response to altitude (increased CO_2 production 2^0 to increased workload).
- In both helicopter and fixed wing aircraft, the main source of noise comes from the engines, propellers / rotors and air turbulence. Prolonged or intense exposure to noise may result in a deterioration in work performance, headaches, fatigue, nausea, visual disturbances, vertigo, general discomfort and ear damage which can be temporary or permanent.
- Options for hearing protection include ear plugs, headsets and helmets.

Vibration

- Vibration is inherent to all transport vehicles, and may interfere with patient assessment and some routine physiological functions. The most common sources of vibration are the aircraft (or road ambulance) engines and air turbulence.
- During helicopter transport, vibration is most severe during the transition to hover or during turbulent weather conditions. In fixed wing transport, vibration increases during high speed, low level flight and during cloud penetration in turbulent weather.
- Vibration may interfere with both invasive and non-invasive patient monitoring.
- Exposure to moderate vibration results in a slight increase in metabolic rate. Low frequency vibration may promote fatigue, irritability, shortness of breath, motion sickness, chest or abdominal pain. Vibration may also interfere with body thermoregulation, and it's effects may be aggravated by either hot or cold temperatures. In a hyperthermic patient, vehicular vibration may cause circulatory vaso-constriction. This can override the body's cooling mechanism and inhibit the patient's ability to sweat.
- Little can be done to minimise vehicular vibration. Efforts can be made however to avoid direct contact with the bulkhead of the vehicle. Padding should be placed where the airframe comes into direct contact with any personnel or equipment. Cushioned seats and stretcher pads should be used, and patients and crew should be restrained properly at all times to minimise the effects of vibration.

Gravitational Forces

- During routine flight operations, G forces will not impact significantly on the patient or the crew. However, an understanding of G forces will explain how such forces may be relevant to crew and patient positioning within the aircraft.

- Gravitational forces are applied to the patient and crew on both ascent and descent, during a change in speed or direction and during take-off and landing.
- Acceleration is the rate of change in velocity, and is measured in 'G's'. During any sudden or excessive change in direction or speed an individual will be subject to the effects of gravitational forces.
- Therefore, G forces are an important consideration to accident prevention and accident survival strategies.
- Each item of mass inside the cabin that could injure an occupant must be restrained. During deceleration (landing), an unrestrained person in a forward facing seat may be injured or ejected from his or her seat.
- A rear facing seat provides better restraint and protection during crash deceleration.
- Patient positioning within the aircraft may enhance or minimise the effects of G forces during take-offs (acceleration) and landings (deceleration).

Thermal Stress

- Helicopter and fixed wing transport can expose the aircraft, crew and patient to temperature extremes. These may be due to inherent seasonal changes, geographic considerations or altitude variations.
- Exposure to extremes in temperature will result in an increased metabolic rate, causing an increased oxygen demand and consumption. This may further compromise an already hypoxic patient.
- In addition, prolonged exposure results in impaired performance, motion sickness, headache, disorientation, fatigue, discomfort and irritability.
- Factors such as exposure time, air circulation, condition and type of clothing and physical condition can exacerbate or mitigate the effects of temperature.
- The air medical crew can take step to prevent potential complications related to thermal stress.
- The aircraft cabin should be kept at a comfortable temperature, minimising exposure to ambient temperature extremes.
- To prevent hypothermia a space blanket, layers of clothing or blankets can limit heat loss.
- Wet clothing or moist dressings should be removed.
- Prolonged exposure to high temperatures may necessitate increased IV or oral fluids to prevent dehydration.
- The effects of thermal exposure can be magnified by other stresses including vibration, dehydration, and alcohol or drug intoxication. Climatic temperature inversions can also create air turbulence that can exaggerate the effects of thermal tolerance.

Dehydration

- High altitude transports expose the patient and crew to low humidity. As altitude increases and air cools, moisture in the air decreases significantly. As a result, pressurised aircraft draw in dry outside air creating an extremely dry pressurised cabin. In addition, dry medical oxygen will further predispose the patient to dehydration.
- As a result of dehydration, hypothalamic stimulation may occur resulting in an increase in metabolic rate and an increase in oxygen requirements.

- Respiratory secretions may become thicker resulting in less efficient gas exchange, further contributing to hypoxia.
- To prevent dehydration during air retrieval, fluid intake must be monitored carefully.
- Patients who exhibit signs of dehydration or hypovolaemia, should be managed aggressively before exposing them to further circulatory changes at altitude.

Fluid Redistribution

- Long distance or high altitude air travel may precipitate the loss of fluids from the intra-vascular space into the extra-vascular tissues.
- This occurs in response to a decreased ambient pressure surrounding blood vessel walls. causing leakage of fluid from the intra-vascular space into the surrounding tissues.
- Increased intra-vascular pressure or an increased permeability of the vessel walls may also contribute to fluid loss.
- The onset and complications of fluid redistribution may be aggravated by pre-existing medical conditions or other stresses of flight.
- Exposure to excessive G forces, vibration and temperature extremes may also exacerbate fluid redistribution.
- Signs and symptoms include oedema, increased heart rate, hypotension and dehydration.

Fatigue

- Fatigue is a state or condition that follows a period of excessive mental or physical activity or inactivity.
- While fatigue is considered one of the stresses of flight, it may also be considered an end product of the contributing factors that make up the stresses of flight.
- Hypoxia, G forces, barometric pressure changes and dehydration contribute to fatigue.
- In addition, the emotional and physical stress of prolonged patient care in the air medical environment may add to crew fatigue.

Self Imposed Stress

- A patient or crew member's self imposed stresses can influence greatly their physiological performance during air medical retrieval.
- Self imposed stresses are often under the control of the individual: drugs, exhaustion, alcohol, tobacco and hypoglycaemia are all contributing factors to susceptibility to fatigue, poor work performance and decision making ability in flight.
- Inattention, distraction, errors in timing, the need for greater stimulation, neglect of secondary tasks, loss of accuracy and control, and awareness of error accumulation can all adversely effect the patient and other crew members alike.
- Acute fatigue is usually remedied by adequate sleep.

Cabin Pressurisation and Decompression

- The most effective way to prevent physiological problems at altitude, is to provide an aircraft pressurisation system so that the occupants of the aircraft are never exposed to pressures outside the physiologically efficient zone of the atmosphere.
- Aircraft pressurisation provides an increased barometric pressure inside the crew and passenger compartments of the aircraft. This effectively reduces cabin altitude, creating near to earth atmospheric conditions within the aircraft.
- Commercial aircraft normally pressurise to the equivalent of 5,000 - 8,000 ft with the aircraft at approximately 40,000 ft.
- The conventional method of pressurisation is to draw air from outside the aircraft, compress it, then deliver it inside the cabin. The continuous flow of compressed air inside the cabin ventilates the compartment, and in most aircraft, also controls the thermal environment within the aircraft.
- The difference between the absolute pressure within the aircraft and that of the atmosphere outside, is called the cabin differential pressure.
- In air medical transports, cabin pressurisation is especially important. Not only does it protect the occupants from the physiological hazards of altitude, but it provides more effective control of cabin temperature and ventilation, promotes greater mobility and comfort, and reduces fatigue.
- Cabin pressure can be lost as a result of structural failure such a window or door blowing out, or through a malfunction of pressurisation equipment.
- A loss of cabin pressure is called decompression.
- Aircraft decompression can be slow and take place over several minutes, or it can be sudden and occur in seconds.
- The risk of injury during decompression increases in proportion to the size of the structural defect, to the volume of the cabin, and to the ratio of cabin to atmospheric pressures before and after decompression.

Slow Decompression

- Onset is insidious and gradual and can occur without detection. Signs and symptoms are the same for hypoxia. Decompression can be determined by checking the cabin altimeter.

Rapid Decompression

- The onset is immediate (1-3 seconds) and is accompanied by a loud noise, flying debris and fog. The noise occurs with sudden differences in air mass colliding, and ranges from a "swish" to an explosive bang.
- On rapid decompression, air from the pressurised cabin rushes toward the structural fault. Loose objects including medical equipment can be extracted through the opening.
- Vision is impaired during rapid decompression as both the temperature and pressure decreases.
- The rapidly cooling air loses it's ability to hold water vapour and fogging occurs as the water vapour condenses.
- Physiological effects of rapid decompression are hypothermia, hypoxia, gas expansion and decompression sickness. Hypoxia is by far the most important hazard of cabin decompression of an aircraft flying at high altitudes.
- Following a loss of cabin pressure, the crew and passengers must take measures to protect themselves from potential physiological hazards.
- All occupants must breathe 100% oxygen. Air medical crew must first ensure that they are breathing 100% oxygen before attempting to assist their patients.
- Patients already suffering from an oxygen deficiency must be monitored after decompression.
- After preventing or correcting hypoxia, descent is made to an altitude of less than 10,000 ft if possible.

Decompression Sickness

- Subatmospheric decompression sickness is classically seen with the following manifestations- limb and joint pain, respiratory disturbances, skin irritation, various disturbances of the CNS and cardiovascular collapse. These symptoms lessen or disappear on descent to sea level.
- The basic mechanism for the various signs and symptoms are due to the super saturation of the tissues with nitrogen. Under certain circumstances, super saturation gives rise to the formation of gas bubbles, the main constituent of which is Nitrogen which concentrates in various tissues of the body.
- At sea level, the amount of Nitrogen dissolved in the body tissues and fluid is in equilibrium with the ambient pressure. At higher altitudes, Nitrogen evolves in a manner similar to the formation of bubbles in a carbonated drink when the top is removed.
- Decompression sickness is not normally encountered at altitudes below 25,000 ft.
- In addition to super saturation of the tissues with Nitrogen, other factors that influence susceptibility are rate of ascent, altitude, time of exposure, re-exposure to altitude, body fat, age (>40 years), presence of infection and the effects of alcohol ingestion.

- Primary treatment for decompression sickness arising at altitude is recompression to ground level as rapidly as possible. Breathing 100% oxygen also relieves the tissue hypoxia produced by the reduction of localised blood flow.
- Serious decompression sickness requires treatment in a hyperbaric chamber.

Motion/Position Interpretation and Motion Sickness

- The sensory organs allow us to interpret motion and the position of our bodies in the vertical and horizontal planes.
- Interpretation of motion in a moving vehicle, and especially motion during flight, results in unusual and unexpected forces being interpreted by these senses.
- Correct interpretation of these forces becomes a learned experience. For the inexperienced, the unusual forces which are applied to the body during flight, and during transit in the rear of an ambulance, may result in sensory disturbances and motion sickness.
- Because the flight crew are frequently exposed to these experiences during flight, their perceptions of motion and position are better adapted than those of the medical crew and the patient. It is important, therefore, to trust the flight crew implicitly with regard to the position and safety of the helicopter.
- If you experience one of the sensory disturbances described below, don't panic. Trust the flight crew. If the disturbances become severe, inform the rest of the team about your condition and remain seated. Try to visualise the horizon or landmarks outside of the vehicle.
- The patient's sensory perceptions may be impaired as a result of trauma, illness or medication. If they are supine they will be unable to visualise the horizon or external landmarks. This makes them more susceptible to motion sickness and sensory disturbances.
- It is important, therefore, to reassure the conscious patient that all is well. Frequently throughout the mission, check that the patient is feeling safe and reassured.

Proprioceptive Kinetic Sensations

- This type of sensation relates to the perception of motion involving body alignment in relation to the vertical axis. Turns, descents and ascents, expose the body to both gravitational and centrifugal forces. This may cause sensations of lightening or increasing weight of the body resulting in sensory disturbances. Some of the terms listed below are often used interchangeably though their meanings differ.
  - **The Leans**: a condition which causes a person to attempt to lean his/her body in the direction of the perceived vertical plane. The perceived vertical plane may not be the true vertical plane.
  - **Disorientation**: a loss of proper bearings, state of mental confusion as to position, location or movement.
  - **Vertigo**: a hallucination of movement. A sensation of rotary motion of the external world relative to the body.
  - **Sensory Illusion**: a false or misinterpreted sensory impression; a false interpretation of a real sensory experience.
  - **The Coriolis Illusion**: brought about by the combination of ear, eye, and proprioceptive disturbances. This illusion completely disturbs the perception of true vertical. This is accompanied by vertigo and a complete loss of motion perception in relation to the true vertical.
  - **Alternobaric Vertigo**: is caused by increased pressure in the middle ear. The specific mechanism by which alternobaric vertigo is produced is not understood. The increase in pressure due to failure of ventilation of the middle ear is gradual and usually not adequate to produce symptoms. But, in an aircraft capable of

climbing at rapid rates, or with the sudden pressure caused by performing a Valsalva manoeuvre, the increase in pressure can be great enough to cause vestibular stimulation.
Mild eustachian tube dysfunction, such as blockage or oedema secondary to upper respiratory tract infection, may cause the individual to use more force than normal when performing the Valsalva manoeuvre. This increases the pressure in the middle ear, and may cause enough pressure build-up to stimulate the vestibular organ.

Motion Sickness

- Motion sickness is thought to be caused by a mismatch of sensory signals to the brain.
- Two main types of motion-perception mismatch can be specified according to the sensory system involved. These are, (1) visual-vestibular mismatch, and (2) canal-otolith mismatch.
- For example, one theory states that signals stimulating the vestibular organs do not match with the visual stimulus. Another theory deals with the fact that the brain has information stored as to the effect of specific force applied to the body. If the force causes a familiar effect then all is well. If the force causes a different effect than anticipated over an extended period of time, motion sickness will most likely develop.

Symptoms

- nausea
- vomiting
- belching
- drowsiness
- cold sweats
- pallor
- flatulence
- anxiety

Questions.

Question 1: Explain the physiology of altitude in relation to Boyle's, Dalton's and Henry's laws of gaseous behaviour.

Question 2: What implications do these laws of gaseous behaviour have on all the occupants of an aircraft?

Question 3: In what layer of the atmosphere do all the JHH air retrievals occur?

Question 4: What is the maximum altitude at which a helicopter can safely fly?

Question 5: What is the limiting factor to higher altitudes of flight in a helicopter?

Question 6: What does the physiologically efficient zone mean? To what altitude does this extend?

Question 7: Discuss the advantages and disadvantages of a pressurised cabin environment.

Question 8: Of what significance is the composition of the atmosphere (air) in relation to air transport and (a) nitrogen narcosis, (b) CO poisoning?

Question 9: List the 9 stresses of flight. Compare and contrast their implications for the retrieval of critically ill patients by air and road, (may be done in table form).

Question 11: Explain the difference between 'trapped' and 'evolved' gases.

Question 12: List some critical events which may occur as a result of trapped gases, during aero medical retrievals.

ANATOMY OF A RETRIEVAL

- Most retrievals begin with a phone call from a medical officer in another hospital to a medical officer in the JHH ICU. From this point the medical officer in the ICU should follow the procedure outlined in the Retrieval Flowchart (see appendix).

Only an ICU Fellow or Specialist may approve a retrieval

- Close consultation between all team members is essential from this first call onwards, until the retrieval is completed. To augment communications during any retrieval a mobile phone may be taken on a retrieval.
- The retrieval team sent out by the ICU is composed of one medical officer and one registered nurse. The skill mix of this team should be adequate to deal with any event likely to occur during the retrieval. One member of the team should be a senior experienced practitioner.

Documentation of the retrieval should begin from this first contact and continue to the completion of the retrieval.
Both team members must sign the retrieval form.

Plan

- From information and advice gained from the referring MO, consultants and senior ICU medical and nursing staff, the retrieval team should be able to develop a plan of action prior to leaving the ICU. Although response time needs to be kept to a minimum, this process should not be rushed. Team cohesion starts at this point and sound communication is essential.
- This plan should allow the selection of equipment required, extra drugs and IV fluids to take, likely treatment at the referring hospital and likely activities on arrival at the receiving hospital.
- The plan should not be inflexible but change as events unfold. Frequently things turn out quite differently from expected.

Equipment List

- Thomas Pack
- Propaq (with cables)
- Infusion pumps (as many as required)
- S8 and S4 drugs (carried in bum bag)
- Green retrieval folder
- External pacer (if required)
- Avian or Oxylog 2000 (with tubing)
- $ETCO_2$ cable (with plastic adaptor)
- Helmets (for helicopter only)
- Mobile phone
- Stretcher Bridge (appropriate for vehicle)
- Battery Pack

Liaise

- Throughout the retrieval each team member should liaise with other members of the team, keeping every member informed of changes that may affect their activities.
- The referring hospital staff need to be aware of an ETA (Estimated Time of Arrival), any change in ETA and any special requirements needed by the team on arrival.
- The referring hospital staff should be encouraged to contact JHH ICU or the team directly with any concerns they have about their patient or any changes in the patient's condition.

- The flight crew or ambulance crew need to be aware of the severity of the patient's condition, any procedures that might be necessary in transit, if there is likely to be any accompanying relatives of the patient and the expected departure time. They will also obviously need to know the destination hospital.
- The ICU needs to know the expected ETA, the destination of the patient (i.e. CT scan or OT), the patient's condition, any special requirements needed on return to the JHH, if any relatives are accompanying the patient, and any procedures that may be urgently required on return.
- If a patient is to be diverted to the JHH Emergency Department, the Specialist in emergency must be notified as early as possible. Ph 49 213500)

Assess

- On arrival at the referring hospital, after introducing the team to the referring staff and patient, gather information from the staff, a history and first hand examination.
- Also assess requirements for IV access (is it necessary or desirable), invasive monitoring, etc. Existing IV access should be reviewed and replaced or augmented if necessary.
- At this point it should be clear if the initial plan needs to be changed. If so communicate this to the other team members. Communication is essential.
- Remember, if in doubt, **S** edate
P aralyse
I ntubate
T ransport
- The patient and their relatives should be informed of the expected plan of action, consent gained if required and arrangements made for the transit of relatives to the receiving hospital i.e. are they driving to the receiving hospital immediately or later, travelling with the team etc. The 'Relative Information' pamphlet may be given to the relatives to assist them during this time.
- If a relative needs to accompany the patient during the transport, this possibility should be communicated to the ambulance or helicopter crew now rather than later.

Stabilise

- The patient's condition should be stabilised prior to departure if possible.
- Any procedures, i.e. intubation, insertion of IVs, CVCs, chest drains, NG tubes etc, resuscitation, should be attended to prior to departure.
- Only those procedures that are definitely required should be attended. Return to the receiving hospital is a high priority.
- All IVs, drainage devices etc. should be checked and secured firmly ready for transport.
- If analgesia or sedation is required this should be given and its effectiveness assessed.

Transfer

- The patient is transferred to the stretcher, secured, and the stretcher bridge attached to the stretcher.
- All equipment is attached to the stretcher bridge, or placed on the stretcher and the patient covered and setup. This is how the patient will be managed during transport.

Care should be taken to avoid placing any equipment on the patient.

- Ensure that all IV sites, drains etc, which need to be accessed during transit, are accessible and the IV access for emergency drugs identified by all medical crew.
- Empty all drainage bags and ensure connections to bags, Heimlich valves and colostomies are secure. Remember to vent N/G tubes to air.
- Check that all monitoring devices are working appropriately now. If they don't work properly now, they will not work reliably in transit. It is much easier to trouble shoot equipment in the hospital before departure.
- It may be helpful to tape all monitoring cables and IV lines together at this point. This avoids lines and cables getting tangled or snagged on other equipment during transfers into and out of vehicles.
- Call the ICU now to let them know your departure time, ETA and requirements on arrival.

Do not leave the referring hospital until both team members are satisfied with the patient's condition and equipment operation. Do not rush or be rushed.

In Flight/Transit

- During transit there should, if all goes well, be a minimum of activity - only observations and patient comforting if conscious.
- The MO should sit at the patient's head for airway management and the nurse opposite the stretcher bridge in reach of the IV access, drugs, Thomas pack and monitoring equipment.
- The blue bag containing the ambubag, guedels and masks should be out of the Thomas pack and with the patient through out the transport.
- Remember to check ETT cuff pressures on ascent and descent. Check colostomy bags and other devices that may be sensitive to gas expansion during transit.
- If interventions are required, communicate with your team members. The flight crew or ambulance crew need to know if defibrillation is to be attempted in the vehicle.
- If a difficult procedure or prolonged resuscitation is required it may be necessary to stop the vehicle or request the pilot to land the helicopter.
- On arrival at the destination hospital, **stay with the patient**. The flight crew or ambulance crew will unload the equipment. The patient is the first priority.

Do not leave the patient's side. Do not rush or be rushed.

Complete

- The retrieval is not completed until the patient is handed over to the receiving hospital staff, the documentation finished and the equipment restocked, cleaned and returned to the Retrieval room.
- As soon as is practical communicate to the referring hospital the safe (or otherwise) arrival of the patient and an update on their condition.
- If relatives have arrived at the ICU, ensure that they are comfortable, are spoken to by a medical officer and allowed to see the patient as soon as possible. If a social worker is required arrange for one to be present.

Feedback to Referring Hospital

- Staff from referring hospitals; have expressed a need for information on the condition and progress of the patients they have cared for. As part of our team it is our responsibility to supply support, education and encouragement.
- Find out the names of the medical and nursing staff caring for the patient at the referring hospital.
- The retrieval nurse should ring the nursing staff at the referring hospital when time allows, and inform them of the patient's condition.
- The retrieval doctor should do the same for the medical staff involved.
- Feedback about any significant factors affecting patient outcome can also be given in a positive and constructive manner, remembering to encourage, support and thank them for their contribution to the patient's care.

BE DIPLOMATIC AND CONSTRUCTIVE

Primary Retrievals

- Infrequently a retrieval team will be directed to a primary site. This only occurs if the team is in transit and is the only available resource in the local area at the time, or when a surgical procedure is required at the primary site, i.e. amputation.
- All team members should be familiar with the procedures outlined in the resource material covering primary response.

Multiple Retrievals

- Occasionally multiple transports will require that two or more patients be transported together. This is only an option on the Bell 412 helicopter or the newer GMC ambulance.
- If multiple helicopter transfers are envisioned the flight crew should be informed prior to their leaving the Broadmeadow base or as soon as possible.
- If multiple ambulance transfers are envisioned the larger GMC ambulance should be requested from ambulance control.
- Before leaving the referring hospital a clear plan should be in place regarding the care of each patient.

Stay and Play

- Retrieval where time is taken at the referring hospital to stabilise the patient, insert lines and/or drains, attend diagnostic procedures etc.

Modes of Transport

Road

- Road retrievals are used for a 30-KM range from the John Hunter Hospital. This includes: -

RNH	Belmont
Maitland	Mater
Kurri	Private hospitals in the Newcastle area.

Helicopter

- Helicopter retrievals are used for mid range destinations including:-

Port Macquarie	Kempsey
Coffs Harbour	Tamworth

Stay and Play

- Retrieval where time is taken at the referring hospital to stabilise the patient, insert lines and /or drains, attend diagnostic procedures etc.

Swoop and Scoop

- Retrieval where the time at the referring hospital is kept to a minimum.

S.P.I.T.

- **S** edate
- **P** aralyse
- **I** ntubate
- **T** ransport

Questions.

Question 1: Teamwork, communication and planning are essential to all successful missions. Why?

Question 2: Who decides if a request for a retrieval is approved?

Question 3: Who needs to be informed if a helicopter is landing at the helipad at the John Hunter Hospital?

Question 4: When is the retrieval finished?

PAEDIATRIC RETRIEVALS

Team Members

- A senior medical officer (intensivist or fellow) should attend all paediatric retrievals.
- Senior nursing staff with paediatric experience should accompany the medical officer, however, less experienced nursing staff may be selected if the medical officer agrees, as a learning experience.
- For patients under 5kg, transport by a specialised paediatric transport team may be considered, ie NETTs etc.

Equipment

- **Paediatric Thomas Pack**: checked and complete.
- **Avian ventilator**: check tubing is clean and complete, include white O_2 cables (the oxylogs are not recommended for paediatric ventilation).
- **Propaq Encore**: check that the BP cuff, pulse oximetry probe and ECG dots are of an appropriate size for the patient (in bumbag attached to Paed Thomas pack).
- **Braun Syringe Pumps**: all IV infusions must be given by pump as gravity feed infusions are unreliable under varying pressures and gravitational forces.
- **Paediatric Printout**: From the help line database obtain two printouts of the ventilation and medication guidelines for weight of the child, ie one for each member of the medical team. Place one in the green folder for easier referencing.
- **Ferno Paediatric restraint:** Designed to secure patients safely for transfer yet still access patient. Able to be used for paediatrics up to 20kgs (Fig 1)

Fig1. Ferno Paediatric transport harness

- **Capsule**: If the … used if the Ferno is not available. It is … ed. (Fig 2)

- **Other**: any other equipment or medications that may be required for the care of the child. Check with your team member to ensure that all possibilities are covered.

Special Considerations

Psycho-social

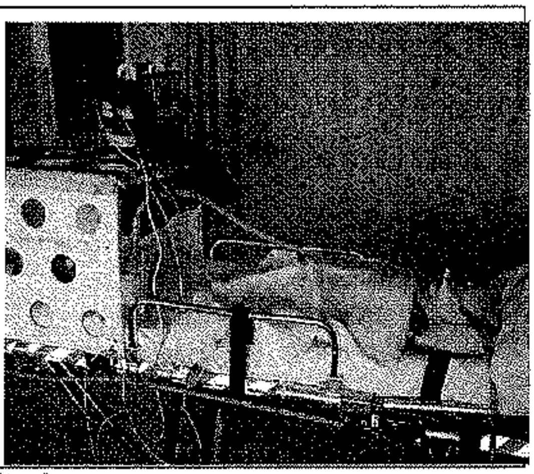
- Children are easily distressed when surrounded by strange adults in a strange environment. When caring for them it is important to remain calm and non-threatening at all times. **Encourage a family member to remain with the child if possible to provide a familiar and secure reference point**. This will help both the child and the family, cope better with the situation.
- Inform the child's relatives of their condition, any procedures that are required and the planned transfer as soon as possible.
- Speak to the family before leaving the referring hospital, informing them of the destination and ETA. Give them one of the 'Information for Relatives' handouts with contact phone numbers clearly identified.
- Encourage the family to stay away from the loading zone, say goodbye at the hospital casualty and drive safely if they are planning to attend the receiving hospital.
- A parent or guardian may accompany the child during the transport. It is important to ensure that there is available space and facilities for them. For road transport ensure that the ambulance is able to carry a sufficient number of adults. For aero medical transport consult the flight crew to ensure an extra passenger is possible. This should be discussed with the pilot as soon as possible so he can calculate the effects of the extra weight on fuel and flight plan.

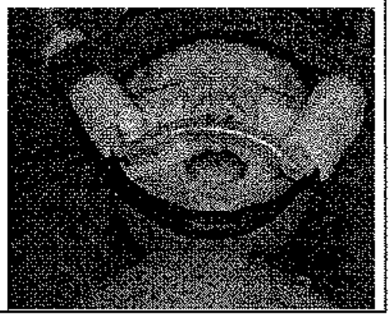
Ventilation

- If ventilation is required the patient should be intubated, the tube placement checked, adequacy of ventilation ensured and tube secured as per JHH ICU policy before loading.
- For children with cuffed tubes (usually >8yrs.) the cuff pressure should be checked before and after loading. During aero medical retrievals the cuff should also be checked during ascent and descent.

Non Invasive Ventilation (NIV) Transport Bubble CPAP

- When planning and gathering transport equipment, check with the Staff specialist to determine whether bubble CPAP would be appropriate.
- Only for infants up to 10kgs
- Set up located in retrieval room and sealed as a kit ready for use.
- Find information on set-up and use of the transport bubble CPAP system in the ICU help library under the paediatric equipment section





Monitoring

- Monitoring for each paediatric patient should be assessed on an individual basis. Minimum requirement is usually Pulse Oximetry. If this proves impossible or undesirable, then, both retrieval team members must observe the child closely and on a continuous basis.

Thermoregulation

- Due to their larger body surface area to mass ratio and poor thermoregulation paediatric patients are more prone to thermal stress and severe hypothermia. Care should be taken to ensure that they are normothermic prior to and remain so during transport.
- Temperature should be checked at regular intervals, a space blanket, cotton blankets, bonnets and booties used to retain heat.
- Ideal temperature range is $37\text{-}37^5$ c.

Hypoglycaemia

- Paediatric patients have high glucose requirements and poor glycogen stores. This makes them particularly susceptible to hypoglycaemia. BSL should be checked prior to departure and on arrival at the receiving facility, and deficits corrected as soon as possible.

Gastrointestinal

- Children are particularly affected by the accumulation of gas or gastric contents in the GIT. To avoid aspiration of and accumulation of gastric contents a N/G tube and aspiration of stomach contents should be considered in all at risk patients.

- N/G tubes must always be insitu on free drainage for all intubated paediatric patients.

IV Access

- IV access may not always be desirable. Each child's needs in this area should be assessed on an individual basis.
- If IV access is essential the site should be dressed and the limb immobilised as per JHH ICU policy. Check the site before loading and frequently during transit if possible.
- All IV infusions should be run using IVAC infusion pumps or bolus infusion. Gravity feed IV sets are affected by the acceleration and deceleration forces experienced during transport and are unreliable.

Questions.

Question 1: Why are paediatric retrievals different?

Question 2: Which ventilator would you elect to take on a paediatric retrieval and why?

Question 3: Why is the preservation of body temperature so important to paediatric patients?

Question 4: Explain the procedure for printing out a paediatric data sheet from the help library.

Question 5: What safety and communication considerations should be addressed if a relative is to accompany the child?

Question 6: **Can you control FiO_2 or deliver humidified gas through the transport bubble CPAP system?**

Question 7: How do you convert the transport bubble CPAP system in order to continue its use on arrival back to JHH ICU?

SAFETY

- Those taking part in the medical transport of critically ill or injured patients face unique and challenging hazards within a variety of environments.
- All team members are responsible for the care and transport of these patients, but they also share a greater responsibility - that of safety advocates.
- Individuals are also responsible for their own health, safety, professional and personal behaviour.
- Team members must bear in mind that their individual and group actions not only affect their own safety, but also the safety of the entire team and mission.
- Patient safety is reliant on our performance as a team and the competent application of safety procedures.
- With this in mind we must all develop a safety consciousness that guides our actions at all times.

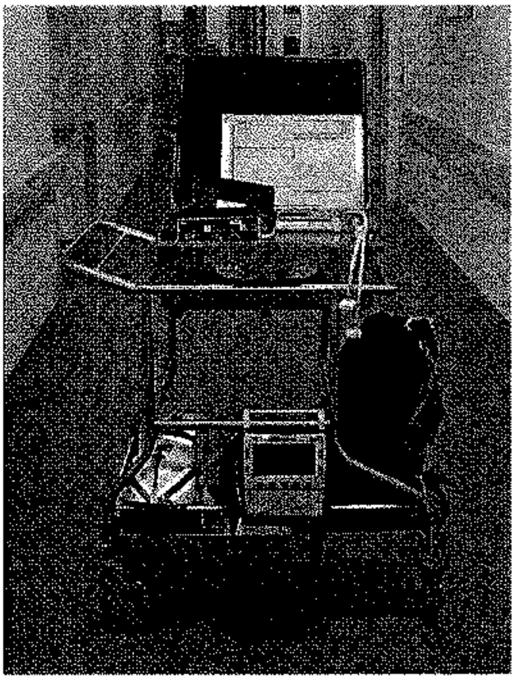
Carrying Equipment

- Due to the amount and weight of equipment now used on retrievals, a silver trolley is used to move this equipment around the John Hunter Hospital.
- During road retrievals this trolley may be left with the security office next to the ambulance bay, and during helicopter retrievals it may be left in the shed near the helipad. This way the trolley can be used to transport the equipment on return to the John Hunter Hospital.
- At referring hospitals enlist the assistance of ambulance officers, flight crew, wardsmen etc. to carry the equipment to the patient care area. Occasionally it is possible to load everything on the ambulance stretcher.

At no time carry more weight than you feel comfortable with. Do not risk injury by carrying excessive loads.

Road Retrievals and Safety

- The safe execution of a mission is the responsibility of all members of the team. This includes the ambulance officers, they are part of our team. Take the time to learn their names and identify yourself to them.
- Keep your seat belt fastened at all times if possible. If you must leave your seat to attend to the patient, return to your seat when finished and fasten your seat belt again.
- Make sure all equipment on the stretcher bridge is secured. All equipment not required in transit should be secured safely out of the way, preferably on the floor. This reduces the risk of loose equipment causing injury to the team or patient during transit.
- Make sure the stretcher is secured and the patient is secured to the stretcher.
- Remember to use the correct stretcher bridge. They are both marked.
- Communicate with the ambulance officers during the mission so they are able to respond appropriately to changing conditions. Poor or misleading communications may increase the risks to everyone's safety.
- Always warn the ambulance officers before attempting to defibrillate or use non-invasive pacing.
- If a relative of the patient requests to travel with the patient in the ambulance or the medical team wish a relative to do so, check with the ambulance officers to see if there is room. Some ambulances are restricted in the number of adults they can carry safely.



Aeromedical Retrievals and Safety

Flight Crew Safety

- The pilot has complete authority regarding all non-medical decisions for the duration of the flight.

Personal Safety Issues

Hypoxia

- In fit healthy individuals hypoxia can affect vision, decision making, reaction time and mood as low as 4000ft in an unpressurised cabin. For anyone who has cardiovascular or respiratory impairment hypoxia can occur at lower altitudes. This may include team members who smoke, drink alcohol, or suffer from common ailments such as colds, asthma or even fatigue.
- It is important to be aware of the signs of early and acute hypoxia.

Early Hypoxia

Impaired night vision	Diminished visual acuity
Loss of peripheral vision	Impaired reaction time
Impaired hand eye coordination	Impaired memory

Acute Hypoxia

Mood change	Loss of insight
Impaired judgement	Euphoria
Memory loss	Sensory loss
Mental or muscular incoordination	Hyperventilation
Dizziness	Feeling of unreality or apprehension
Neuromuscular irritability	Paraesthesia of face or peripheries
Carpo-pedal spasm	

- If you experience one of the disturbances described above, don't panic. Inform the rest of the team about your condition and remain seated. If necessary 1-2 litre/min O_2 can be given by nasal prongs or mask to relieve the symptoms.
- Prevention is a more effective strategy.

Don't smoke before flying. Don't consume alcohol before flying. If you have a condition that may impair your function at altitude, don't fly

Fitness

- There is no official fitness criteria. If any team member feels that they unable to participate in a mission for health or fitness reasons they should make this known as soon as possible to the In Charge person or NUM II.
- The ability to fit into the regulation safety belt and the ability to work within the confined space limitations of the aircraft or ambulance are essential.
- Pre-existing conditions that interfere with flexibility, strength and cardiovascular fitness may be a contraindication to flying.
- Taking part in aeromedical retrievals is not compulsory. However, failure to participate in a mission without good cause may result in removal from the team pro-term.
- You can request not to do retrievals because of sinusitis, headaches, etc.

Pregnancy and Flight

- Staff members who are 26 weeks pregnant and beyond are not to participate in retrievals.
- The effects of altitude, noise, vibration and increased risk of injury from mishaps may adversely affect the foetus.
- Staff may decline to undertake retrievals at any time prior to this in their pregnancy.

Protective Equipment

Helmets

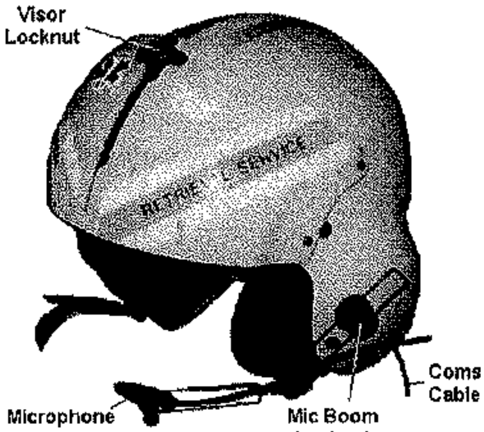


Figure 5. Aeromedical safety helmet, *diagram by Rob Bell.*

- Helmets must be worn in flight during all aeromedical retrievals. They provide protection from impact, noise and debris.
- Helmets are located in the Equipment Officer's office.
- They should be tried on to find the one that fits you best prior to participating in a mission.
- The Mic Boom should be adjusted so the microphone rests just in front of the lips. When adjusting the Mic Boom loosen the locknuts. Forcing the boom into position without loosening the locknuts will break the boom ; **repairs are costly** ! and communications problems inflight are dangerous.
- The helmets have a sun visor which can be lowered by loosening the visor locknut. This visor will not only protect your eyes from glare during daylight flights, but can also protect your eyes and face from flying debris during hot loading. Use it, but be sure to loosen the locknut when moving it into and out of position. The visor lock nut should not be tightened too tightly, as this may result in degloving or fracture of your nose in an accident.
- There are 5 helmets available in three sizes. If you are unsure how to fit your helmet correctly see the Equipment Officer.
- Helmets are fragile. A hairline fracture can render them useless as a safety apparatus. The helmets cost $1,800 each so be careful with them. Don't drop, scratch or load other equipment on top of them and remember to use the locknuts when positioning the visor and Mic Boom.
- Should they be dropped or damaged in any way let the Equipment Officer or in charge person know as soon as possible. Dropped or damaged helmets may not offer adequate protection to the user.
- Helmets should be put on prior to the arrival of the helicopter to ensure comfortable fit as well as protection from noise and debris.

Flight Suits

- Must be worn during all aeromedical retrievals.
- The suits are located in the hallway access to the Clinical support Unit (CSU).
- Designated "DOCTOR" and "NURSE" badges should be worn on suits for identification. This prevents confusion for patients, relatives and other staff.
- Sharp objects or glass objects should not be placed in chest pockets, as they have the potential to cause penetrating injury.
- Nylon or polyester fabrics should be avoided in all clothing worn, including undergarments. Nylon hosiery should not be worn. Cotton or woollen socks are preferred.
- Try on the suits to find two that fit you correctly prior to participating in a mission.
- All flight suits are numbered. Remember the numbers of two suits that fit you - this makes it easier when you are in a hurry to find a suit.
- Used flight suits should be put in the linen trolley provided and the KC's will launder them.

Footwear

- Selection should take into account protection and safety.
- Shoes must have fully enclosed toes and heels and have a slip resistant sole, no high heels.(refer to Operational Policies & Procedures Manual - Staff Footwear Management 2000).

Patient Safety

- Safety of patients and prevention of mishaps begins with thorough preparation, proper patient assessment, appropriate interventions and stabilisation before preparation for loading.
- Be aware of the 9 stressers of flight. These will guide you in identifying preventative interventions for safe and expeditious transportation.
- Ensure that conscious patients are made aware of a general outline of the flight plan, the general environmental limitations of the helicopter and the use of ear muffs.
- Ensure that earmuffs are in place for all patients, conscious or unconscious.
- During all retrievals the A2 bag from the Thomas pack containing ambubag, guedels and masks, should always be with the patient or a member of the medical team.
- For all ventilated patients ensure that chest wall movement, ventilator tubing connections and IV sites are observable at all times. Frequently check that ventilation is adequate.

Relatives Safety

- Relatives not travelling with the patient in the helicopter should be warned not to approach the helicopter during hot loading. They should be encouraged to say goodbye in the hospital, not on the helipad.
- If a relative of the patient requests to travel with the patient in the helicopter or the medical team wish a relative to do so, this must be cleared with the pilot before it can be considered.
- Any relative travelling with the team should be given earmuffs, and warm clothing obtained for them if possible (preferably their own).
- Clearly explain the environmental limitations of the helicopter and a general outline of the flight plan.
- Ensure that the relative is escorted to and from the helicopter by a member of the team, and is secured in their seat before take off. Do not allow the relative to wander around the helicopter, they must be escorted !
- Be aware that if a relative is plugged into the communications network they can hear everything you hear. This may not always be appropriate.

Helicopter Safety

- Helicopter safety requires common sense and familiarity with the aircraft.
- Remember that the safety briefing is compulsory annually. Failure to complete the safety briefing will result in removal from the team.
- Check with the Helicopter base regarding times and availability of the helicopter prior to going to the base at Broadmeadow.
- Dangers can be minimised by following the instructions that you will be given by the crew.

Awaiting the Helicopter

- While waiting for the helicopter it is recommended that your helmet is on and the face shield is down with strap secured. This provides protection from noise and flying debris.
- Wait for the helicopter at the landing pad gate near the shed.
- Do not approach the helicopter until signalled to do so by the crew (thumbs up).

Approaching the Helicopter

- Once the crew are happy for you to approach the helicopter a crew member will give you the thumbs up signal.
- You must approach the helicopter within the pilots field of vision (see diagram).
- Never approach the helicopter from the rear.

Never approach the rear of the helicopter at any time, whether the blades are rotating or still. The rear of the helicopter is a no go area

Around the Helicopter

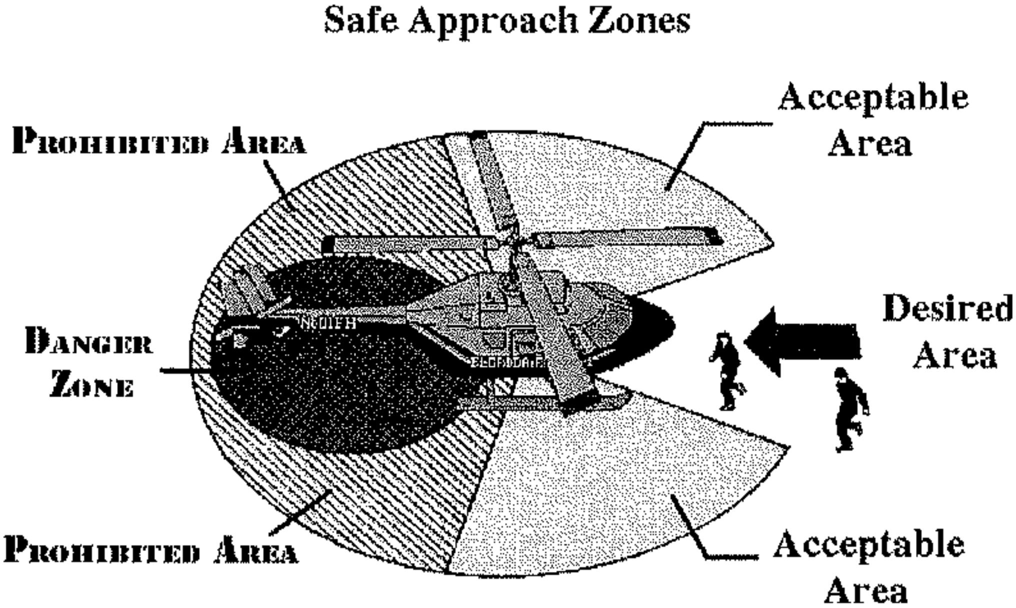


Figure 6. Safe approach zones for hot and cold loading.

- **Never** walk beyond the skids towards the tail of the helicopter.
- **Never** duck under the tail or body of the helicopter.
- Remember the pilot must keep all crew members in view at all times.
- If you need to get to the other side of the helicopter go around the front.

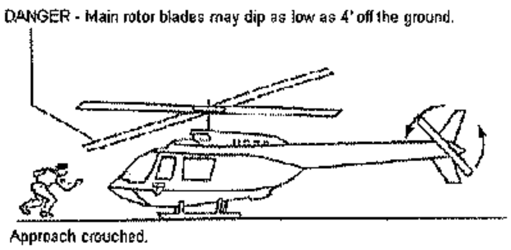


Figure 7. Approach helicopters with caution, *from JHH Retrieval Service Safety Notes, 1994.*

- Keep low to avoid the main rotor during hot loading. Wind gusts can influence the height of the blades (see diagram).
- Long hair should be covered or tied back securely to avoid entanglement in rotor blades.

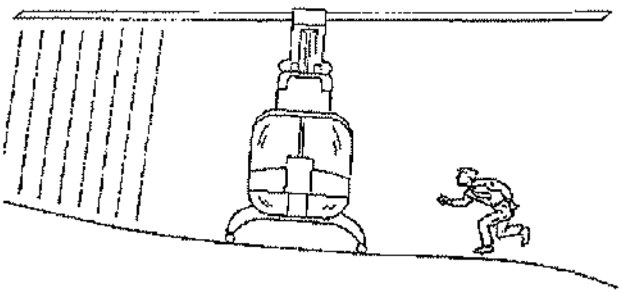


Figure 8. Approaching the helicopter on a slope, *from JHH Retrieval Service Safety Notes, 1994.*

- Landing on a slope. We rarely have to do this but if you get diverted to a primary response you must approach and depart from the down slope side only. Obviously this is where the blades are at their highest above ground level (see diagram).
- Please be careful not to raise your hands or any equipment above your head, eg IV poles.
- All linen and objects covering the patient should be secured to avoid entanglement in the rotor blades.

Within the Helicopter

- Keep your seat belt fastened at all times when possible. If you must leave your seat to attend to the patient return to your seat when finished and fasten your seat belt again.
- Make sure all equipment on the stretcher bridge is secured. All equipment not required inflight will be secured in the rear of the helicopter by the crew prior to take off. This reduces the risk of loose equipment causing injury to crew or patient during flight.
- Make sure the stretcher is secured and the patient is secured to the stretcher.
- Attach the communication piece to your helmet and establish that it is working prior to take-off.
- Keep communications to a minimum (preferably none), during take-offs and landings.
- Remember that if you need to be isolated from the flight crew in terms of communication let the crew know. The pilot will inform you if he needs to isolate your communications.
- Always warn the flight crew before attempting to defibrillate or use non-invasive pacing. This equipment can cause disturbances to the electrical equipment on the helicopter.

Leaving the Helicopter

- Remain in the helicopter until the flight crew open the left hand door for removal of the patient unless the pilot says otherwise. All medical crew should depart via the left hand door.
- Stay with the patient and attend to their safety. The flight crew will unload the equipment.
- If a relative is travelling with you ensure that they are escorted away from the helicopter.

- The same safety rules apply to leaving the helicopter as apply to approaching the helicopter.

Stretcher Bridge

- The stretcher bridge has been designed to secure the monitor, two Braun syringe pumps, and the ventilator during aeromedical transport. It should only be used for helicopter missions as it doesn't fit the standard road ambulance stretchers.
- Loose equipment may inflict severe injury during ascent, descent and air turbulence.
- The bridge is secured to the stretcher using lock pins. Usually this is over the feet of the patient.

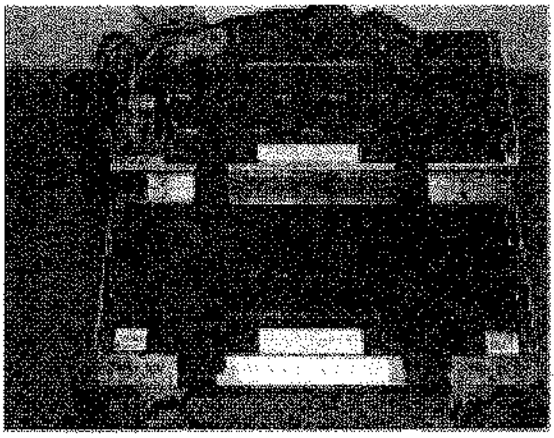
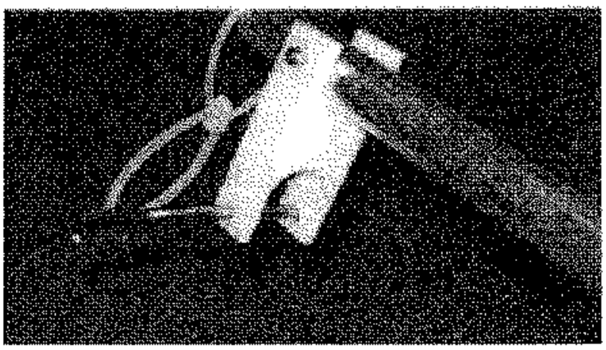


Figure 9. Stretcher Bridge for use in aeromedical retrievals

- Using the bridge keeps this equipment safely secured during transport, keeps it off the patients legs and body, and allows easy access to and observation of the equipment.
- The locking pins must have the button depressed, to be removed or put into place. Do not attempt to force the pin. If you have difficulty in securing the lock pins, ask the helicopter crew for assistance.



Questions.

Question 1: Who has authority regarding all non-medical decisions ?

Question 2: Which conditions may effect a team members fitness to participate in a mission ?

Question 3: Describe the personal protective equipment that should be worn during all aeromedical retrievals ?

Question 4: Who signals when it is safe to approach the helicopter and how may they signal you ?

Question 5: Describe the safe approach zones ?

Question 6: If the helicopter is on sloping ground, from which direction should you approach ?

Question 7: When should seat belts be worn ?

Question 8: When, and through which door do you leave the helicopter ?

Question 9: Who is responsible for the safety of any relatives in the proximity of or travelling on the helicopter ?

Question 10: Who is responsible for your safety ?

PROCEDURES

Analgesia

- Analgesia should be given at the medical officers discretion in consultation with the flight nurse.
- Any patient requiring large amounts of analgesia should be considered for elective intubation.
- All S8 and S4 drugs are to be carried by the nurse in the blue bum bag at all times.

Arterial and CVC Cannulas

- When using a Fenwell Pump to flush arterial or CVC cannulas, use Normal Saline 500 ml bag instead of Heparinised Saline 500 ml bag. This should be changed to Heparinised Saline at the completion of the mission.

Burn Injury Management

Referral Guidelines

- For all patients in the following categories, hospitals should ensure that consultation with the appropriate burns unit takes place at presentation. Although not all patients in these categories will require transfer to a specialised burns unit, advice should be sought early in their management.
    1. Deep burns involving: 10% or more of the body surface area in adults, or 5% or more of the body surface area in children
    2. Burns to the face, hands, feet, perineum, inner joint surfaces,
    3. Inhalation injury
    4. Burns and any of the following: major pre-existing disease, suspected child abuse, concomitant injury
    5. Electrical and chemical burns

Transfer of Burn Injury Patients to a Burns Unit

- The NSW Health Dept. guidelines for the transfer of burn injury patients should be consulted in deciding which patients may require transfer to a major burns unit.
- The recommendations for transfer include:
    1. any intubated patient
    2. facial or airway burns
    3. any child with burns >10%
    4. any adult with burns >20%
- The patient must be stabilised prior to transfer and if possible the transfer should take place within 4 hours of the injury.
- Adults are referred to Royal North Shore Hospital, Plastic Surgery Registrar, paediatrics are referred to Royal Alexandra Hospital for Children, Surgical registrar, Burns Unit.
- The NSW Burns Transfer Information Chart may be used when transferring a patient to a burns unit (see below).

Management

- Dress burns in saline soaked pads.
- Cold packs, not ice packs may be used to relieve discomfort.
- Analgesia should be given as required.

Replacement Fluids

- In the first 24 hours after the burn give
  Hartmann's solution 2-4ml × kgs × % burn surface area
- Half of this dose is given in the first 8 hours
- The remaining half in the following 16 hours

Adult Maintenance Fluid

- 2-3 litres of maintenance fluid daily in addition to the replacement fluids.

Paediatric Maintenance Fluid (< 30 kg.)

- Use 4% Dextrose with N/5 or 3.75% Dextrose with N/4

WEIGHT INCREMENTS	MAINTENANCE FLUID RATE
First 0 - 10 kg	100 ml / kg / 24 hrs
Next 11 - 20 kg	Add 50 ml / kg / 24 hrs
Next 21 - 30 kg	Add 20 ml / kg / 24 hrs

Table 2. Infusion rate for paediatric maintenance fluids by weight, *from Management Guidelines for People with Burns Injury, NSW Health Dept. 1996.*

Cardiac Arrest

- Inform the flight crew immediately if cardiac arrest occurs and defibrillation is envisioned.
- Follow normal JHH ALS protocols, (see BLS and ALS flowcharts in appendix).
- All flight crew are trained in BLS or better so make use of their skills if required.
- Frequently the medical officer is seated at the head of the patient and controls the airway. A member of the flight crew or the flight nurse attends to chest compressions, while the medical officer or the flight nurse administers drugs.
- If there is only the flight nurse and medical officer available for resuscitation the patient may be left on the ventilator at 100% O_2.

Defibrillation

- Inform the flight crew prior to defibrillation and proceed only after receiving the OK from the pilot. Sensitive navigation and flight instruments may be effected by the discharge of the defibrillator.
- Follow the JHH ICU ALS and BLS procedures.

Heimlich Valves with Bag *(single unit)*

- Tape all connections securely prior to transport.
- Ensure the arrow on the valve points away from the patient.
- The heimlich valve and bag are provided as a single unit and are connected directly to the end of the ICC.
- These have replaced the old Heimlich valves in the Thomas packs, but the older stock may still be in use at some hospitals within our catchment area.
- The valve in the bag may become stuck through packaging, so a syringe is required to push air up the tube and open the flutter valve. (It is not a tight or neat connection between the syringe and tubing).
- Observe the valve leaflets for flutter or pulsation, indicating drainage of air or fluid.
- Ensure that valve remains free of clots and debris. If valve becomes obstructed with clots or debris, replace with a fresh valve.

Figure 2. Single Heimlich Valve Unit.

Intercostal Catheters

- ICCs should be considered for all patients with a pneumothorax. Even a small pneumothorax will expand with altitude to a significant size.
- ICCs should by attached to a heimlich valve and the valve connected to a drainage bag or combine dressing, if the single unit is not available.

All ICCs should be unclamped for transport.

Intraoseous Needles

- To be inserted by medical officer only.
- Select a site.
  1. Proximal tibia, 1-2cms below the tibial tuberosity in the middle of the flat surface of the medial aspect of the tibia.
  2. Distal tibia, medial surface of the tibia just above the medial malleolus.
- If the bone is fractured or punctured by a previous attempt, select another site, ie distal tibia, distal femur/proximal tibia.

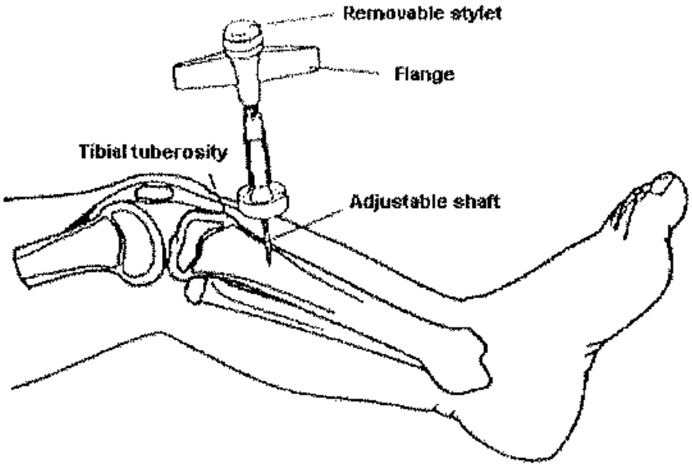


Figure 10. Insertion of an intraoseous needle.

- Local anaesthetic can be used if time allows.
- Grasping the base of needle with finger tips, use palm of hand to apply pressure.
- Using only a moderate force and a twisting motion allow the needle to cut a straight path through the bone cortex.

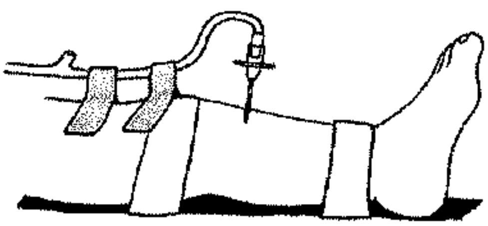


Figure 11. Securing an intraoseous needle for transport, *from Jenny Carter, Paediatric Advanced Life Support.*

- Sudden give, loss of resistance or pop indicates penetration of the needle past the bone cortex into the medullary cortex.
- The needle should be about 1 cm into the skin and will be self supporting.
- Excessive penetration may result in the needle advancing through the opposite side of the bone.
- It may be possible to aspirate marrow from needle.
- Do not access needle directly. Use an extension with 3-way tap. Firmly secure the IV tubing to the skin, immobilise the limb and apply a clear dressing to the insertion site.
- Check for patency. Check for swelling of site or limb.

Intubation

- All intubated patients must have a nasogastric or orogastric tube inserted and left on free drainage.
- Any patient who may require intubation, should be intubated electively at the referring hospital. Intubations inflight are problematic as lack of extensive equipment and staff, as well as the restrictions imposed by space, noise and vibration make the procedure very difficult.
- Any patient who's neurological state may present a danger to themselves, the flight crew or the mission should be sedated and electively intubated.
- Inform the flight crew if an inflight intubation may become be necessary. This may alter the flight plan if an emergency landing is required to complete a difficult intubation.

IV Infusions

- All IV infusions should be delivered via infusion pump or blood pump sets.
- Any gravity feed IVs should be turned off or observed closely during ascent, descent and any change in altitude.
- Interlink bungs and connections have replaced needles in all retrievals.

No needles are to be used in retrievals during transport

Monitoring

- Inflight monitoring should include all parameters relevant to patient safety and clinical indicators.
- The monitoring requirements of all patient during transport should be tailored to each patient's individual needs. It is not always best to use every device available.
- All patients should have base line observations prior to departure. These baseline observations should be clearly marked on the inflight record. For paediatric patients this should include a BSL and temperature.

Nasogastric and Orogastric Tubes

- All adults requiring a nasogastric tube should have a sump tube inserted in preference to a soft silicon tube.
- Nasogastric tubes should be inserted for all patients who are intubated, have had recent abdominal surgery, present with acute abdominal pain or have been vomiting.
- All nasogastric tubes should be left on free drainage via a soft drainage bag.

Pacing

- Inform the flight crew prior to commencing pacing.
- Make sure all personnel are aware that the patient is paced. External pacing may deliver a small shock to anyone touching the patient.
- If the patient requires pacing in transit, explain the procedure to the patient prior to departure. The procedure can be painful and is certainly uncomfortable. Sedation or anaesthesia may be required.
- Follow the JHH ICU external pacing procedure, ensuring correct placement of electrodes and skin preparation.

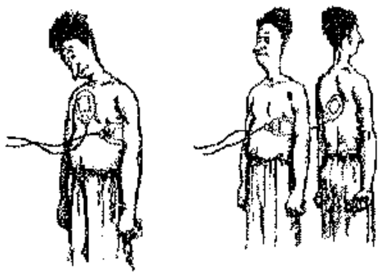


Figure 12. Anterior (left), and Anterior-posterior (right) pacing electrode placement, *from Physio Control Product Information.*

Sedation

- Sedation should be given at the medical officers discretion in consultation with the nurse.
- Any patient requiring large amounts of sedation should be considered for elective intubation.
- Don't rely on being able to "talk down" a patient's anxiety during the transport. Noise levels will make this impossible.

Tension Pneumothorax

- Any pneumothorax will expand with altitude. Without decompression a tension pneumothorax may develop.
- Decompression should be attended immediately.
- Locate the 2nd intercostal space at the mid-clavicular line on the affected side.
- Insert a large bore IV cannula over the top of the 3rd rib angled towards the vertebral column.
- Air should be heard escaping as the pneumothorax is tapped.
- Advance the cannula and withdraw the needle.
- Firmly secure the cannula.

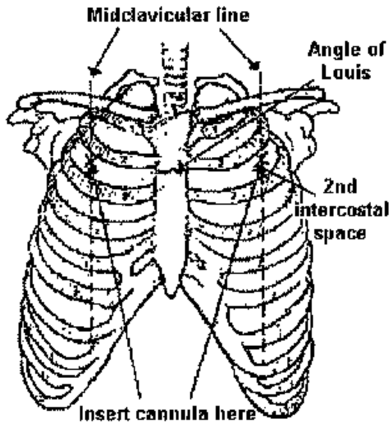


Figure 13. Placement of large bore IV cannula for decompression of tension pneumothorax, *from 'Primary Response Paramedic Lecture Notes' by Neville Grieve, 1993.*

Ventilation

- All ventilated patients must have some form of apnoea monitoring throughout the transport. This must include the in built apnoea alarm on the ventilator (Bird Avian® and Drägar Oxylog 2000®) as well as $ETCO_2$ monitoring (Propaq Encore®).

- No ventilated patient should leave the referring hospital until both team members are satisfied that ventilation of the patient is adequate. This should include a primary assessment conducted by both team members ensuring the following points
  - Airway secured
  - Chest wall movement noted
  - Ventilation adequate (S_pO_2, $ETCO_2$, etc)
  - All monitoring and alarms working
  - O_2 supply adequate
  - All airway intervention equipment ready, (ambubag etc) and available
  - All other necessary equipment ready, (Thomas pack, pumps etc)
- All ventilated patients must be attended by at least one team member at all times.
- Cuff pressures in endotracheal tube should be checked during ascent and descent.

Questions.

Question 1: Explain the procedure for transporting a patient with a chest drain.

Question 2: Should all patients have IV access prior to transfer ? Explain ?

Question 3: Which alarm parameter is compulsory for the transport of ventilated patients ?

Question 4: Explain the safe use of heimlich valves and some common complications that may occur during their use.

EQUIPMENT

Dragar Oxylog 3000® Ventilator

Function

The **Oxylog 3000®** transport ventilator is microprocessor controlled and provides for ventilation of adults and children providing PCV, Volume Cycled and CPAP ventilation modes. It can also provide pressure support and NIV.

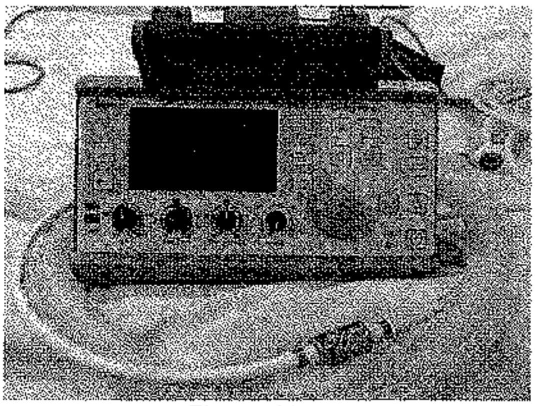


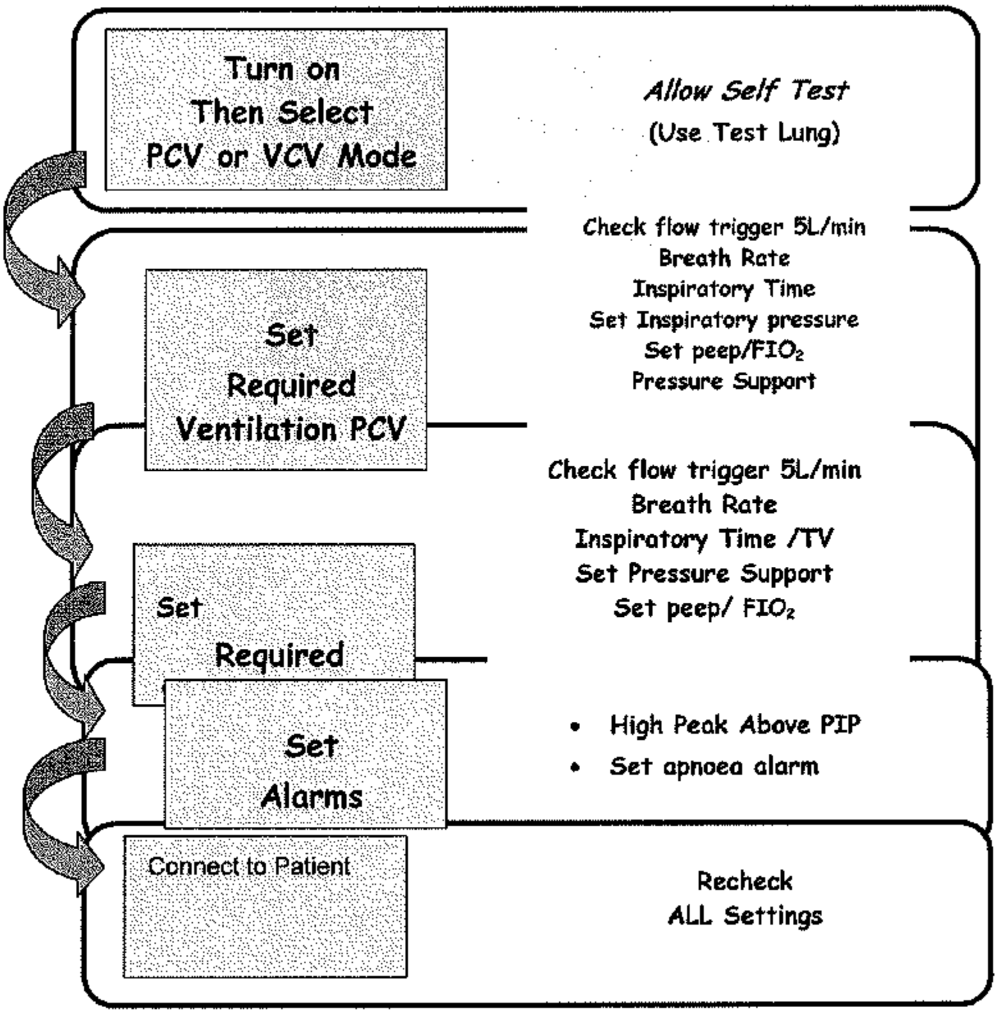
Figure 14. Oxylog 3000.

Description

Transport Mode	Fully portable.
Weight	4.9kg.
Power Source	Lithium battery.
Battery Life	Presuming fully charged battery, 4 hours operation.
Requirements	Compressed O_2,
Cost	$26,000

OXYLOG

PCV or VCV MODE



OXYLOG

NIV MODE

Turn on Select CPAP Mode
Allow Self Test
(Use Test Lung)
select and turn NIV on

Set Required Ventilation
Check flow trigger 5L/min
Set - pressure support
Peep
FIO_2

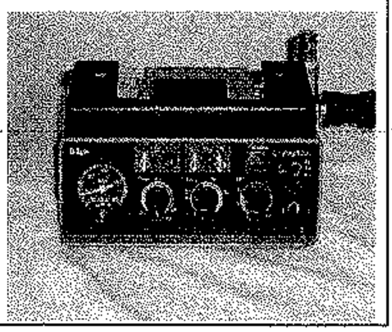
Set Alarms
- High Peak Above PIP

Connect to Patient
Recheck
ALL Settings

Drägar Oxylog 1000®

Comment [RB1]:

Function



Comment [RB2]:

The **Drägar Oxylog 1000®** transport ventilator is a time-cycled, volume constant ventilator with pressure relief valve, for patients up to 10kgs or 1 yr old, with

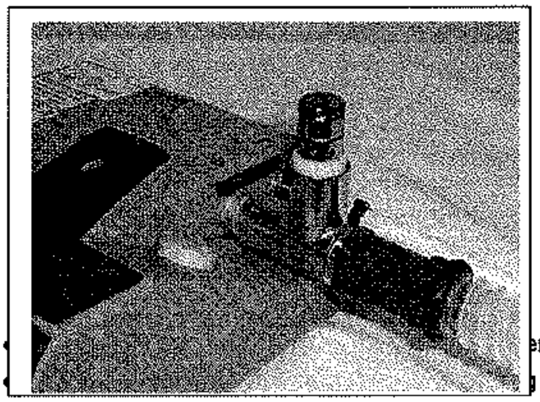
F_iO_2 settings of either 1.0 or 0.6. There is a visual analogue display
Alarm parameters are available for high pressure limit and low pressure such as leakage and also a gas supply pressure indicator. It requires a gas pressure supply to work.

Description

Transport Mode	Fully portable.
Weight	2 kg.
Power Source	None.
Requirements	Compressed O_2
Cost	$8,000

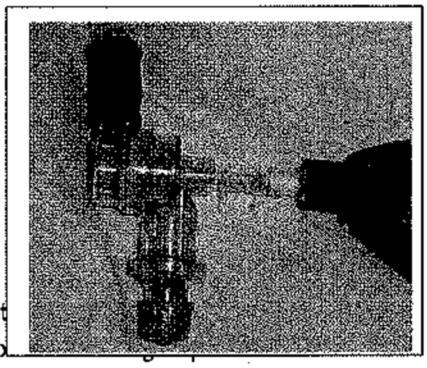
Correct Assembly of Breathing Valve Circuit

Pressure relief Valve



Patient Connection

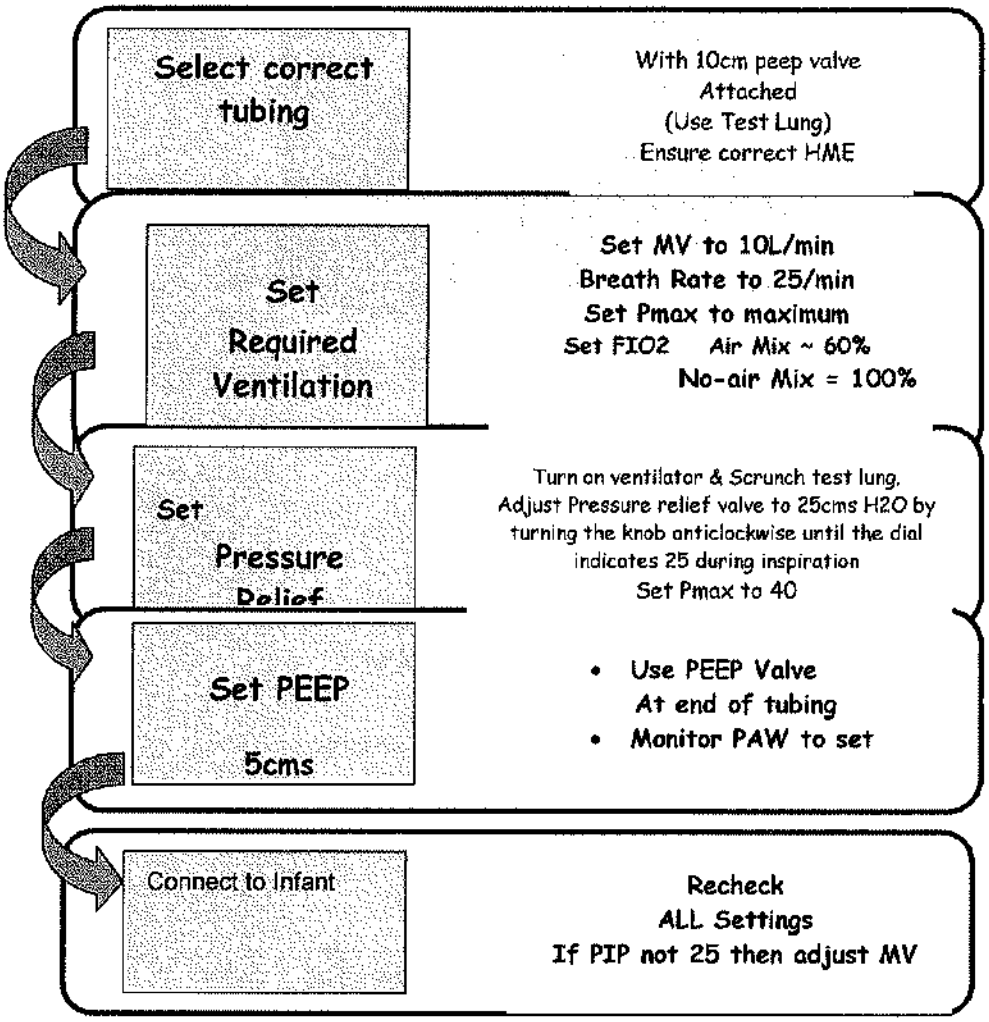
Including position of $ETCO_2$ and filter.



- ment
- befo
- Always check for adequate ventilation to verify correct operation.

OXYLOG

PCV MODE for Paeds <10kgs



Oxylog 2000 Ventilator

Function

The Drägar Oxylog 2000® transport ventilator is a time-cycled, volume constant microprocessor controlled ventilator for patients with tidal volumes from 100mls to 1,500mls. It provides time cycled, volume cycled ventilation in IPPV, SIMV and CPAP modes with F_iO_2 settings of either 1.0 or 0.6.

Comment [RB3]:

Alarm parameters are available for apnoea, high / low pressure, leakage and low supply pressure.

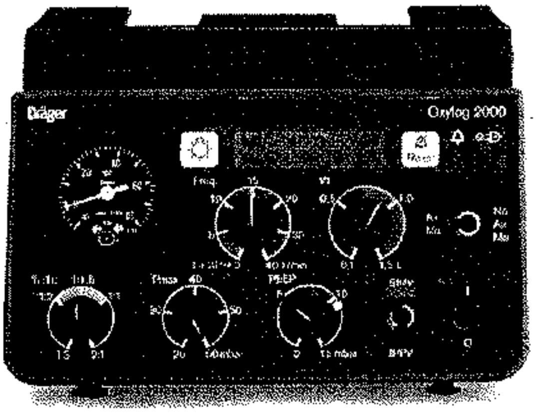


Figure 15. Drägar Oxylog 2000® ventilator.

In the event of a power failure spontaneous breathing can continue via an integrated demand valve.

Description

Transport Mode	Fully portable.
Weight	4.3kg.
Power Source	Nicad battery.
Battery Life	Presuming fully charged new battery, 8 hours minimum operation.
Recharge Time	Presuming fully depleted battery, 5 hours.
Requirements	Compressed O_2, air, or blended gas source with at least 2.7 to 6.0 bar pressure.
Cost	$12,000

Correct Assembly of Breathing Valve

- Check all valves for patency and correct placement before connecting to patient.
- Always test ventilation settings with black lung before connecting to patient.
- Always check for adequate ventilation to verify correct operation.

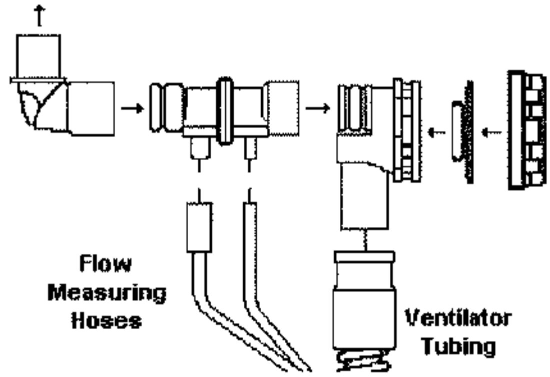
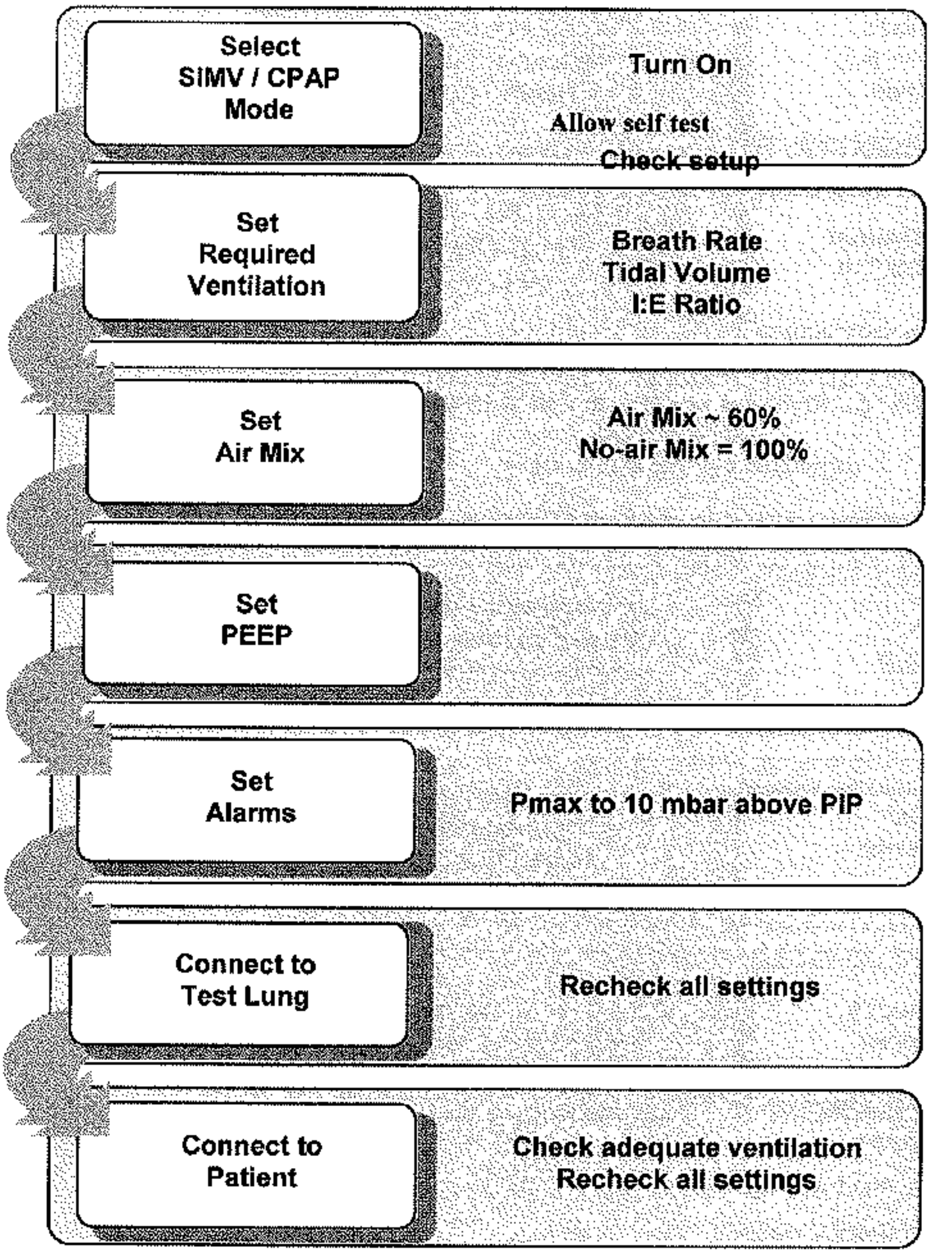


Figure 16. Correct assembly of breathing valve for Oxylog 2000®, Oxylog 2000® Emergency Ventilator Instructions for Use, Drägar.

Oxylog
Adult SIMV



Oxylog
Adult CPAP

- **Select SIMV / CPAP Mode** — Turn on, Allow self test, Check setup
- **Set required Ventilation** — Set Breath Rate to zero
- **All spontaneous breaths are delivered with 100% O2 regardless of Air Mix setting**
- **Set PEEP** — Patient must be able to produce negative pressure 2 mbar below PEEP
- **Set Alarms** — Pmax to 10 mbar above PIP, Paw Low alarm disabled in CPAP mode
- **Connect to Patient** — Check adequate ventilation, Recheck all settings

Encore I

Func

The porta... non-inv ranging

Descript

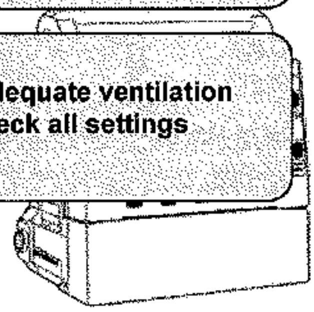


Figure 17. Propaq Encore® monitor.

Transport Mode	Fully portable.
Weight	Weight less than 4kg.
Power Source	Sealed lead-acid battery.
Battery Life	Operating time presuming fully charged new battery is 6.5

hours.

Approximately 3.5-4 hours dependent on modes used.

Screen Display Only 3 waveforms will be displayed. If the ECG channel is active it is always displayed. If more than 3 waveforms are active the 3 waveforms with highest priority will be displayed.
If the **PROPAQ ENCORE®** detects a vital sign value outside measurable range the monitor displays ' - - - ' for below range or ' + + + ' for above range.

Display Priority ECG , P1 , P2 , $ETCO_2$, S_PO_2 , RESP , NIBP .

Requirements Operation altitude -1000 - 15,000 feet.
The **PROPAQ ENCORE®** is water resistant but **NOT WATER PROOF**.
During defibrillation keep paddles clear of ECG electrodes and other sensors.
Do not use in MRI suite or HYPERBARIC unit.
Do not operate in the presence of flammable anaesthetic gases.

LifePak 10P Defibrillator

Function

The Physio Control **LifePak10P** is a complete cardiac life support system including ECG monitoring, defibrillation, cardioversion and non-invasive pacing.

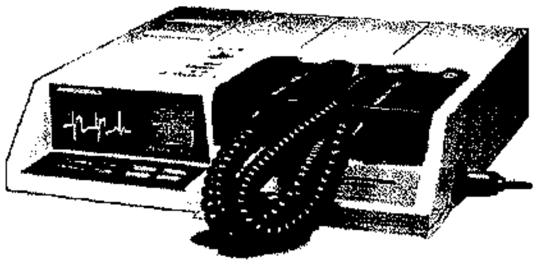


Figure 18. Physio Control LifePak10P defibrillator.

Description

Transport Mode	Fully portable.	
Weight	9kg.	
Power Source	3 Ni-cad batteries.	
Battery Life	Presuming a new battery at 100% charge each battery supplies approximately,	
	Monitoring	45minsor
	Pacing	30minsor
	Defibrillation	25 discharges of 360j.
Screen Display	ECG leads I, II, III or paddles.	
Sweep Speed	25 mm/sec.	

HeartStart 3000 Defibrillator

Function

The **HeartStart 3000®** is a light weight portable battery powered semi-automatic or manual defibrillator/monitor carried in all NSW road ambulances.

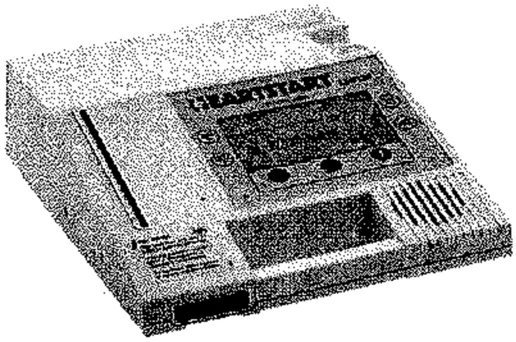


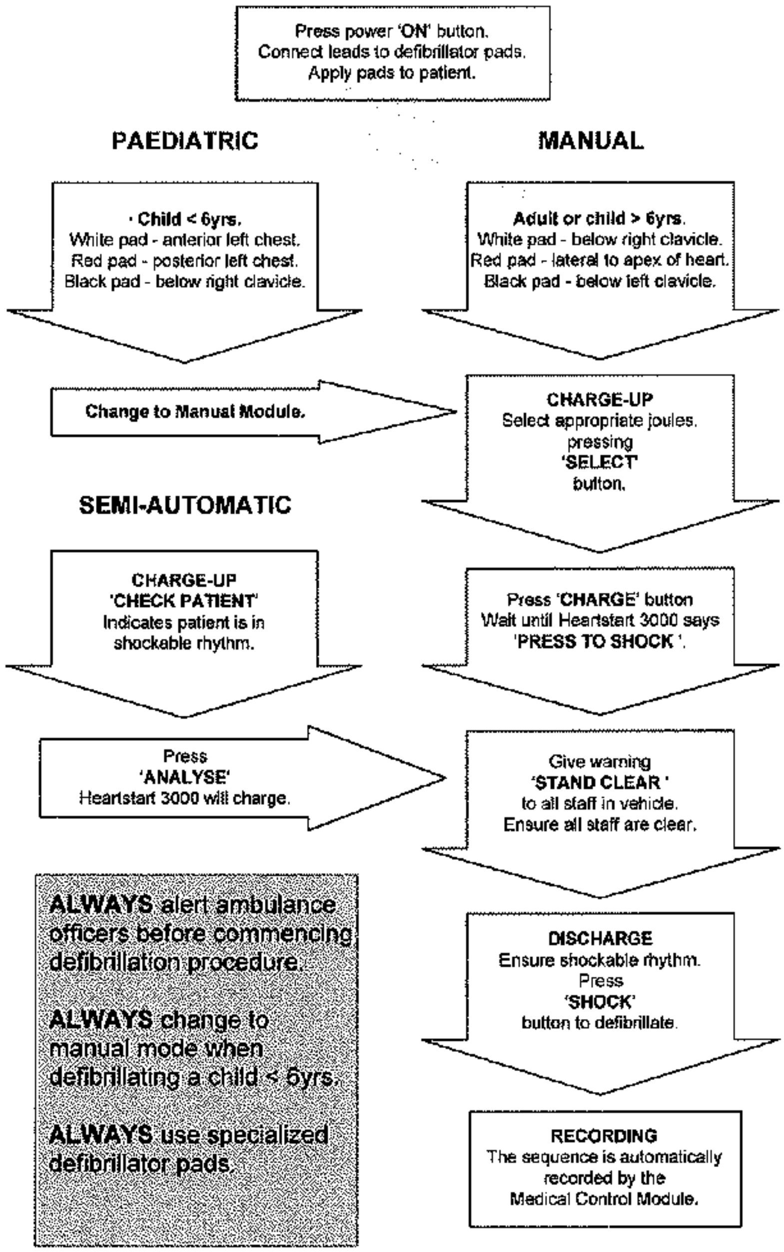
Figure 19. Heartsart 3000® AED.

Description

Transport Mode	Fully portable.
Weight	4.4kg.
Power Source	Sealed lead-acid battery. 16 hours recharge time.
Battery Life	Battery life is equivalent to a delivery of a 360j shock 30 times or 3.3 hours monitoring.
Energy Levels	Semi-Automatic 200j, 360j. Manual 25j, 50j, 100j, 200j, 360j.
Charge Time	6-10 secs on fully charged battery.
Sweep Speed	25mm/sec.
Amplitude	1cm/mV.
Rate Meter	30-300 bpm.
Requirements	Defibrillation is only possible if approved Laerdal defibrillation pads are used to connect Heartstart 3000 to patient. Monitoring function only is available if normal ECG dots used.

HEARTSTART 3000 DEFIBRILLATOR

Operations Flow Diagram



Bell 412 SP Helicopter

Description

Call Sign Westpac 1.

Navigation GPS navigation system. Full pilot IFR. All pilots with IFR ratings. Weather Radar.

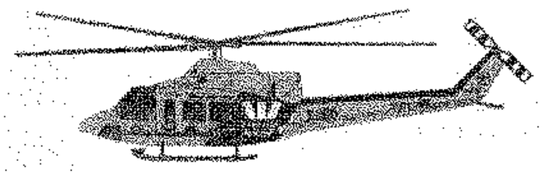


Figure 20. Bell 412 Helicopter, *courtesy of 'Westpac Rescue Helicopter base' Broadmeadow.*

Communication All UHF and VHF ambulance and police bands. Mobile phone.

Speed 220 kph.

Range 550 kms.

Configuration 5 different stretcher positions.

Payload Maximum 4 stretcher patients + 4 medical staff and crew.
Maximum 2 neonatal units + parents, medical staff and crew.

Equipment

- Propaq 906, Lifepak 5.
  2 x 'D' size O_2 cylinders.
  4 O_2 outlets, (1 supply + 1 suction).
  Mechanical suction with disposable canisters.

Lighting

- Lighting in the rear of the Bell 412 can be adjusted by using the switches located on the right ceiling of the rear compartment.

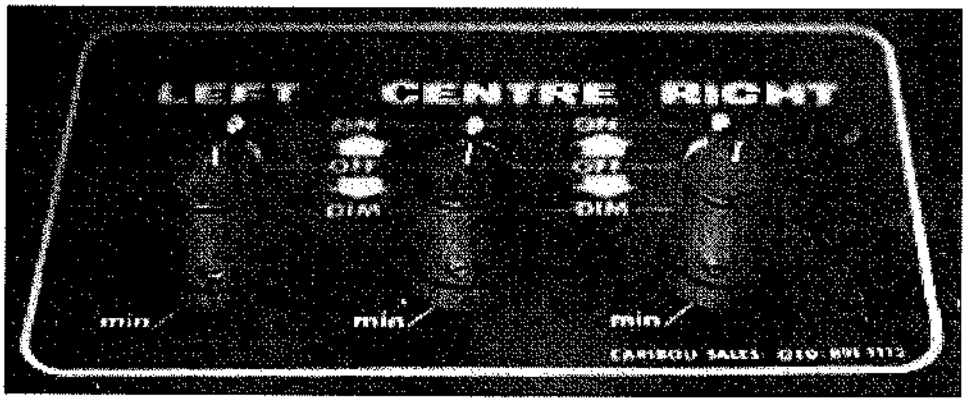


Figure 21. Lighting dimmer switches mounted on ceiling of Bell 412. *courtesy of Westpac Rescue Helicopter base' Broadmeadow.*

Internal Communication

- During flights the crew, pilot and medical crew communicate through the internal coms system. This requires the lead from a helmet or headset being plugged into the handset, (pictured right).
- All communications are heard by all parties. If you have given a relative or patient a headset and plugged them into the coms system they will hear everything you hear and say.
- To speak the sliding button on the coms handset should be slid to the com position, held there during speech and released when speech is finished.

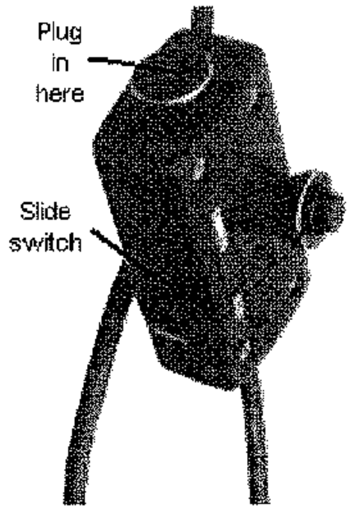


Figure 22. Coms handset in Bell 412, *courtesy of 'Westpac Rescue Helicopter base' Broadmeadow.*

Isolation of Rear Compartment

- The rear compartment communications can be isolated from the pilot compartment on request to the pilot or crew. This may be necessary if a lot of communication is required during the flight concerning patient management.
- Once the rear compartment has been isolated contact may be re-established with the pilot compartment by pressing the button on the left ceiling of the rear compartment.
- Communications during take-off and landing should be keep to a minimum to ensure that vital communications between the pilot and crew are not interfered with.
- During other times, don't be afraid to speak with the crew and the other members of your team. Communication is a key point in a successful mission.

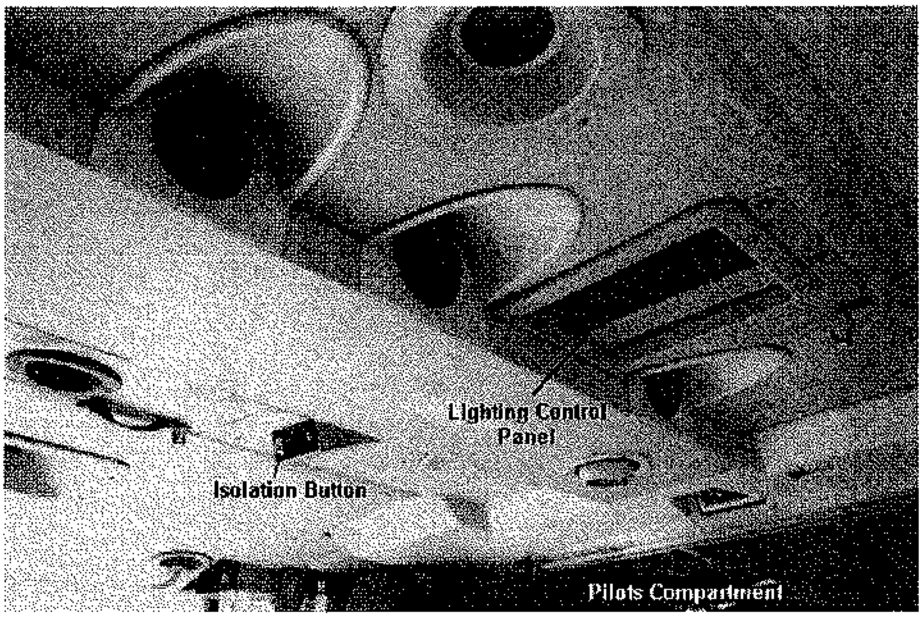


Figure 23. Interior ceiling of Bell 412, *courtesy of 'Westpac Rescue Helicopter base', Broadmeadow.*

Oxygen Outlets

- Oxygen outlets are located on the left side front of the rear compartment. Directly below the O_2 outlets is a status indicator for 2 of the cylinders. As the indicator begins to flash the O_2 cylinder switch should be turned to engage the other cylinder.

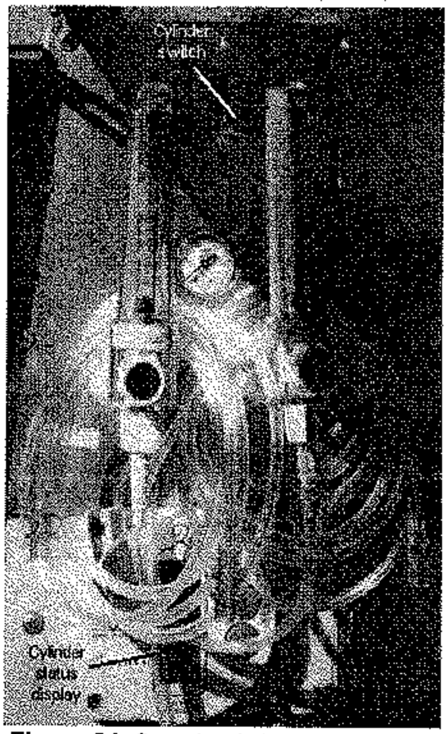


Figure 24. O_2 outlets in Bell 412, *courtesy of 'Westpac Rescue Helicopter base' Broadmeadow.*

Suction

- The suction unit is located on the left side front of the rear compartment. It should only be turned on when in use. If it has been used please let the flight crew know so it may be cleaned before the next mission. They will check it themselves but this is a curtesy that ensures good relations between team members.

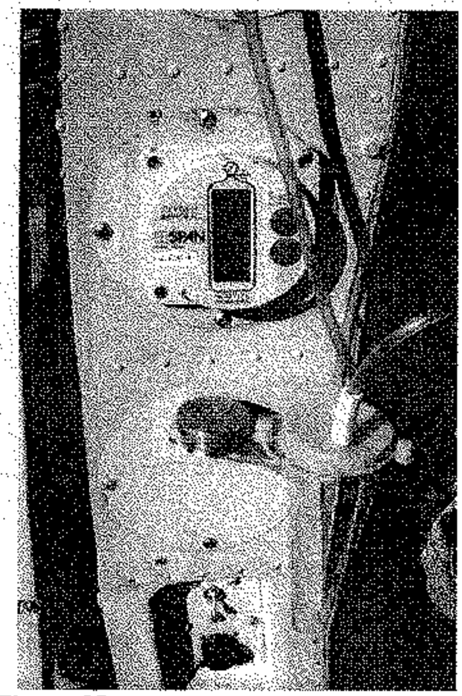


Figure 25. Suction outlet in Bell 412, *courtesy of 'Westpac Rescue Helicopter base' Broadmeadow.*

Seating

- The seat belts in the Bell 412 have a 4 point harnesses configuration.
  The two shoulder straps are draped down over the shoulders and the lap belt locking mechanism passed through the two metal loops at the end of these shoulder straps.

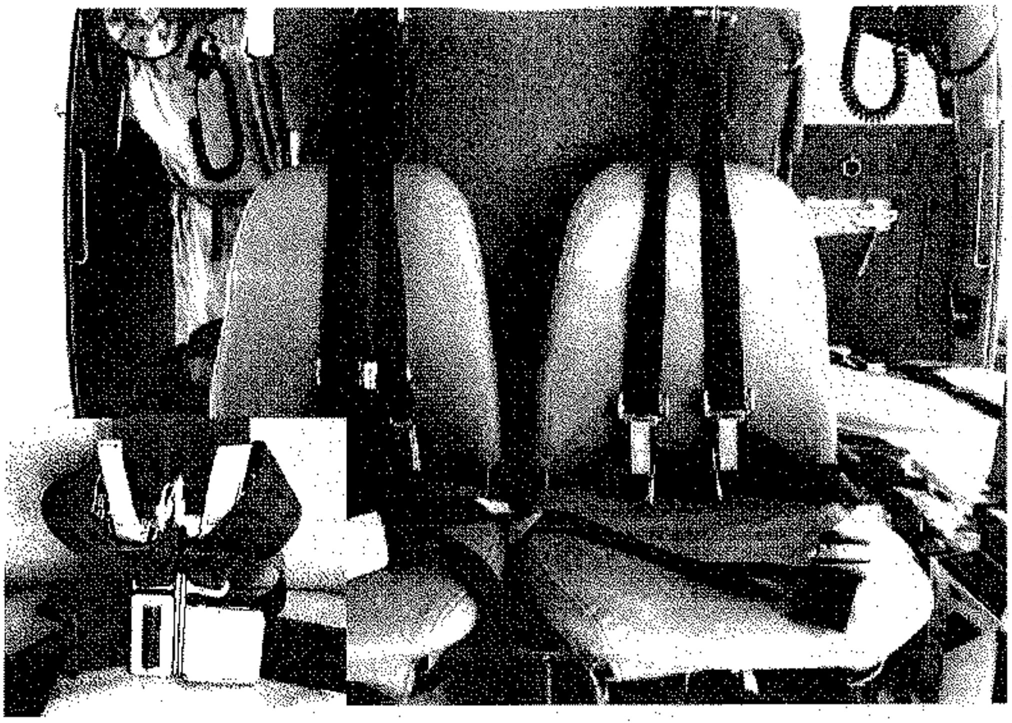


Figure 26. Middle rear seats in Bell 412, detail showing seatbelt arrangement,
courtesy of 'Westpac Rescue Helicopter base' Broadmeadow.

Bell 407 Helicopter

Description

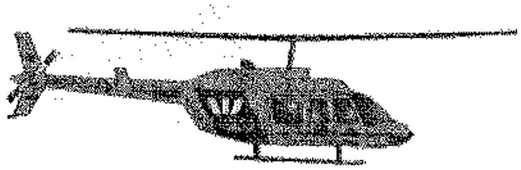


Figure 27. Bell 407, *courtesy of 'Westpac Rescue Helicopter Base' Broadmeadow.*

Call Sign:	Westpac 2.
Navigation:	GPS navigation system. VFR. Night VFR.
Communication:	All UHF and VHF ambulance and police bands. Mobile phone.
Speed:	250 kph.
Range:	510 kms.
Configuration:	2 different stretcher positions.
Payload:	Maximum 1 stretcher patient + medical staff and crew. Maximum 1 neonatal unit + medical staff and crew.
Equipment:	Propaq 906, IVAC infusion pump, Lifepak 5. 1 x 'D' size O_2 cylinder. 2 x O_2 outlets, (1 supply + 1 suction).

CARE AND CLEANING OF EQUIPMENT

Equipment Faults

- Aims reports should be used if any equipment defects occur during a mission. This includes missing and out of date equipment.
- All missing, faulty or broken equipment should be brought to the attention of the equipment officer or the in charge nurse as soon as possible.

Flight suits

- Flight suits should be placed in the linen bag beside their hanging rack and will be cleaned by the Kookaburra Carers, Monday to Friday.
- Any suits that have blood or body fluids spilt on them should be washed off in soapy water and left to dry, then placed in the soiled linen blue liner bag. They will then be washed by the KC's as above.
- **MRSA contaminated suits** should be washed separately. Place them in a soiled linen blue liner bag and then in the linen bag.

Helmets

- Care must be taken to prevent damage to helmets through dropping or scratching. This means the helmets should not be placed under other equipment or placed where damage may occur. It may be best to leave the helmets in the helicopter at the destination hospital.

- Any obvious damage or dropping of the helmets should be reported to the Equipment officer. A damaged helmet may not provide adequate protect in the event of an accident.
- When adjusting the microphone swing arm the nuts must be loosened. Trying to force the swingarm into position without loosening these nuts will result in damage to the helmet.

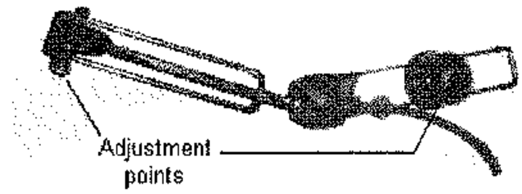


Figure 28. Helmet mic boom, *diagram by Rob Bell.*

- A clean new Skull cap should be worn each time inside the Helmut.

Skull Cap inside Helmut

$ETCO_2$ Cable

- This cable is delicate and may be easily damaged if handled without care.
- The cable should be kept in its box at all times when not in use and handled with care when used.
- The cable must not be kinked or bent at an acute angle.
- If the cable requires cleaning this should be done with a clean cloth and Viraclean.

Thomas Packs

- Thomas Packs are to checked by the In Charge nurse on every shift. The packs should be fully stocked, inner section sealed and outer pockets checked. Only seal a pack if you are sure it is complete and all equipment is within its expiratory date.
- Any broken, out of date or missing equipment should be noted, replaced as soon as possible and reported.

- Packs can be cleaned by the Kookaburra Carers - only as required.

Other Equipment

- All other equipment should be cleaned using a clean cloth and Viraclean.
- Never use Milton's solution on any retrieval equipment.
- It is the responsibility of the doctor and nurse participating in the mission to ensure that the equipment is cleaned, restocked and returned to the Retrieval room at the completion of the mission. All equipment should be ready for use in another mission or labelled for defects and left in the appropriate area for repair.

Questions.

Question 1: Where are flight suits put for cleaning?

Question 2: Who should be notified of defective or damaged equipment?

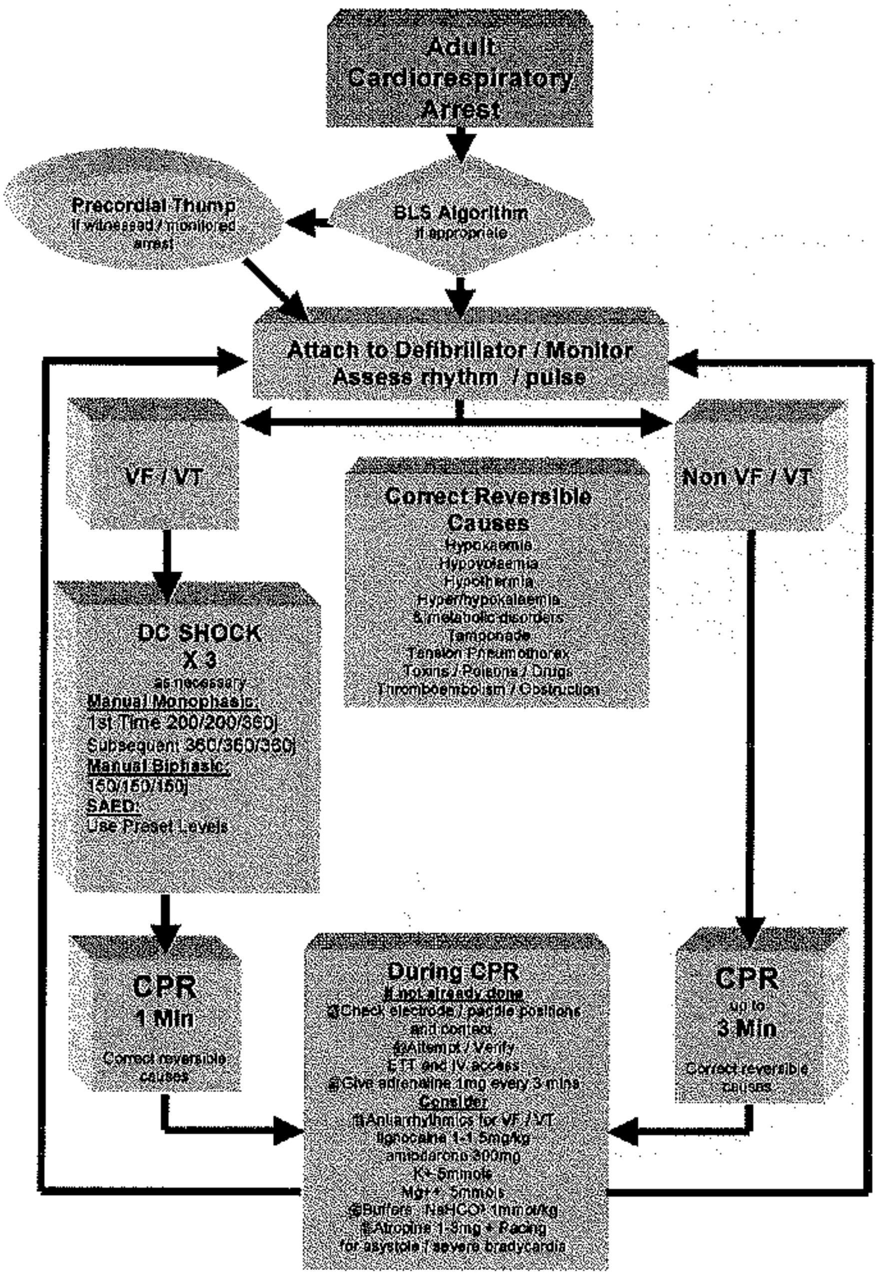
Question 3: Locate the microphone boom on a helmet and identify the adjustment points.

Question 4: Which cleaning solution is used to clean equipment?

Question 5: What is the penalty for dropping a helmet and not telling anyone about it?

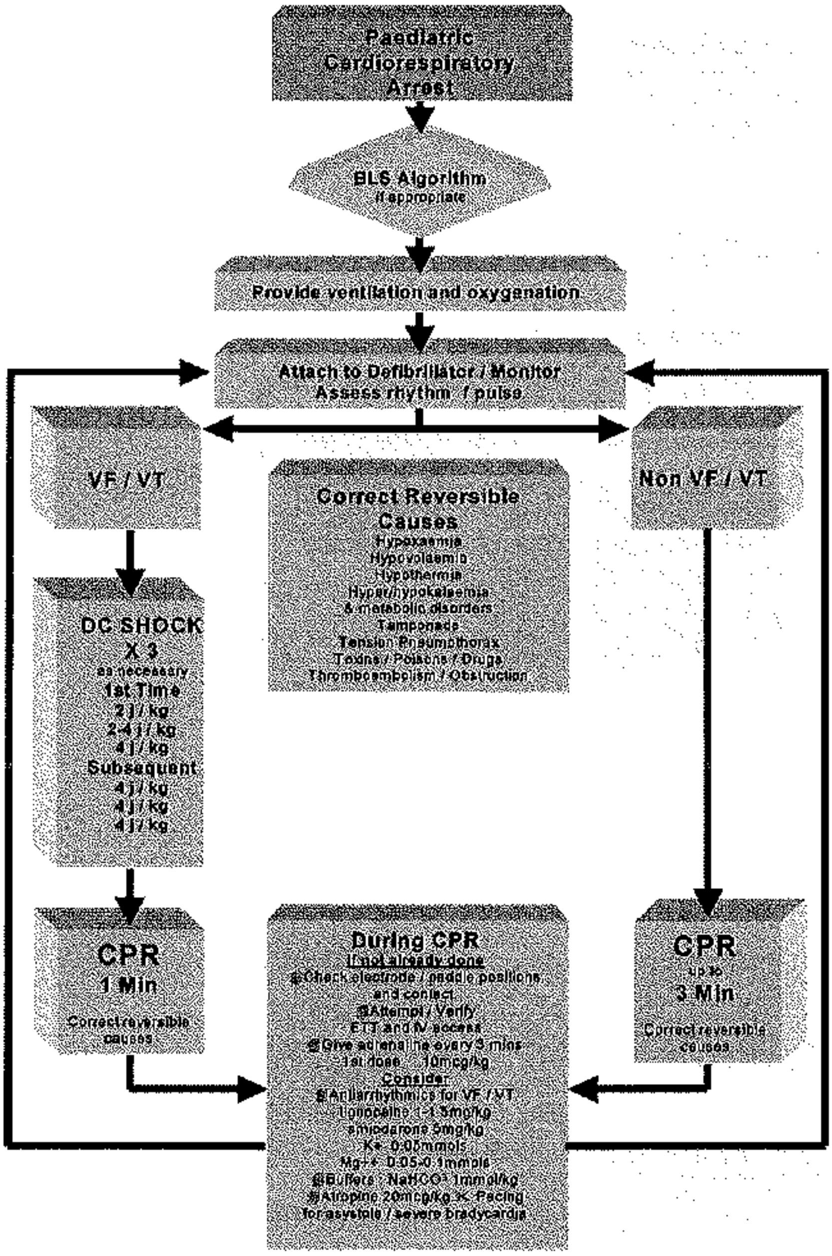
APPENDIX

Retrieval Flowchart.

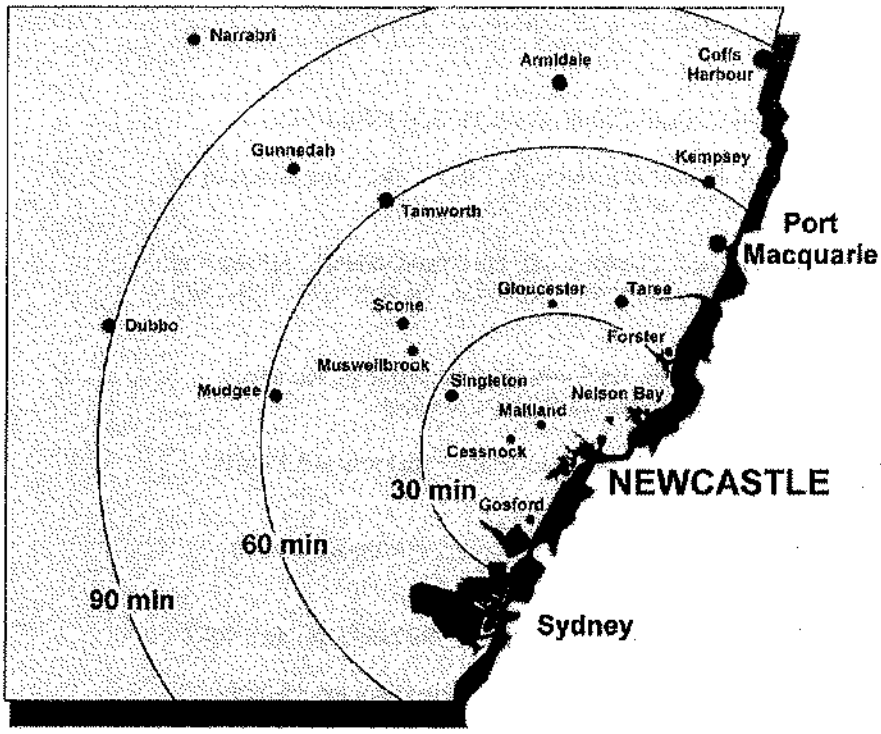


Adult ALS Flowchart

Paediatric ALS Flowchart



Catchment Map



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PRIMARY SCENE RETRIEVALS

Assessment, identification of current and potential problems and initiation of critical interventions provide a baseline for preparing a patient for transport from a primary scene. Each of these tasks must be performed in an organized, rapid and complete manner occurring before, during and after transportation.

The purpose of this package is to provide insight for the medical retrieval team as to what to expect upon arrival at a primary trauma scene and the role of the medical retrieval team as part of the rescue team, so that the safe extrication, transport and medical care of the patient is achieved.

Assessment of the patient in the prehospital care environment

Assessment of the patient at the primary scene can be an intense challenge thus making adaptation and flexibility paramount. The location of the patient (i.e. trapped in a vehicle), limited availability of personnel and equipment, and the nature of the illness or injury which the patient has sustained all present potential barriers to performing in-depth assessment.

The environment in which the patient is located can also pose additional barriers. This can be due to noise, a lack of light, space, movement of vehicles or outside weather conditions. However it may also be from people such as other emergency personnel, bystanders (onlookers) or distressed relatives.

It is important at all times to remember that although you are there to treat the patient, the safety of yourself is paramount. For this reason, assessment of the surrounding environment for any hazards is important.

Below is a list of potential hazards that may be encountered at a scene.

Potential Hazards at the Scene

Wires	Light Poles
Uneven ground	Water
Vehicles	Chemicals
Accident itself	Loose Debris
People	Signs

The assessment of a patient at a primary scene begins with obtaining a history. This may be either from the ambulance supervisor, or the primary carer of the patient.

The gathering of a patients history at a trauma scene is slightly different than when in the controlled environment of a hospital. The mechanisms of injury, and the current location of the patient all play a large part in the injuries that may have been sustained. The manner, when, where and how the patient was injured is important, however a complete description of the incident is often limited and difficult to obtain. A general description will provide adequate clues for potential problems and complications that may occur. **Don't waste valuable time obtaining detailed information.**

Some of the following questions may provide information about potential injuries. Were other people involved in the accident? Are all of the victims accounted for? The number of victims requiring treatment? Other members of the rescue team may be able to assist with this information.

The primary assessment is based on the assessment of the:

1. Airway with Cervical Spine Control
2. Breathing and Ventilation
3. Circulation with Control of bleeding
4. Disability Neurological
5. Exposure usually part of a Secondary Survey - but be aware of it

A. Airway

The patient's airway needs to be assessed to determine whether it is patent or obstructed. For any patient who is suspected of being involved in a traumatic injury, spinal precautions need to be maintained. If an airway problem is identified (usually the primary reason to be called), appropriate intervention needs to be initiated.

Ask the patient – "How are you?" – "What happened?"
The patient who replies has a patent airway, is breathing and has sufficient cardiac output to maintain consciousness. Beware of the patient unable to speak.

> ***Summary of airway assessment***
>
> Airway patent or obstructed
> Airway clearance
> Sounds of obstruction
> Skin appearance: pink, pale, grey, ashen, mottled, cyanotic

B. Breathing

Supplemental oxygen (15 liters via a non re-breather mask), should be given to all patients at the scene along with continual monitoring either by pulse oximeter or visual observation.

Do not allow the effects of head injury, shock or tissue damage to be compounded by hypoxemia.

> **Summary of breathing assessment**
>
> Rate and depth of respirations
> Work of breathing
> Position of trachea
> Presence of obvious injury or deformity

C. Circulation

The urgent task is to control haemorrhage and restore cardiac output levels.

Palpation of both peripheral and central pulses provides information about a patients circulatory status. The quality, location, and rate of the patient's pulses should be noted, along with rate of capillary return. The temperature of the patients skin can also be assessed at the same time.

Two (2) large bore cannullas for intravenous access also needs to be obtained for possible rapid administration of fluid and drugs.

Any active bleeding should be controlled with interventions such as direct pressure, tourniquets or bandages. Circulation compromise should be monitored and treated as able.

> **Summary of circulation assessment**
>
> Skin Circulation: cold pale skin with sweating indicates a severe problem
> Pulse and Blood Pressure:
> Identification of injury: active bleeding, deformation
> Intravenous access: peripheral, central, intra-osseous

D. Disability

This entails only a very brief global assessment of the patient's level of consciousness and pupil size and reaction. Be aware of the many factors that could impair this such as a head injury, hypotension and shock, impaired gas exchange, hypothermia, chemical ingestion.

> ***Summary of primary neurological assessment***
>
> Level of consciousness: alert, responds to voice or pain, unresponsive (AVPU)
> Motor sensory function

E. Exposure

As much as possible of the patient's body as should be exposed for examination. But keep in mind the effects of the environment on the patient at the same time. Cold wet clothing may affect the circulation of the victim, as could suffering from shock. The application of a space blanket may be necessary.

A Secondary assessment will be performed in the emergency department of the receiving hospital.

So when will we be called?

The ASNSW will contact the Director of the JHH ICU for an incident involving a patient that is injured at a primary site and request medical assistance.

For multiple patients of a major incident/disaster the ASNSW will contact the Hunter Area Health Service Functional Area Coordinator and activate the Hunter Healthplan (Disaster Plan) requesting assistance. (See http:// hal site for this policy)

The main reason for which we will be called for would be for airway protection, if there are multiple patients, delayed extrication time, or delayed time till transportation to a hospital. In most cases though, the paramedics are able to provide airway support and care for the victims at a scene, however in some situations, paramedics either may not be available or it may be beyond their scope of practice. In this situation the medical retrieval team are there to assist them and to work with them.

As with most retrievals, we are contacted by an outside source requesting assistance. For a primary scene, the contacting source is the ambulance officers. Minimal notification is usually given, so a quick, thorough and organised preparation is necessary.

In some cases though you may be on your way to a secondary retrieval and will be diverted (retasked) to the primary retrieval.

What information will we be given?

The information which will be conveyed to us prior to departure to a primary scene may not be very much. The ambulance officers will notify us of any basic information that they know and have found out since their arrival. This will usually include:

- The number of patients including the gender, approx weight and age if a child, reason for requesting a retrieval team to attend, and the presenting injury of illness.

Example:
Male driver, late teens, LOC 10 mins
Difficult extrication
Obs - BP100/50, P110
Abdo appears fine
? # right leg

What information do we need to tell the receiving hospital?

All information available should be told to the medical staff awaiting the arrival of the patient:

- Personnel details i.e. name, age and next of kin if known
- Events known about the accident incident i.e. number of victims, condition of the motor vehicle, extrication time, position in the motor vehicle, etc
- The location of the patient at the scene i.e. were they in the car or thrown from the car
- Suspected injuries and level of consciousness at the scene
- Treatment given

Any easy way to remember this is to use the word **MIST:**

M – mechanism
I – injuries

S – signs and symptoms
T – treatment

Teams responsibilities

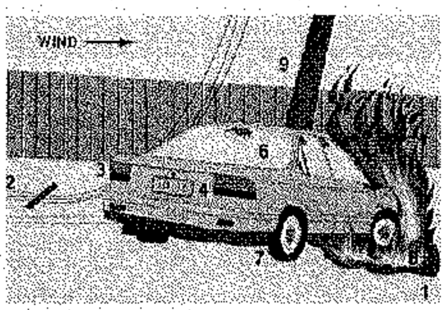
- Stay together in a place where everyone knows where you are. You may not be set up where the patient is located, but nearby at a safe distance, and where the ambulance officers are able to quickly contact you. They will then be able to contact you for assistance in treatment, updates on current condition and ensure your safety.
- Everyone at a primary trauma scene are able to be identified as to who they are and the role in which they play. For this reason it is important to be identified as to who you are.
- Don't wander around the scene. There are many potential risks for injuries at a trauma scene, bypassing cars, telegraph wires, chemical spills and equipment.

- Try and avoid the temptation to have a "sticky beak". Powerful equipment is being used for extrication, along with a potentially dangerous working environment, and you could be putting yourself and others in harms way.
- Take note of where everyone else is standing – the scene may be secured only in certain places. Usually the rescue vehicles will assist in providing a safety barrier – especially in the case of motor vehicle accidents. If you step beyond this "barrier" you could be putting yourself at risk or injury or accident.

- Avoid walking through any fuel, oil, battery acid etc that is on the ground as you can spread it further. Additionally you are putting yourself at risk of being ignited in flames if there is a flame spark.

- Be aware! Use common sense. And always have 'eyes in the back of your head'. Potential risks may not be known till later. Report anything that may be of concern.

1. Passing Traffic
2. Downed power lines
3. LPG
4. Possible hazardous load
5. Some components may explode
6. Broken glass
7. Vehicle may roll or tilt
8. Spilt fuel or chemicals
9. Damaged power pole



- Once extrication has occurred is it important that minimal time be spent at the scene prior to transport to the designated hospital and emergency department where a trauma team may be waiting.

Safety

Personnel Safety of the retrieval team is paramount.

- Ensure that you have adequate warmth on for the possible circumstances. Night time near the beach in summer can still be cold, especially if you have to be there for an extended period of time.

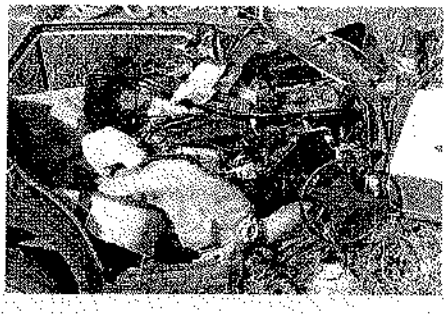
- Wet Weather Gear. Our retrieval suits are not water-proof and there is usually little protection from the weather at a scene. We have wet weather gear available – use it. There aren't any spares available at the scene for you.

- Ensure that you have your correct retrieval apparel on. This will not only help identify you, and act as a fire retardant in case of explosion, it also protects you from environmental injury due to uneven ground or debris.

- Reflector Vests also need to be worn. This not only helps you to be identified by the rescue team, but assists in you to be seen in adverse weather conditions and at the trauma scene. i.e. at night, in wet weather, on the road, railway line or building site. (The provision and the location of these is yet to be decided by the retrieval committee.)

- Don't forget to take your own personal safety equipment, i.e. glasses, gloves. There could be a large amount of blood and body fluid around. Having more than one pair of gloves available is imperative.

- A hard hat may be required depending on the location of the incident and the environment that you are working in. This may be due to sharp edges as a result of the work undertaken by the rescue squad in the extrication of the victim, or from the mechanisms of the accident. Imagine every piece of twisted and broken car as a potential 'needle stick injury'!

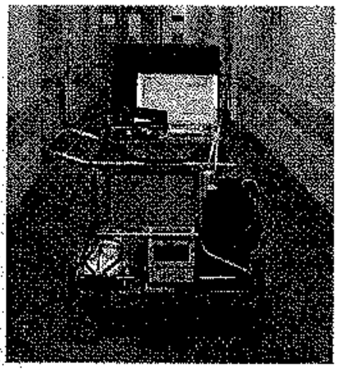


- Remember your helicopter safety brief – especially in regards to the departure from an aircraft. The ground may be uneven, and the risk of injury is even greater.
    - Take your time – we don't want to be another patient.
    - Follow the directions of the aircrew. They are experienced in this matter.

Equipment

Normal retrieval equipment still needs to be taken. This includes:

- Thomas pack
- Propaq
- Orange case with contents i.e. ventilator and correct tubing, CO^2 cable, 2 pumps, 2 oxygen tails.
- Retrieval phone
- Folder
- Drugs



If you are not diverted then any extra equipment that may need to be taken is dependent upon the information that is able to be obtained prior to departure from the Intensive Care Unit. This may include:

- A second Thomas Pack for multi-victim primary scenes

- Extra chest tubes – the ambulance officers carry only 1 chest tube per car, and we carry 2 in the Thomas pack. If there are multiple victims, i.e. 2 persons to one car, extra chest tubes may be required.
- The difficult intubation bag – the maintenance of a difficult airway is the main reason that we get called.
- Blood products – O Neg
- Extra drugs – Each ambulance carries a maximum of 50 mg of Morphine and 50 mg of Midazolam.
  - All intubation drugs, Ketamine, Fentanyl and extra Morphine and Midazolam need to be provided by the retrieval team.

Rescue Team Members

Ambulance Service of NSW (ASNSW)

Upon arrival at a primary scene, it is important to find out who is in charge of the ASNSW and report to them. They may be able to provide information on the events occurring prior to incident, potential hazards at the scene, and the primary carer of the patient. They will be able to provide current information on the patient, injuries obtained, treatment provided, and their current status.

It is important to remember that although they have requested our assistance at the site, and are usually more than happy that we have arrived, they are still the primary carers. We are not there to take over, but rather to assist them to care for the patient for the best outcome possible.

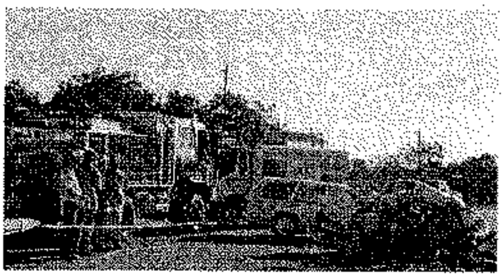
The other team members that may be assisting at a primary scene may be the rescue squad, NSW Fire Brigade and the NSW Police. Although they may not be providing direct patient care, their roles are just as important.

Rescue Squad

The **rescue squad's** role is the extrication of victims as quickly as possible. It is important to be aware of where they are working and to communicate with them as able. They may let you know as to what action they are about to undertake so that you may shield the patient and protect yourself, or they may not. Be aware that their primary role is to extricate, and they will do what they have to in order to do this. If this means to get you away from the patient, then they will do this.

NSW Fire Brigade

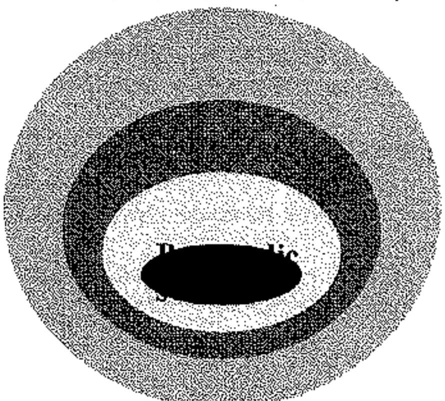
Be aware of where they are, and the environment in which you are working in. They will always have their hoses charged, ready for any potential fire that may occur, therefore avoid walking in front of them and blocking their line of sight. The Fire Brigade are responsible for the hazards at the accident scene and therefore the safety of all personnel.



You are not to enter the scene till the firemen have deemed that it is safe to do so. Remember: they have the protective equipment to wear, we don't. In the case of a chemical spill (i.e. petrol, chemical etc.), they will remove the patient from the scene to a safer location for medical treatment to occur.

NSW Police

They may be silent watching the movements of the team, but they are in absolute control of the scene. The senior member of the police service present at the scene of a rescue operation is responsible for coordinating and determining the priorities of action of the agencies engaged in the rescue operation. They control and determine who has access to the accident scene. All team members are guided by their advice in regards to the preservation of any evidence and identification of the victims. The police officers will follow-up any transfer of a patient to hospital, and will notify the hospital of personal details if patient is unidentified. All means of identification and personal effects are to be kept with the patient on transport to hospital.



Those that attend a primary accident scene all have roles. Someone is always delegated to be in charge of their area of experience.

The police are in overall control of the incident. The fire officers are responsible for the hazards at the immediate scene of the accident, while the ambulance officers are responsible for the care of the patient.

They all aim to liaise together for the safety of each other, and the safety, well-being and extrication of the patient.

Conclusion

We are an integral part of the rescue team and are in an environment which is unfamiliar to us.

Remember to communicate with other members of the team, and be prepared for anything.

Be aware! Use common sense! And always have 'eyes in the back of your head'.

Be adaptable – you won't have all of the services/equipment that you are use to in the Intensive Care.

Potential risks may not be known till later. Report anything that may be of concern.

Although the retrieval team may not be directly involved in the extrication or rescue activities, the team members should be prepared to help in the rescue effort but not endanger themselves so that they are unable to help the injured after they are rescued.

Questions

It is a rainy winter day when you, as the 2IC on for the afternoon, are requested to assist at a primary scene. All the information that you have available is that it is a single vehicle MVA.

1. List any extra equipment that may be required when attending a primary scene?
2. List any potential hazards to be aware of that you may come across at the motor accident site.
3. You are told that there is only one accident victim – the driver who has been trapped for about 1 hour, with the vehicle on its side. Outline what would be involved in a primary assessment of the driver at the scene.
4. You won't be the only people at the accident site. Who else will be there and what are their roles at the accident site?

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