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First Nations and Inuit Health Branch Emergency Medical Transportation Guidelines for Nurses in Primary Care

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Direction générale de la santé des Premières nations et des Inuits

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First Nations and Inuit Health Branch Emergency Medical Transportation Guidelines for Nurses in Primary Care

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Preface

These *First Nations and Inuit Health Branch Emergency Medical Transportation Guidelines for Nurses in Primary Care* are intended primarily for use by qualified and licensed nurses working in nursing stations and treatment health centers located in semi-isolated and isolated First Nations and Inuit communities, where medical evacuation is often a necessary course of action.

The information presented here is intended to provide guidance in the assessment and management of the client requiring urgent or emergency transportation for appropriate medical care. It is important to note that while the guidelines contain useful information, they are not intended to be exhaustive. The manual is to be used for reference and educational purposes only and should not be used under any circumstances as a substitute for clinical judgment, independent research or the seeking of appropriate advice from qualified healthcare professionals.

Whenever possible the decision to transport a client for urgent or emergency care should be made in consultation with a physician. In addition, the *First Nations and Inuit Health Branch Clinical Practice Guidelines for Nurses in Primary Care* and the *First Nations and Inuit Health Branch Pediatric Clinical Practice Guidelines for Nurses in Primary Care* may be of assistance in reaching a decision to transport.

Although every effort has been made to ensure that the information contained in the guidelines is accurate and reflective of existing healthcare standards, it should be understood that the field of medical science is in constant evolution. In particular, all drug dosages, indications, contraindications and possible side effects should be verified and confirmed by consulting the *Compendium of Pharmaceuticals and Specialties* (CPS) or the manufacturer's drug insert. A drug's classification according to the National Nurses' Drug Classification System (NNDCS) should also be verified.

Finally, it should be noted that the information in the guidelines may have been superseded by a local policy or other guideline particular to a region or zone, by a common local medical practice or by the orders of a local medical practitioner. The reader is encouraged to verify the existence of these alternative sources of information.

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CHAPTER 1 — PRINCIPLES AND PROCESS OF MEDICAL EVACUATION

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INTRODUCTION

Medical evacuation (medevac) usually refers to the transport between facilities of clients requiring urgent or emergent medical care. It can also refer to movement of patients requiring care that is unavailable in their own communities, such as a special diagnostic test or a planned surgery.

Various modes of transport are used for medevac, including aircraft and motorized vehicle (e.g., land ambulance). In more remote areas, medevac may also encompass movement between smaller communities by boat or snowmobile.

In some regions, emergency medical evacuations are carried out by dedicated ambulance services, with trained medical personnel, including doctors, nurses, paramedics and emergency medical care attendants (EMCAs) providing the escort. In other areas and under certain conditions, the community nurse and/or physician may be required to escort the client and provide care during transport to hospital.

Although it can be a life-saving link between remote communities and higher-level medical centers, the medevac process can itself endanger the client's life.

The nurse needs additional knowledge about the potential effects of the choice of transport on the client's condition (e.g., the physiological effects of flight) and the corresponding actions required to meet the client's needs in transit.

Although medical evacuation frequently implies an emergency situation, the first requisite is to ensure that the client is sufficiently stabilized to withstand travel. The accuracy of pre-transport assessment of the client's condition is paramount.

There are three main components of interfacility transport. These must be carefully considered before any transport, so as to optimize client care and safety.

– Preparation, which involves stabilization of the client, anticipation of needs and potential problems, and preparation of equipment
– Selection of transport vehicle and medical escort personnel
– Transportation, including medical and nursing care needed en route

GENERAL PRINCIPLES

Safe and effective medical evacuation requires that careful decisions be made regarding the following aspects of the client's condition and the transport itself:

– stability of the client's condition
– priority level (how soon transport should occur)
– requirements for medical and nursing care en route
– most appropriate escort
– most appropriate mode of transport

See Tables 1-1 and 1-2 for guidelines in making these decisions.

Other considerations for transport:

– The client must be stabilized as much as possible before transfer, e.g., airway secure, IV lines started and appropriate medications administered.
– Any kind of transport has the potential to negatively affect a client's condition. Therefore, consider carefully the risks to which the client will be exposed during transport before deciding whether it is medically necessary to transport the client *right now* rather than keeping the client in the referring facility until stabilized.
– Transport during inclement weather and nighttime medevacs should take place only if the vehicle operator (e.g., the aircraft pilot or ground ambulance driver) feels that it is safe to proceed. The operator should not be subjected to undue pressure from healthcare personnel, from the family or from other community members.
– In many areas and in some emergency situations, it may be more appropriate to bring a medical-nursing transfer team into the community to stabilize and transfer the client. Specialized personnel and equipment, if required, may be requested and brought along.

Table 1-1: Guidelines for Classification of Clients for Medical Evacuation, Escort Requirements and Mode of Transport

Priority	Client Condition	Client Requirements	Escort Requirements	Mode of Transport
Critical: Transport as soon as possible	• Critical and unstable trauma or illness requiring immediate specialty care not available at referring facility • Immediate threat to life or function • Physiologically unstable • Non-ambulatory • Prenatal, in labor	• Stretcher required • Intensive monitoring, nursing assessment and treatment changes required • Frequent and active medical assessments, decisions and treatment changes before and during transport required (e.g., ventilation, intensive drug therapy, massive volume resuscitation and specialized medical procedures) • Therapeutics intensive	• Registered nurse, physician or paramedic • Specialty team as required (e.g., for neonatal)	Air or ground ambulance
Emergent: Transport as soon as possible	• Acute trauma or illness requiring immediate speciality care that is not available at referring facility • Potential threat to life or function • Physiologically stable on initial contact but with history of recent instability • Postpartum or neonate	• Stretcher required • Intensive monitoring, nursing assessments and management required • Medical assessments, decisions or treatment changes before and during transport may be required • Personnel and technology intensive	Registered nurse, physician, paramedic or specialty team as required	Air or ground ambulance
Urgent: Transport required within 12 hours	• Subacute trauma or illness requiring medical care and attention not available at referring facility • No immediate threat to life or function • Physiologically stable • Postpartum or neonate	• Stretcher required • Acute care monitoring and nursing assessments required • Changes in nursing management during transport may be required • Active medical assessment and treatment changes not likely to be required during transport • Technology intensive	Registered nurse, physician, paramedic or specialty team as required	Air or ground ambulance
Non-urgent: Scheduled transport within 24 hours coinciding with prearranged client referral	• Non-acute trauma or illness requiring medical diagnostic procedures, evaluation or treatment not available at referring facility • No threat to life or function • Physiologically stable	• Non-ambulatory or ambulatory • Routine nursing monitoring or healthcare management required • Minimal medical equipment required (routine hospital care)	Registered nurse, family member or emergency medical technician (EMT)	Air taxi (i.e., scheduled flight) Air or ground ambulance
Deferrable: Can travel at any time with sufficient notice	• Non-acute trauma or illness requiring medical diagnostic procedures, evaluation or treatment not available at referring facility • No threat to life or function • Physiologically stable	• Non-ambulatory or ambulatory • Medical and nursing assessment or management not required during transport • No medical equipment required	Non-medical escort as appropriate	Air taxi (i.e., scheduled flight) Some form of ground transport (train, bus or private vehicle)

Source: First Nations and Inuit Health Branch, Alberta Region (October 2001).

Table 1-2: Factors in Decision on Mode of Transport

Main Factors

The decision to transport a client from a particular facility is usually dictated by the inability of that facility to provide the level of care that the client requires. The decision as to mode of transport should be based on the following main factors:

- Diagnosis and medical stability of the client, including analysis of possible complications in his or her condition during transport
- Urgency of providing a higher level of care
- Level of medical care that the client is currently receiving
- Distance and duration of transport to the receiving hospital
- Geographic characteristics that affect expedient transport
- Methods of transport available

Time and Distance Factors

In medically urgent or emergent situations, reducing out of hospital time is beneficial to client outcome. Careful evaluation of the time and distance from the client's location to the receiving institution is important. Include the following factors in the calculation:

- Modes(s) of transportation being considered
- Time necessary to mobilize a medical team
- Estimated time needed to travel with the client, accounting for distance, terrain, weather and traffic
- Amount of time that will be spent stabilizing the client
- Amount of time to return staff and equipment from the receiving institution to their point of origin

Personnel Factors

In communities where the number of healthcare professionals is limited, the following factors should also be considered:

- Ability to replace nursing staff
- Ability to replace physician
- Ability to replace local ambulance or other transportation service

The recommendations of the healthcare provider in determining the most appropriate mode of transport should be documented on the client's chart.

PRIMARY MODES OF TRANSPORT

AEROMEDICAL EVACUATION — SPECIAL CONSIDERATIONS

Although aeromedical evacuation is often considered just another way of transporting a client, there are great differences between this kind of transport and ground transport.

The existence of these differences does not mean that clients at risk should not be transported by air. In fact, aeromedical evacuation is safe for transporting almost any client, even those who are seriously ill or injured, if the following conditions are met:

- well-prepared, well-trained medical or nursing escort
- medical equipment that is qualified as "safe for use" in an aircraft

A client may be exposed to some specific risks during flight. Therefore, the accompanying medical and nursing personnel must have a good understanding of the basics of aerospace medicine and the specific interactions that might occur for a particular illness or injury. *See chapters 2, 3 and 4 of these guidelines for more details regarding aeromedical evacuation.*

The following clients require special consideration in flight, and, whenever possible, pressurized aircraft should be used and the cabin pressure carefully controlled *(see chapters 2, 3 and 4 of these guidelines for more details)*:

- Clients who have or who may develop airway compromise (e.g., moderate to severe lung disease or airway problem, such as chronic obstructive pulmonary disease [COPD], pneumonia, respiratory distress syndrome, asthma, chest trauma)
- Clients with congestive heart failure, unstable angina or acute myocardial infarction (MI) and those who have had MI in the past
- Clients with severe anemia: hemoglobin < 70 g/L (7.0 g/100 mL) or RBC < 2.5×10^{12}/L (2.5 million/mm^3)
- Clients with gas trapped within any body cavity (e.g., pneumothorax)
- Clients who have had thoracotomy or laparotomy (if possible, such clients should not be moved within 10 days after the surgery except in pressurized aircraft)
- Clients whose jaws are wired together (such clients must have an escort who can, if necessary, use an appropriate wire cutter to remove the tie wires, should the client become air sick)
- Newborn and premature infants

Unpressurized aircraft should be used for seriously ill or injured clients only when there are no pressurized aircraft available for the transport.

See chapter 2, "Aeromedical Evacuation," for more information on types of aircraft.

NON-EMERGENCY ROAD TRANSPORTATION

Healthcare professionals must be aware that an ambulance may not be necessary for all clients undergoing interfacility transfer. Clients can be safety transported in a vehicle other than an ambulance, such as a taxi or private automobile, if the following conditions are met:

- The attendant or driver will not be expected to provide any medical attention to the client.
- The client is considered medically stable, and the act of transportation and (if they are to return by the same mode of transport) any diagnostic or therapeutic intervention at the receiving institution are not expected to change the level of stability.
- The client is not using any device (e.g., stretcher or splint) or treatment modality (e.g., IV line) unless such a device or treatment modality is a part of the client's lifestyle and/or the client (or a companion such as a parent who will accompany the client) has been trained to care for the device or treatment modality.

If a client does not meet these criteria, or if there is any uncertainty as to the most appropriate transfer method, the client should be transported by ambulance.

Source: Saskatchewan Health Ambulance Services, 1994.

RESPONSIBILITIES OF REFERRING PRACTITIONER

STEP 1. PRE-TRANSPORT ASSESSMENT AND PLANNING

The need for medical evacuation and the care provided before and during transport of a particular client are usually determined by the nurse at the local facility, in consultation with a physician. The ultimate decision to evacuate lies with the most qualified person on the scene.

The client should be completely assessed in a systematic fashion and all the potential problems identified and managed.

The following should be considered or performed before the transport of any client:

- An appropriate **SAMPLE** history should be obtained: Symptoms (history of the current illness or injury), Allergies, Medications, Past medical history, Last meal and Events before illness or injury.
- An appropriate systematic physical examination should be performed, with particular attention to assessing and securing **ABCs**.
- The results of appropriate (available) diagnostic tests and results (e.g., ECG and blood work), if performed, should be made available for review by the transporting medical personnel and should be transported with the client.
- The nurse must try to anticipate any problems that might develop during transport, so that steps can be taken to prevent them. If prevention is not possible, the nurse should be prepared for the problems to occur during transport and should have available appropriate medications, supplies and equipment.
- A physician should be consulted to determine the appropriate care, the urgency of the transport, the appropriate level of escort (see Table 1-1, above) and the appropriate mode of transport (see Table 1-2, above)

STEP 2. PRE-TRANSPORT INITIAL STABILIZATION

This is the most important step in determining the safety of the transport. Avoid the “scoop and run” approach, unless there is danger at the originating scene for those involved.

The following steps must be *considered* when stabilizing a seriously ill or injured client for transport. Some of these procedures (e.g., inserting IV lines) may be performed by the referring healthcare practitioner. Others (e.g., intubation) are not within the CHN’s scope of practice; therefore, if they are needed, they must be carried out by other qualified medical personnel.

A FOR AIRWAY

Airway management is always the first priority. The airway must be opened and maintained (ensure protection of the cervical spine and take appropriate precautions in the injured client).

If the airway is compromised, if there is any potential for airway compromise en route or if there is a need for therapeutic interventions such as hyperventilation, intubation before transport is indicated. This procedure is not within the CHN’s scope of practice and must be performed by authorized emergency transport personnel (e.g., physician, emergency flight nurse or paramedic).

Proper immobilization in clients with suspected C-spine injury is especially important, in view of the number of movements that may be required in loading and unloading the client from the transport vehicle.

B FOR BREATHING

Breathing must be assessed and assisted as necessary.

Respiratory emergencies such as pulmonary edema, hemothorax, flail chest, open chest wound or pneumothorax must be stabilized as much as possible before transport. For example, it may be necessary to insert a chest tube if there is any evidence of significant pneumothorax, especially if transport is by air in an unpressurized aircraft.

Inserting a chest tube is not within the CHN’s scope of practice. This procedure must be carried out by authorized emergency transport personnel (e.g., physician, emergency flight nurse or paramedic).

C FOR CIRCULATION

Stabilization of the cardiovascular system before transport, including control of any bleeding, is essential. Transport should not be initiated until the pulse and blood pressure are stabilized through fluid volume replacement or medication (or both).

It is advisable to institute a minimum of two large-bore IV lines for all seriously ill or injured clients before transport. Hypovolemia can be treated initially with crystalloid IV fluid replacement (e.g., normal saline or Ringer's lactate).

D FOR DISABILITY

Neurological status must be assessed before and during transport. The Glasgow Coma Scale is a useful tool for such assessments.

Assess for increased intracranial pressure and manage in consultation with a physician. This may entail initiating a controlled airway, hyperventilation, elevation of the head on the stretcher, administration of an osmotic diuretic or a combination of these strategies.

OTHER CONSIDERATIONS

Consider inserting a nasogastric or orogastric tube to straight drainage for clients with gastric or GI distension, major GI disorders, diminished or absent bowel sounds, or artificial airways in situ.

Consider inserting a urinary catheter for all seriously ill or injured clients, unless such is specifically contraindicated (e.g., suspected injury to urinary meatus). Also consider a urinary catheter for any client who has received a diuretic. Document urine output.

Institute cardiac monitoring (if available) for all clients with potential for arrhythmias, ischemia or other cardiac abnormalities.

Consider administering analgesia or sedation before transport as required. Discuss use of these medications with a consulting physician if possible.

STEP 3. PREPARATION OF EQUIPMENT

Prepare an inventory of all necessary supplies and equipment for the transfer, and test all equipment to make sure it is operating properly before the transport.

The dedicated aeromedical and ground ambulance transport services available in many regions usually have most of the required equipment. However, they may not have some of the specialized equipment required for interfacility transport. *See chapter 6, "Equipment and Supplies."*

STEP 4. PREPARATION OF CLIENT AND ESCORTS

Arrange for an appropriate escort(s) to accompany the client. See Table 1-1, above, for information on choosing an appropriate escort according to the client's needs. The safety of the client and the escort(s) during transport must be a priority at all times.

Prepare the client and escort(s) for transport (e.g., proper clothing and wrapping, especially in cold weather).

In remote areas, review survival procedures before the transport, especially during the colder seasons. In addition, review the policy in your area regarding access to and use of survival gear when traveling significant distances between communities in remote areas, especially if traveling in smaller, unpressurized aircraft, boats, or motorized vehicles such as trucks or snowmobiles. Transport Canada requires that all aircraft flying in remote regions carry survival gear appropriate for the terrain and environment over which they are flying. However, if flying routinely with a specific airline, the passengers (including escorting nurses) should ask specifically about what survival gear is carried on board and should be familiar with its use.

Have safety equipment and supplies available and use as indicated (e.g., wear seat belts whenever possible, wear life jackets at all times when transportation is over water).

Secure all passengers, equipment and supplies within the transport vehicle.

Do not take along too much equipment.

Know how to operate the emergency exits.

STEP 5. COMMUNICATION WITH RECEIVING PHYSICIAN AND HEALTHCARE FACILITY AND WITH MEDICAL ESCORT PERSONNEL

Before the transport begins, contact the receiving physician and healthcare facility where the client is being transferred:

- Ensure that they can accept the client
- Discuss the relevant clinical information and additional steps that can be taken to further stabilize the client
- Advise them of the estimated time of arrival

If outside medical personnel will be arriving in the community of origin to take over the care of the client during transport, they will need some information in order to provide appropriate care. Initial contact is often by telephone, followed by a verbal report in person at the time of the transfer. They will need the following information:

- Names of referring and receiving facilities and physicians
- Name and phone number of a contact person familiar with the case
- Client's name and age
- Chief complaint and history of present illness
- Significant past medical history, including allergies
- Treatment given in local facility while awaiting transport
- Present clinical status (stable or unstable); for a child, report body weight
- Names of any passengers who will be traveling with the client
- Specific concerns, considerations and client needs (e.g., deafness, blindness, need for an interpreter)
- Type of medical escort personnel required
- Special equipment or supplies that may be needed (e.g., transport incubator)

Medical personnel who are taking responsibility for care of a client during transport must have an opportunity to assess the client before transport. The transport team may find that further stabilization is required before moving the client. Airport transfers should be performed *only* if the client's condition is very stable.

STEP 6. MANAGEMENT DURING TRANSPORT

The aim is to have the client well prepared and stabilized for transport, so that only monitoring and supportive care are required during transport. Stabilization must always incorporate attention to ABCs.

A FOR AIRWAY

- Protect and monitor airway.
- Ensure that appropriate-sized resuscitation equipment is available on all transports, and ensure that transport personnel are familiar with the use of each item.
- Carefully secure airway devices to prevent displacement during client movement. The airway should be reassessed whenever the client moves to ensure that any problems, especially during loading and unloading, are identified early.
- Ensure that suction is available and functioning during all phases of transport (including land transport), to assist with basic airway maneuvers that may be required.
- Have wire cutters available for any client whose jaws are wired shut.

B FOR BREATHING

- Deliver oxygen liberally through a non-rebreather mask with reservoir bag to ensure good oxygenation.
- Monitor oxygen saturations with a pulse oximeter (if available); oxygen saturations may be inaccurate in the presence of carbon monoxide poisoning.
- Humidify the oxygen if possible.

Significant respiratory emergencies, including pneumothorax, hemothorax, open chest wounds and flail chest, must be adequately managed before transport.

C FOR CIRCULATION

- Maintaining adequate IV access is critical.
- Make sure all IV tubes and other attached lines are secured well. Monitor them closely during transport, especially after loading and unloading. IV tubes can be coiled and secured to prevent them from being dislodged.
- During loading and unloading from the transport vehicle, consider saline locks for IV lines that are not needed for volume replacement or administering medications. A locked IV can be reopened once the client is on board or in the receiving facility.
- IV lines may freeze in cold temperatures. Use body heat (yours or the client's) to prevent freezing (e.g., place the line under your parka or in a sleeping bag).
- Monitor vital signs closely. Blood pressure may have to be checked by palpation if non-invasive technology is not available, as the noisy environment will interfere with auscultation.
- Remember that edema and bleeding increase during aeromedical transport.
- Elevate injured parts and monitor color, warmth, circulation and movements of injured extremities.

For aeromedical transfers in a fixed-wing aircraft, ensure that loading and unloading of the client are as smooth as possible, without excessive movement or rotation of the stretcher. Load the client in an attitude that will lessen the effects of gravitational forces *(see chapter 4, "Primary Care during Transport," for details)*. Always ensure that the client's position allows access to the head and other body areas of concern.

OTHER FACTORS

- *Motion sickness:* Ensure that equipment to deal with motion sickness is readily available, including sick sacs, kidney basins, and suction and tonsil-tip suction devices.
- *Dressings:* Be prepared to reinforce wet dressings; avoid changing them during medical evacuation.
- *Narcotic analgesia:* If administration of narcotic analgesia is required during transport, dispense the drug and document this action according to the region's policy on narcotics and controlled substances.
- *Documentation:* Throughout the transport, clearly and concisely record, on the appropriate forms, all clinical observations, interventions and medications given.

STEP 7. TERMINATION OF TRANSPORT

The following guidelines apply if the community nurse is providing escort

- Supervise disembarkation of the client, any documents, and supplies or equipment.
- Accompany the client to the receiving medical facility and provide hospital staff with a complete report of the client's condition and pre-hospital medical treatment provided. Provide a copy of the medical record to the receiving practitioner.
- Ensure that all equipment and unused supplies are checked and returned to the originating facility in a usable state. Ensure that the address of the originating facility is clearly visible on all equipment and supplies.

CHAPTER 2 — AEROMEDICAL EVACUATION

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THE BASICS OF AEROSPACE MEDICINE

THE ATMOSPHERE

The atmosphere is the envelope of gases surrounding the Earth. It is divided into four stratified layers: the troposphere, the stratosphere, the ionosphere and the exosphere. The troposphere is the layer closest to the earth, extending upward for 50 000 to 60 000 ft (15 240 to 18 290 m) at the equator and to 25 000 to 30 000 ft (7620 to 9145 m) at the poles.

All unpressurized fixed-wing aircraft and most pressurized fixed-wing aircraft used for medevac fly in the troposphere. Unpressurized fixed-wing aircraft usually fly within the first 10 000 ft (about 3000 m) above the ground. As an aircraft ascends in the troposphere, the following factors come into play:

- the temperature drops (by 2°C for every 1000 ft [300 m] ascended)
- atmospheric pressure falls
- water vapor is reduced
- weather problems and turbulence occur

COMPOSITION

The atmosphere is composed primarily of oxygen and nitrogen (Table 2-1).

Table 2-1: Gaseous Components of the Atmosphere

Gas	% of Total
Oxygen	21
Nitrogen	78
Trace gases	1
Total	100

BAROMETRIC (ATMOSPHERIC) PRESSURE

Barometric (atmospheric) pressure is the pressure exerted against an object or a person by the atmosphere. The pressure is usually measured in millimeters of mercury (mm Hg) for medical purposes. As an aircraft ascends, barometric pressure falls (see Table 2-2).

Table 2-2: Barometric Pressure at Various Altitudes

	Barometric Pressure	
Altitude (ft)*	In mm Hg	In psi
Sea level	760	14.7
1 000	733	14.2
3 000	681	13.2
5 000	632	11.8
7 000	586	11.3
10 000	523	10.1
12 000	483	9.3
14 000	447	8.6
16 000	412	8.0
18 000	380	7.3
20 000	350	6.8
25 000	282	5.5
30 000	226	4.4
35 000	179	3.5

Note: psi = pounds per square inch.
*1000 ft = 304.8 m.

GAS LAWS

Changes in atmospheric pressure affect the human body according to the following laws governing atmospheric gases.

DALTON'S LAW

The total pressure of a mixture of gases is equal to the sum of the partial pressures of the individual gases present.

Physiological significance: Oxygen transfer from the air to the vital organs of a human being is a direct result of atmospheric pressure. Increasing altitude results in a drop in atmospheric pressure. As this occurs, the pressure of the individual gaseous components in the atmosphere also decreases. Therefore, the availability of oxygen declines as altitude increases, which results in oxygen deficiency (hypoxia). Even healthy people will suffer hypoxia during flight, and the impact on a seriously ill or injured person is greater than that on a healthy person. *(See "Hypoxia," below, this chapter)*

BOYLE'S LAW

The volume of a gas is inversely proportional to its pressure when temperature remains constant.

Physiological significance: As altitude increases, atmospheric pressure drops, and gases (including gases trapped in any body cavity) expand. The expansion of gases causes an increase in the pressure on surrounding tissues and may result in tissue damage. This expansion of gases explains the effects of changes in atmospheric pressure on ears, sinuses, teeth and the gastrointestinal tract. Gas in the middle ear or the sinuses that expands under these conditions may not be vented adequately, which can result in pain, inflammation and, in the case of the middle ear, the possibility of rupture of the ear drum.

HENRY'S LAW

The amount of gas that will dissolve in a solution and remain in solution is directly related to the partial pressure of the gas over the solution.

Physiological significance: Henry's law explains the phenomenon of decompression sickness. As decompression occurs, nitrogen may evolve out of solution in the body's tissues, causing localized irritation, localized manifestations such as the "bends" and skin manifestations, and systemic responses such as neurological effects or shock.

TYPES OF AIRCRAFT

PRESSURIZED AIRCRAFT

Pressurized aircraft can fly at higher altitudes, including those that are dangerous to human life, while maintaining physiologically compatible conditions inside the cabin. The aviation benefits of using a pressurized aircraft and flying at higher altitudes are the ability to fly over bad weather and improvements in gas mileage. In medical terms, use of a pressurized aircraft allows control of the atmospheric pressure within the aircraft ("cabin altitude") to meet the client's needs. Pilots and air medical escorts can work together to provide the optimal cabin altitude for the client, according to clinical needs and aviation safety.

See Appendix 4-1, "Suggested Cabin Altitude Restrictions," in chapter 4, "Primary Care during Transport," for optimum cabin altitudes for specific clinical problems.

Types of Pressurized Aircraft

– Citation 1
– King Air Lear Jet
– Electra
– Boeing 737
– Hawker Siddeley 748

UNPRESSURIZED AIRCRAFT

Unpressurized aircraft are useful for transporting clients with non-emergency conditions. However, the role of unpressurized aircraft in the transport of acutely ill clients is severely limited by the altitude restrictions indicated for various medical conditions *(see Appendix 4-1, "Suggested Cabin Altitude Restrictions," in chapter 4, "Primary Care during Transport").*

These restrictions force the unpressurized aircraft to fly at altitudes much lower than usual. This factor has several important implications for the transport of acutely ill clients:

– Lower-altitude trips may take longer because of inclement weather, which delays the arrival and subsequent treatment of the client at the receiving hospital
– Greater turbulence at lower altitudes may result in:
  ▪ more hemorrhage in a client with injuries to an organ (e.g., liver or spleen)
  ▪ more pain, especially in clients with musculoskeletal trauma
  ▪ greater anxiety leading to higher oxygen demands and resultant cardiovascular or pulmonary deterioration
  ▪ greater risk of vomiting and possible pulmonary aspiration
– Greater turbulence at lower altitudes will also directly affect medical care by:
  ▪ making invasive procedures such as initiating an IV line more difficult
  ▪ adversely affecting the performance of medical personnel because of air sickness (i.e., nausea, vomiting, faintness, anxiety)

Aviation considerations may prevent flight at the altitude that offers the best cabin altitude for the client. In such situations, overall safety must be the major consideration.

Types of Unpressurized Aircraft

– Cessna 185
– Twin Otter
– Beechcraft 1900
– Beaver
– Chinook helicopter

PHYSIOLOGICAL EFFECTS OF FLIGHT ON THE HUMAN BODY

ALTITUDE AND OXYGEN DELIVERY

The availability of oxygen declines with increasing altitude because of a drop in barometric pressure (according to Dalton's law; see above). The higher the cabin altitude, the lower the atmospheric pressure inside the aircraft and the more significant the effect on tissue oxygenation (Table 2-3). These changes are most pronounced in unpressurized aircraft, where cabin altitude is essentially the same as true altitude. *See "Hypoxia," below, this chapter.*

Table 2-3: Effects of Altitude on a Typical Healthy Person

Altitude*	Oxygen Saturation	Effects on Vision	Other Effects
4000 to 5000 ft ASL	>93% (no effects of hypoxia)	Some impairment of night vision	
5000 to 8000 ft ASL	90% to 93%	Greater impairment of night vision	
8 000 to 10 000 ft ASL	88% to 90%	Some impairment of day vision	Reduced ability to perform tasks
10 000 to 14 000 ft ASL	83% to 85%		Critical loss of judgment, accompanied by euphoria and fatigue
14 000 to 20 000 ft ASL	<83%		Severe loss of judgment, accompanied by belligerence or euphoria
> 20 000 ft ASL	Severe hypoxia		Death occurs in a short time

Note: ASL = above sea level.
*1000 ft = 304.8 m.

HYPOXIA

Hypoxia is a state of oxygen deficiency causing impairment of bodily functions. Onset may be gradual or rapid. Intellectual impairment may be manifested by slow thinking, faulty memory, delayed reaction time, poor judgment and other features. There are both subjective and objective manifestations of hypoxia (Table 2-4).

Table 2-4: Clinical Manifestations of Hypoxia

Subjective Signs	Objective Signs
Insidious onset	Dyspnea
Visual signs	Hyperventilation
Night vision reduced at 4000 ft (1219 m)	Cyanosis (late sign)
Day vision reduced at 15 000 ft (4572 m)	Tremors, muscle incoordination
Blurred vision	Decreased level of consciousness (confusion, stupor, unconsciousness)
Tunnel vision	Restlessness
Air hunger	Euphoria, belligerence
Apprehension	Clamminess
Fatigue	Tachycardia or bradycardia
Nausea	Tachypnea
Headache	Hypertension (initially)
Dizziness	Hypotension (late sign)
Confusion	Seizures
Euphoria, belligerence, overconfidence	Arrhythmia
Insomnia	
Hot or cold flashes	
Numbness	
Tingling	

TYPES OF HYPOXIA

- *Hypoxic hypoxia* occurs as a result of interference in the movement of oxygen from the alveoli of the lungs into the bloodstream (e.g., in severe asthma, hyperventilation, pneumonia, emphysema or pneumothorax). This is the type of hypoxia that occurs with altitude.
- *Hypemic (anemic) hypoxia* occurs when there is a reduction in the oxygen-carrying capacity of the blood. (e.g., in anemias, carbon monoxide poisoning, hemorrhage or circulatory malfunction).
- *Stagnant hypoxia* occurs when there is a decrease in blood flow to the tissue cells (e.g., in shock, prolonged cold or congestive heart failure).
- *Histotoxic (toxic) hypoxia* occurs when the tissues are poisoned by some toxic substance, such that the cells are unable to utilize the oxygen (e.g., with drugs, cigarette smoke, carbon monoxide or alcohol).

FACTORS INFLUENCING DEVELOPMENT OF HYPOXIA

- *Altitude:* Tolerance decreases as altitude increases
- *Rate of ascent:* Tolerance decreases as rate increases
- *Time at altitude:* Tolerance decreases as time at altitude is prolonged
- *Individual tolerance:* Individual variation in tolerance may be due to individual metabolic rate, diet and other factors
- *Physical fitness:* Tolerance increases with physical fitness
- *Physical activity at altitude:* Tolerance decreases with exercise
- *Psychological factors:* Oxygen consumption is greater than normal in psychologically disturbed people
- *Environmental temperatures:* Tolerance decreases with extreme cold or heat
- *Medications, toxic substances, smoking:* Oxygen utilization is inhibited by some drugs and toxins (e.g., carbon monoxide); tolerance decreases with smoking

TIME OF USEFUL CONSCIOUSNESS

Time of useful consciousness (TUC) is the period of time from the interruption of oxygen supply to the time when useful function is lost (when the person may be awake and conscious but incapable of taking proper action).

Table 2-5: Time of Useful Consciousness (TUC) at Various Altitudes

Altitude (ft)	Altitude (m)	Approximate TUC* (minutes)
18 000	5 486	20–30
25 000	7 620	3–5
30 000	9 144	1.5 (90 seconds)
40 000	12 192	≤0.25 (15 seconds or less)

*Individual tolerance varies.

MANAGEMENT

- Identify people at risk before transport
- Supply oxygen and titrate it to maintain saturations as high as possible (unless contraindicated, for example, in COPD; see below)
- Use pulse oximeter (if available) to monitor oxygen saturation
- Bring adequate amounts of oxygen *(see Appendix 3-1, "Administration of Oxygen in Flight," in chapter 3, "General Nursing Care Considerations in Aeromedical Evacuations")*
- Because the aircraft environment is very dry, humidify the oxygen, unless flight time is expected to be less than 1 hour
- Treat underlying causes of hypoxia (e.g., administer blood for severe anemia or acute and significant blood loss)
- Reduce cabin altitude to minimize the hypoxia associated with flight

Clients with COPD may have chronic hypercapnia, and their respiratory drive may be based on their hypoxic state. In such clients, excessive elevation of oxygen saturation through administration of oxygen *may* result in respiratory depression. Despite this possibility, it is much more dangerous to withhold oxygen. Supervised oxygen delivery is indicated. If pulse oximetry is available, oxygen should be delivered so as to maintain saturations between 90% and 93%. *(See Appendix 3-1, "Administration of Oxygen in Flight," in chapter 3, "General Nursing Care Considerations in Aeromedical Evacuations," for details of oxygen delivery)*

OXYGEN PARADOX

When oxygen is supplied to a person who is hypoxic, the symptoms may initially appear to worsen. This condition is referred to as the oxygen paradox and will disappear after about 15 seconds. The oxygen supply should *not* be stopped.

The explanation for this phenomenon is not well understood. It is believed that oxygen delivery results in depression of the hypoxic drive. The brief interruption in breathing that results when the hypoxic drive is suppressed causes a short period of cerebral hypoxia and clinical deterioration. The situation resolves as the client's ventilatory drive is depressed and the partial pressure of carbon dioxide (PCO_2) rises, stimulating respirations.

ALTITUDE AND EXPANSION OF TRAPPED GASES

With increasing altitude, gases within body cavities expand (according to Boyle's law; see above and Table 2-6). Such expansion does not result in any difficulty if the concomitant pressure can be relieved. However, if the gases are "trapped" in an organ with inelastic walls and the gases continue to expand within the walls of the organ, some degree of pain and other clinical symptoms and signs may be experienced.

Table 2-6: Volume Expansion of Gases

Altitude (ft)	Altitude (m)	Relative Gas Volume
0	0	1.0
5 000	1500	1.2
10 000	3000	1.5
15 000	4500	1.9
18 000	5400	2.0
20 000	6000	2.4

HEAD AND NECK (FACE, EYES, EARS, NOSE AND THROAT)

Aviation factors affecting disorders of the HEENT:

- Reduced partial pressure of oxygen (hypoxemia)
- Reduced atmospheric pressure (gas expansion)
- Decreased presence of water vapor (dehydration)
- Gravitational forces
- Motion sickness
- Vibration

EYE

The following eye injuries may necessitate air medevac:

- penetrating trauma
- chemical or thermal injury
- problems such as acute glaucoma

After penetrating trauma or recent surgery, gas may be trapped in the eyes. Flight at even low cabin altitudes may cause sutures to rupture. Gas can expand, exerting pressure on the blood vessels and the optic nerve. Intraocular contents may be lost.

Hypoxia caused by increasing altitude (ascent) complicates the picture. The retina requires more oxygen per cell than any other tissue. Hypoxia may result in retinal vasodilatation (which may cause rebleeding), increased intraocular pressure and aggravation of pre-existing eye diseases.

MIDDLE EAR: BAROTITIS MEDIA

Barotitis media is inflammation of the middle ear resulting from an increase or decrease in pressure in the middle ear (according to Boyle's law; see above). It occurs when the pressure differential between the middle ear and the external atmosphere exceeds 100–150 mm Hg. Barotitis media occurs more commonly at lower altitudes, where changes in barometric pressure are greatest. Severity is greater at low temperatures. If the pressure on the tympanic membrane is not relieved, it may cause tissue damage, rupture of the ear drum or seepage of serous fluid into the middle ear cavity.

Risk Factors

- Intercurrent upper respiratory tract infection
- Otitis media
- Soft-tissue injury secondary to head or facial trauma

Additional Stresses

- During sleep, the swallowing reflex is diminished and the middle ear is not ventilated as often as when the client is awake
- Breathing 100% oxygen on long flights can cause ear discomfort and distress several hours after descent

Signs and Symptoms

- Feeling of fullness in the ear
- Hearing dull
- Pain and tenderness
- Rupture of tympanic membrane (during ascent, the eardrum is pushed outward, whereas during descent, the eardrum is actually drawn inward)
- Bleeding from the ear

Management: Considerations for Transport

- Before ascent and descent, instruct client about the importance of clearing the ears
- Teach maneuvers to equalize pressure:
  - Yawning
  - Swallowing
  - Extension of lower jaw
  - Valsalva maneuver: close the mouth, pinch the nostrils and blow sharply; several short blows are more effective than one continuous effort
- Have infants feed from a bottle (watch for gastric distension and gas)
- Administer decongestants, including topical vasoconstrictors (e.g., xylometazoline)
- Request pilot to ascend and descend slowly and gradually
- May be necessary to restrict cabin altitude for high-risk clients (e.g., children and anyone with upper respiratory tract infection [URTI])
- Awaken sleeping passengers and clients before descent so they can consciously clear their ears

SINUSES: BAROSINUSITIS

Barosinusitis is an inflammation of the soft tissues in the sinuses due to positive and negative pressure changes that occur as a result of changes in barometric pressure (according to Boyle's law; see above).

Signs and Symptoms

- Dull to sharp pain below one or both eyes or, occasionally, in the cheek bones
- Lacrimation
- Nosebleed

Management: Considerations for Transport

- Administer decongestants or topical vasoconstrictors (e.g., xylometazoline)
- On descent, recommend Valsalva maneuver, but do not allow the client to perform this maneuver during ascent, as it will worsen the situation
- Advise vigorous nose blowing
- Use topical or systemic vasoconstrictors and analgesics in accordance with the severity of the condition
- If possible, avoid transporting the client by air if he or she has a concurrent URTI
- Restriction of cabin altitude or a more gradual descent (or both) will help

TEETH: DENTAL PAIN (BARODONTALGIA)

Teeth with cavities or recent fillings may be sensitive to gas expansion during ascent (according to Boyle's law; see above). Toothache and pain (barodontalgia) may result. Usually the pain is in a single tooth.

Management: Considerations for Transport

- Descend to a lower altitude
- Take preventive measures (dental care)
- Restrict flying for at least 24 hours after invasive dental work (e.g., root canal)

RESPIRATORY SYSTEM

Aviation factors affecting lower respiratory tract conditions (e.g., asthma, COPD, bronchiolitis):

- Reduced atmospheric pressure (gas expansion)
- Decreased presence of water vapor (dehydration)
- Gravitational forces
- Reduction in partial pressure of oxygen leading to hypoxia *(see "Hypoxia," above, this chapter)*

Overpressurization syndrome (relating to Boyle's law; see above) may develop when alveoli spontaneously rupture in association with gas expansion during ascent. This is most common in clients with air-trapping disease such as asthma, bronchiolitis or emphysema. Sudden decompression in the aircraft results in rapid expansion of gases, which could result in pneumothorax, pneumomediastinum or air embolus.

Pre-existing pneumothorax could become a tension pneumothorax if not treated with appropriate decompression (with a chest tube) before the flight. For a client who has had a chest tube, extreme caution should be taken if the client must be transported by air within 7 days after the tube is removed.

CARDIOVASCULAR SYSTEM

Aviation factors affecting cardiovascular conditions:

- Reduced partial pressure of oxygen (hypoxemia)
- Reduced atmospheric pressure (gas expansion)
- Decreased presence of water vapor (dehydration)
- Gravitational forces

Cardiorespiratory stresses associated with flight, such as hypoxia, fatigue and increased catecholamine levels, can be hazardous for anyone with cardiovascular disease.

A client with unstable angina or MI is at risk of more ischemia if not managed appropriately in flight. The potential for arrhythmias must be recognized.

Expansion of gases in the abdominal or chest cavity may impair venous return to the heart, reducing cardiac output and compromising tissue perfusion

GASTROINTESTINAL SYSTEM

Aviation factors affecting GI conditions:

- Reduced atmospheric pressure (gas expansion)
- Reduced water vapor (dehydration)
- Gravitational forces
- Turbulence

Gas pressure in the GI tract is normally equal to the surrounding atmospheric pressure. With increasing altitude (ascent), this gas expands (according to Boyle's law; see above), but pressure can usually be equalized by belching or passing flatus. However, gas expansion in a client with closed-loop intestinal obstruction may cause significant pain, nausea, vomiting, syncope and deterioration; in the worst case, a partial obstruction may be converted into a complete obstruction.

Perforation of a bowel wall may occur if the wall has already been weakened by ulceration, diverticulitis or surgical anastomosis. Gaseous distension of the stomach may limit diaphragmatic excursion, compromising respiratory function. Expansion of gas in an inflamed appendix could result in rupture.

Air sickness is a form of motion sickness resulting from many factors, including movement of the aircraft. It is usually not caused by any single factor. The loss of familiar orientation in flight and apprehension about safety may produce tension, which in turn results in nausea and vomiting. Reassuring clients and making them feel comfortable and at ease can do much to reduce the occurrence of air sickness. For more information about motion sickness, *see "Gastrointestinal System," in chapter 4, "Primary Care during Transport"*

Fatigue, overindulgence in alcoholic beverages or dietary indiscretion may also predispose a person to air sickness. There will be less danger from these sources if the client has been properly prepared for the flight.

MUSCULOSKELETAL SYSTEM

Aviation factors affecting musculoskeletal conditions:

- Reduced partial pressure of oxygen (hypoxemia)
- Reduced atmospheric pressure (gas expansion and tissue swelling)
- Gravitational forces

Reduced atmospheric pressure during flight causes injured tissue to swell. This can result in neurovascular compromise, particularly if there are casts or restrictive splints on the extremity. Traction splints must not be based on free-hanging weight systems but should be replaced with transport-compatible traction splints

NEUROLOGICAL SYSTEM (CNS)

Aviation factors affecting neurological disorders:

- Reduced partial pressure of oxygen (hypoxemia)
- Reduced atmospheric pressure (gas expansion and tissue swelling)
- Gravitational forces
- Motion sickness
- Lack of humidity (especially dehydration of the cornea in an unconscious person)
- Increased risk of seizure activity (see below) caused by "flicker vertigo" from strobe lights on aircraft

A decrease in atmospheric pressure increases intracranial pressure, reducing blood flow. The resulting tissue hypoxia compounds the problem, leading to further edema.

Seizure activity may occur as a result of anxiety, hypoxia or hyperventilation. The risk of seizures may be enhanced in any client with head injury or a history of seizures.

Certain skull fractures, particularly basal fractures involving the sinuses, have the potential to introduce air into the brain, a condition called pneumoencephalopathy. Gas trapped in the brain is very dangerous for two reasons:

- Brain tissue is highly sensitive to damage because of its soft, pliable consistency
- The rigidity of the skull means that the brain cannot adapt to the volume expansion

THE SKIN (INTEGUMENTARY SYSTEM)

Aviation factors affecting conditions of the skin:

- Reduced partial pressure of oxygen (hypoxemia)
- Reduced atmospheric pressure (gas expansion)
- Decreased presence of water vapor (dehydration)

SKIN WOUNDS (LACERATIONS, SURGICAL INCISIONS)

Air may be trapped in certain wounds, so there may be increased tension on suture lines or compression of local circulation as the gas expands with ascent.

Bleeding may increase during flight. Therefore, control bleeding before transport.

BURNS

The condition of clients with inhalation burns may worsen during flight because of increased swelling of the airways, resulting in hypoxia. Inhalational injury may also result in carbon monoxide poisoning and poisoning by other types of inhaled substances. Such poisoning may result in both hypemic and histotoxic hypoxia. Oxygen saturations may not be accurate in the presence of carbon monoxide poisoning!

Clients with major burns are at risk of hypothermia, as the skin represents a very important means of thermoregulation. Maintenance of a warm cabin temperature is important.

Generalized swelling may be enhanced. Circumferential burns may cause neurovascular compromise and impair respiratory excursion.

BAROBARIATRAUMA IN OBESE CLIENTS

Adipose tissue has greater nitrogen content than other tissue. This nitrogen can be released at high altitudes (according to Henry's law and Boyle's law; see above). The fragility of the cell membrane in fat increases the risk of fat and nitrogen emboli.

Obese clients may be at greater risk during long, high-altitude flights and may experience dyspnea, chest pain, petechiae on the upper body, pallor, tachycardia or tachypnea, or any combination of these.

CHAPTER 3 — GENERAL NURSING CARE CONSIDERATIONS IN AEROMEDICAL EVACUATIONS

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ENVIRONMENTAL FLIGHT STRESSORS

NOISE AND VIBRATION

The high noise level and vibrations experienced in most aircraft may lead to auditory and general physical fatigue on the part of the caregiver, reduced ability to concentrate, problems in communicating with the client and the crew, and difficulties in monitoring the client.

Auditory fatigue consists of a reversible shift in the threshold of hearing caused by prolonged exposure to high noise levels. Use of headsets (if available) will prevent this problem.

TEMPERATURE AND RELATED FACTORS

Unstable temperature, lack of humidity (which may result in dehydration), and drafts or ventilation problems are three interrelated, potentially troublesome factors in air transport. The degree to which they occur depends upon the aircraft.

Thermal stress can cause a variety of physiologic responses, including changes in oxygen demands, changes in the size of blood vessels and excessive perspiration. Thermal stress can lead to fatigue and motion sickness. The main problem with temperature occurs during transfer of the client from the community facility (e.g., the nursing station) to the aircraft in winter. An open truck may be the only vehicle available. If the client is able and his or her condition is stable enough, seat the client in the cab of a heated truck for transport to the airstrip; ensure that the stretcher is brought along. Be organized so as to ensure that the client is not exposed to the outside environment for any longer than necessary. The pilot should be requested to adjust temperature and ventilation in the aircraft according to the needs of the client.

LIGHTING AND SPACE

In general, the lighting and space available on most aircrafts are less than optimal for assessing the client and performing procedures. Therefore, all medevac bags should contain at least one flashlight with extra batteries. Small pen flashlights are often useful as well.

Because of space limitations, familiarize yourself with the interior of the aircraft to be used before the client is loaded. The medical escort should supervise the placement of the client and equipment. Oxygen and emergency equipment should be within easy reach. In most circumstances the client will be positioned with his or her head toward the nose of the aircraft. *See chapter 4, "Primary Care during Transport," for details about positioning the client for specific clinical conditions.* The client and equipment should be safely secured by the air crew and checked by the medical escort.

EQUIPMENT IN THE AEROMEDICAL ENVIRONMENT

Many pieces of equipment that run on electricity may interfere with the aircraft's avionics. Therefore, use only equipment that has been tested for safety in the aviation environment.

INTRAVENOUS THERAPY

IV lines can be affected by reduced atmospheric pressure (which results in gas expansion) and turbulence. Possible effects include variable flow rate and dislodgement. In addition, flow rates may be affected by the lower gravity at high altitudes, as the IV reservoir may be only 0.6 m (2 ft) or less above the infusion cannula.

The IV tubing may become constricted because of confined spaces or problems in positioning the client's hand or arm.

If an IV line is required for administration of medications or maintenance of body fluids, it should be inserted before the flight begins. At least two sites should be available for all seriously ill clients. It is preferable to insert the largest-bore IV cannula possible (18 gauge or larger for adults).

MANAGEMENT OF IV LINES

- Carefully secure all IV lines, particularly during loading and unloading procedures.
- Position the IV fluid as high as possible above the IV insertion site.
- Use infusion pumps (if available) to control IV rates, especially in children and for the administration of medications by continuous infusion in any client.
- Closely monitor IV infusions during flight, particularly during ascent and descent.
- If the transfer from the community facility to the aircraft is expected to be lengthy or difficult, a saline lock cannula may be inserted, with full IV hookup on board the plane.
- To keep IV solutions from freezing, place containers in a sleeping bag during transit, if possible.
- If low flow rate in the IV line creates a problem, flow may be increased by applying pressure to the IV bag. This should be done with an IV pressure infusor whenever possible. Care is needed when the reservoir is almost depleted, as applying pressure on the IV bag at this stage may result in air embolus. A blood pressure cuff should not be used to apply pressure, as the cuff obscures the fluid level in the bag, and changes in altitude will cause changes in the pressure exerted by the cuff. If IV flow rates must be increased, it is safest to do so by intermittently squeezing the bag to deliver boluses of fluid when required.

SUCTIONING

For oral, nasal or pharyngeal suctioning, higher-pressure suctioning is required for prompt removal of viscous secretions, vomitus and blood. Conversely, lower-pressure suctioning will minimize mucosal trauma.

Provide continuous reassurance during any suctioning procedure.

Suction should be continued for no more than 5–10 seconds at a time.

SUCTIONING EQUIPMENT

- In most dedicated aircraft used for medevac, suctioning units are permanently installed.
- A manual or foot-operated suction pump (e.g., Ambu Suction Pump) may offer a backup. Although cumbersome, this equipment may be used until electrical suction can be instituted or can be used as emergency backup for the latter.

SUCTION CATHETER

- Have available a tonsil-tip suction device
- Have available suction catheters in a variety of sizes, to accommodate clients of all ages
- Be aware that in cold temperatures, fluid in small-bore tubing may freeze and the tubing may become plugged up

NASOGASTRIC TUBES

It is best to leave the nasogastric tube to straight drainage. It may be left open to ambient cabin pressure, with intermittent suction applied manually by a catheter-tipped syringe.

ORTHOPEDIC DEVICES

Orthopedic air splints are not to be used because of the hazards associated with expansion of gas during ascent.

Back slab casts or wood splints are safer for initial immobilization, as either can accommodate tissue swelling and gas expansion. Full casts that have been in place for less than 72 hours should be split on two sides (bi-valving) before flight.

ENDOTRACHEAL AND TRACHEOSTOMY TUBES

Cuffs on tubes such as endotracheal and tracheostomy tubes are usually filled with air. During flight this air can expand, putting pressure on the trachea and causing ischemia. Therefore, before the flight, replace the air with sterile water.

COLOSTOMY BAGS

The expansion of gas within the bowel stimulates colonic motility, which results in large amounts of gaseous discharge and distension of the bag during flight.

MANAGEMENT

- If gaseous distension occurs, relieve it by inserting a catheter through the colostomy opening
- If the bag has a tight seal, open the end of the bag, expel the gas and re-close bag.
- Have an extra supply of colostomy bags on hand
- During the flight, moderately restrict the client’s intake of fluids

FOLEY CATHETERS

During flight, air in the catheter can expand, putting pressure on the urethra. Therefore, the balloon should be filled with sterile water, not air.

OXYGEN THERAPY

It is frequently difficult to clinically assess for signs of hypoxia during flight because of noise, poor lighting and other factors. Therefore, pre-flight assessment for the presence or risk of hypoxia, liberal use of oxygen and monitoring of oxygen saturation by pulse oximetry (if available) in flight are very important.

Pulse oximetry readings are not accurate in clients with poor perfusion or carbon monoxide poisoning.

There are several key points about oxygen delivery in the aeromedical environment:

- As altitude increases, oxygen requirements increase
- As altitude decreases, oxygen requirements decrease
- Clients requiring oxygen on the ground may require a higher flow rate or a different delivery system to meet their oxygen needs during flight
- Estimated oxygen consumption must be calculated before the flight to ensure that an adequate supply of oxygen is available

See Appendix 3-1, “Administration of Oxygen in Flight,” below, for further details on use of oxygen in the aeromedical environment.

OXYGEN DELIVERY SYSTEMS

See Table 3-1 to determine the oxygen percentage delivered at various flow rates with different types of equipment.

NASAL CANNULA

- Preferable to nasal catheter
- Delivers low concentration of inspired oxygen (24% at 1 L/min) while allowing the client to eat, speak and drink
- Oxygen is partly humidified and warmed by the nasal passages
- Humidify oxygen if transport is expected to exceed 1 hour

VENTURI MASK

- Delivers a concentration percentage ranging from 24% to 60%
- Does not guarantee delivery of a specified percentage of oxygen; rather guarantees that the specified oxygen concentration is not exceeded
- May be modified to deliver inhaled medications (e.g., salbutamol)
- Air entrainment parts must be kept clear and open

NON-REBREATHER MASK WITH RESERVOIR BAG

- For any client requiring a high concentration of oxygen (e.g., asthma or multiple trauma)
- At 10–12 L/min, oxygen concentration of 95% may be obtained, assuming that mask fit is adequate
- Flow rate must be high enough to prevent complete collapse of the reservoir bag with each breath
- Oxygen should be flowing into the mask and the bag should be full before it is put on the client

POSITIVE PRESSURE OXYGENATION

Positive pressure ventilation may be delivered by any of the following means:

- Mouth-to-mouth resuscitation
- Mouth-to-mask resuscitation
- Bag-valve mask device (e.g., Ambu bag)

Table 3-1: Determining Oxygen Percentage from Flow Rate (L/min)*

Nasal Cannula (Low Flow†)		Simple Mask (Low Flow†)		Venturi Mask (Low Flow†)		Partial Non-rebreather Mask (High Flow‡)	
L/min	**% O_2**	**L/min**	**% O_2**	**L/min**	**% O_2**	**L/min**	**% O_2**
1	24	5–6	40	4	24	6	60
2	28	6–7	50	4	28	7	70
3	32	7–8	60	8	35	8	80
4	36			8	40	9	90
5	40			12	50	10–12	≥95
6	44			12	60		

*Assumes respiratory rate of 16–20 breaths/min.
†Low-flow systems: % oxygen delivered is variable and unpredictable.
‡High-flow systems: % oxygen delivered is consistent and predictable, *assuming that the mask fits*.

APPENDIX 3-1: ADMINISTRATION OF OXYGEN IN FLIGHT

OXYGEN SUPPLY

Oxygen for transport is usually supplied as gaseous compressed oxygen (GOX).

The most common type of container for gaseous compressed oxygen is a cylinder. The cylinders are usually made of steel and come in different sizes (size E is the most common). Many dedicated medevac aircraft use aluminum tanks because of the significant weight advantage. In most medevac aircraft, large tanks of oxygen (often 2-M size) are installed in the cabin, providing a reliable source of oxygen. Portable tanks may be taken on charter flights and on medevac by surface transport.

Check all oxygen cylinders before the transport to ensure that they are completely filled, since tanks may leak or they may inadvertently be returned empty from a previous medevac. In addition, carefully estimate the number of tanks required for the trip, based on the flow rate required and the air time to destination or an alternate destination.

OXYGEN REQUIREMENTS AT SPECIFIC ALTITUDES

The following equation is used to determine the fraction of inspired oxygen (FiO_2) requirement when flying to a different altitude.

$$\frac{Fio_2 \times AP_1}{AP_2} = Fio_2(a)$$

where

FiO_2 = fraction of inspired oxygen that client is currently receiving

AP_1 = current barometric or atmospheric pressure (in mm Hg)

AP_2 = destination barometric or atmospheric pressure (in mm Hg)

$FiO_2(a)$ = fraction of inspired oxygen that client will need at destination altitude

EXAMPLE

Client is receiving 30% oxygen, current altitude is 2000 ft (where pressure is 706 mm Hg), and flight altitude is expected to be 6000 ft (where pressure is 609 mm Hg).

$$\frac{0.30 \times 706}{609} = 0.35$$

Therefore, the client will need oxygen delivered at 35% throughout the transport at 6000 ft *if his or her condition remains unchanged.*

To determine barometric pressures at various altitudes, *see Table 2-2, "Barometric Pressure at Various Altitudes," in chapter 2, "Aeromedical Evacuation"*

DURATION OF OXYGEN SUPPLY

To calculate the length of time that an oxygen tank will last, you must be familiar with the capacity of the various sizes of tanks, the "tank factors" and the equation that follows.

Tanks come in a variety of sizes, each with its own multiplying factor used in calculating capacity:

Tank Size	Tank Capacity (L)	Tank Factor
D	300	0.16
E	600	0.28
M	3450	1.37

The following equation is used to calculate duration of oxygen supply:

$$\frac{\text{pressure in tank} - 200\ (\text{residual}) \times \text{tank factor}}{\text{flow rate}} = \text{duration of supply}$$

where tank pressure is in pounds per square inch, flow rate is in liters per minute, and duration of supply is in minutes.

EXAMPLE

For an E cylinder with a pressure of 1500 psi and a flow rate of 3 L/min:

$$\frac{1500\ \text{psi} - 200 \times 0.28}{3\ \text{L/min}} = 121\ \text{min}$$

See below for duration of oxygen supply of different tank sizes at various rates.

Estimated Duration of Oxygen Supply

		Flow Rate; Duration of Supply				
Cylinder Size	**Usable Volume (L)**	**2 L/min**	**4 L/min**	**6 L/min**	**8 L/min**	**10 L/min**
D	300	2 h, 30 min	1 h, 15 min	50 min	35 min	30 min
E	600	5 h	2 h, 3 min	1 h, 40 min	1 h, 10 min	1 h
M	3450	28 h, 45 min	14 h, 23 min	9 h, 34 min	7 h, 11 min	5 h, 45 min

In determining how much oxygen will be needed, add 2 hours to estimated flight time, to ensure adequate oxygen supply in case of delay.

OXYGEN REGULATORS

Oxygen regulators are calibrated for accuracy at sea level. At altitude, oxygen will flow faster than the setting on the flow meter.

Effect of Altitude on Flow Rates

Reading on Ohio Flow Meter (L/min)	Actual Flow Rates at Altitude (L/min)	
	2000 ft	**8000 ft**
2	2.1	2.6
4	4.2	5.3
6	6.3	7.9
8	8.4	10.6
10	10.5	13.2
12	12.6	15.8

CHAPTER 4 — PRIMARY CARE DURING TRANSPORT

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INTRODUCTION

The following guidelines are limited to information pertinent to the assessment, monitoring and care, during transport, of clients with a specific (suspected or confirmed) medical or surgical condition.

If possible, the nurse should review the care of a particular client with a consulting physician before transport.

For details concerning the clinical presentation, assessment and pre-transport management of clients with such specific medical or surgical conditions, see *Clinical Practice Guidelines for Nurses in Primary Care* and *Pediatric Clinical Practice Guidelines for Nurses in Primary Care* (First Nations and Inuit Health Branch 2000, 2001).

GENERAL GUIDELINES FOR ALL URGENT OR EMERGENCY MEDEVACS

For all seriously ill or injured clients, the following principles apply:

– Stabilize ABCs before transport begins
– Administer high-flow oxygen through a non-rebreather mask with reservoir bag
– Establish two secure large-bore IV lines
– For air medevacs, use of pressurized aircraft is recommended
– If air medevac must be by unpressurized aircraft, discuss with the pilot, before the flight begins, the optimal cabin altitude *(see Appendix 4-1, "Suggested Cabin Altitude Restrictions," below, this chapter)*
– Collect the basic supplies that should be carried on all trips; in addition, bring supplies according to the client's specific needs *(see "Basic Interfacility Transport Equipment," in chapter 6, "Equipment and Supplies)*

HEAD AND NECK (FACE, EYES, EARS, NOSE AND THROAT)

MAXILLOFACIAL INJURY

EFFECTS OF AIR TRANSPORT

Facial trauma may result in airway compromise. Tissue swelling may increase with flight, further compromising the airway. Remember, mid-face fractures may be associated with pneumo-encephalopathy, so careful transport is required.

In addition, facial injuries are often associated with cervical spine injury, so C-spine precautions must be taken.

For clients whose jaws are wired, ensure availability of a means of quick release in the event of air sickness (e.g., wire cutters).

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

– Airway should be secured before transport
– If the airway is not secured, insert an oropharyngeal airway, but be careful not to cause vomiting
– If the client is conscious, do not insert airway
– Give oxygen (humidified if possible), and keep oxygen saturations ≥95%
– Elevate head to 30 degrees (immobilize using C-spine precautions)
– If possible, position client on side, to protect the airway
– Ensure that suction equipment is readily available
– An antiemetic (e.g., dimenhydrinate) may be used
– Monitor ABCs and neurological status frequently during transport, as these type of injuries may be associated with intracranial damage
– Because of the nature of the injury, constant care and reassurance will be required to allay the client's anxiety and prevent panic
– Proper mouth hygiene will contribute to reassurance
– Position client with head toward the nose of the aircraft
– If possible, use pressurized aircraft
– Restrict aircraft cabin altitude to 1000 ft above ground level (AGL)

EYE DISORDERS AND EYE TRAUMA

EFFECTS OF AIR TRANSPORT

- Retinal hypoxia
- Gas expansion in globe causes vascular or optic nerve compression and possible extrusion of the intraocular contents
- Corneal drying
- Tension on optic nerve
- Vomiting increases intraocular pressure

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- If possible, consult an ophthalmologist for cases of eye trauma before flight
- Give humidified oxygen, and keep oxygen saturations ≥95%
- For eye injuries, keep the eye covered with a sterile patch or an eye shield; apply dressings firmly enough over closed lid to prevent the eye from opening but lightly enough to avoid pressure on the globe
- Protect extruded eyes with moist dressings, with a cup or cone covering
- If an open eye injury is present, do not use eye drops or ointments
- Transport by stretcher; elevate head 30–45 degrees
- Do not let client bend over or perform tasks that might increase intraocular pressure
- An antiemetic (e.g., dimenhydrinate) may be used
- Give analgesia as needed (discuss with a physician beforehand, if possible); note that morphine can cause pupillary constriction
- Reduce anxiety by offering reassurance and orienting the client to the aircraft
- Monitor client closely for new or evolving symptoms and signs
- Consider sedation as indicated
- Position client with head toward the nose of the aircraft
- If possible, use pressurized aircraft
- Restrict aircraft cabin altitude to 2000 ft AGL

UPPER RESPIRATORY TRACT INFECTION OR CONGESTION

EFFECTS OF AIR TRANSPORT

Gas expansion causes pressure changes, which result in increased congestion and pain in the tissues of the upper respiratory tract.

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Request a slow, gradual descent
- Restrict cabin altitude in unpressurized aircraft
- Awaken sleeping clients
- Encourage maneuvers to equalize pressure in the middle ear and sinuses with that of the atmosphere
- Decongestants (oral or nasal) may be of benefit

EPIGLOTTITIS

EFFECTS OF AIR TRANSPORT

- Swelling of epiglottis increases

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Secure airway before transport
- Intubation may be needed; this procedure is not within the CHN's scope of practice and must be performed by authorized emergency transport personnel (e.g., physician, emergency flight nurse or paramedic)
- If the client is not intubated, provide oral airway and ventilatory assistance with bag-valve mask (BVM) device as required
- Give humidified oxygen, and keep oxygen saturations ≥95% (monitor with pulse oximetry, if available)
- Start IV therapy with normal saline (unless insertion of an IV line would worsen anxiety and airway compromise)
- Monitor ABCs and vital signs closely
- Give nothing by mouth (NPO) if unable to swallow saliva
- Position client with head elevated and toward the nose of the aircraft
- Restrict aircraft cabin altitude to 3000 ft AGL

RESPIRATORY SYSTEM

RESPIRATORY INSUFFICIENCY OR HYPOXIA

EFFECTS OF AIR TRANSPORT

- Increased hypoxia
- Gas expansion may result in spontaneous pneumothorax (especially in high-risk clients and those with history of pneumothorax)
- Dehydration
- Vomiting, with potential for aspiration

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Protect airway by inserting an oropharyngeal airway if necessary
- Assist ventilation as required with bag-valve mask (BVM) device
- Give humidified oxygen, and keep oxygen saturations ≥95% (monitor frequently with pulse oximetry, if available)
- Start IV therapy with normal saline to maintain hydration
- Monitor ABCs and vital signs frequently
- Monitor for evidence of pneumothorax
- An antiemetic (e.g., dimenhydrinate) may be used
- Have appropriate equipment and supplies available (e.g., oral airways, BVM device, IV supplies, suction, 14- to 18-gauge needles or angiocatheters to perform needle decompression in the event of tension pneumothorax; *see "Pneumothorax," below)*
- Reassure and support client to reduce apprehension
- Position client with head elevated and toward the nose of the aircraft
- Restrict aircraft cabin altitude to 2000 ft AGL

PNEUMOTHORAX

A client with pneumothorax, especially if induced by trauma, is at significant risk during air transport. All cases of pneumothorax must be treated before air transport. Treatment may include inserting a chest tube. Consultation with a physician is essential.

Clients and escorts with a history of spontaneous pneumothorax require special consideration. Consultation with a physician is recommended.

EFFECTS OF AIR TRANSPORT

- Increased hypoxia
- Expansion of gas in the pleural space, which may cause an increase in the size of the pneumothorax and may result in tension pneumothorax

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Protect airway by inserting an oropharyngeal airway if necessary
- Assist ventilation as required with bag-valve mask (BVM) device
- Give high-flow oxygen, and keep oxygen saturations ≥95% (monitor frequently with pulse oximetry, if available)
- Start IV therapy with normal saline
- Insertion of a chest tube may be required before transport; this procedure is not within the CHN's scope of practice and must be performed by authorized emergency transport personnel (physician, emergency flight nurse or paramedic)
- Monitor ABCs and vital signs frequently
- Observe for development of tension pneumothorax; be prepared to carry out needle decompression if tension pneumothorax occurs
- Have appropriate equipment and supplies available (e.g., oral airways, BVM device, IV supplies, suction, needle decompression kit)
- Needle decompression kit:
  - variety of IV cannulas (#14, 2 inch for adults; #16, 1.5–2 inch for adolescents and older children; #18, 1.5 inch for children; #20 1.5 inch for infants)
  - skin disinfectant
  - gloves
  - tape
  - stopcock
  - small-bore latex tubing (3–5 inches [7.5–12.5 cm])
  - one-way flutter valve
  - dressing material
- Position client with head elevated and toward the nose of the aircraft
- Restrict aircraft cabin altitude to 2000 ft AGL

CHRONIC OBSTRUCTIVE LUNG DISEASE (COPD)

EFFECTS OF AIR TRANSPORT

- Increased hypoxia
- Possibly spontaneous pneumothorax

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Protect airway by inserting an oropharyngeal airway if necessary
- Assist ventilation as required with bag-valve mask (BVM) device
- Careful oxygen supplementation to keep oxygen saturations at 90% to 93% (monitor frequently with pulse oximeter, if available)
- Start IV therapy with normal saline to maintain hydration
- Monitor ABCs and vital signs frequently
- Monitor for spontaneous pneumothorax and be prepared to treat as needed *(see "Pneumothorax," above, this chapter)*
- Reassure and support client to reduce apprehension
- Position client with head elevated and toward the nose of the aircraft
- Restrict aircraft cabin altitude to 2000–4000 ft AGL

CARDIOVASCULAR SYSTEM

GENERAL

EFFECTS OF AIR TRANSPORT

Clients with cardiovascular problems are affected by altitude and acceleration forces. The effects of increasing altitude include hypoxia (which may aggravate existing ischemia and cardiac failure), increase in heart rate, increase in respiratory rate, changes in systolic blood pressure, changes in cardiac output and increase in myocardial consumption of oxygen. Gravitational forces may cause hypotension and tachycardia.

Each client with a cardiovascular disorder should be assessed individually with respect to age, general state of health, extent of myocardial compromise and presence of complications.

For clients with myocardial infarction (MI), it is preferable if personnel with advanced cardiac skills, using a portable cardiac monitor, evacuate the client, if time and aircraft permit, especially if the infarction is complicated. In clients suffering from acute MI, thrombolytic therapy should be considered before transport, unless contraindicated, but only if ordered by a physician.

ANGINA, MYOCARDIAL INFARCTION AND CONGESTIVE HEART FAILURE

EFFECTS OF AIR TRANSPORT

- Hypoxia may aggravate existing ischemia and cardiac failure
- Gravitational forces may cause hypotension and tachycardia

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs before transport, as follows (the sequence is important):
  - If client is in cardiogenic shock, secure the airway, and ventilate to reduce work of breathing
  - Give high-flow oxygen, and keep oxygen saturations ≥95% (monitor frequently with pulse oximeter, if available)
  - Start IV therapy with normal saline to keep vein open
  - Be prepared to treat hypotension as required; in these conditions, hypotension is related to poor cardiac contractility, consult a physician regarding appropriate treatment (e.g., medication)
- Treat and stabilize ischemia, MI or CHF appropriately before transport, with the intention of preventing complications
- Limit oral intake
- Insert a Foley catheter if the client is seriously ill or has received a diuretic (e.g., furosemide)
- Institute cardiac monitoring (if available); watch for signs of cardiac arrhythmias
- Monitor ABCs, vital signs, intake and output
- Monitor for signs of complications, such as arrhythmias, pulmonary edema or hypotension (shock), and treat accordingly; consult a physician as necessary for advice and medication orders
- Sedate to minimize risk of arrhythmia and for apprehension as required (discuss with a physician, if possible)
- Be prepared with medications to treat increasing chest pain or acute pulmonary edema (e.g., nitroglycerin, morphine, furosemide)

- Be prepared to perform CPR in the event of cardiac arrest
- Have appropriate equipment and supplies available (e.g., cardiac arrest board, airways, BVM device, IV supplies, suction, air sickness supplies)
- Position client on stretcher with head elevated 30–45 degrees and toward the nose of the aircraft (except for clients with known right ventricular infarct)
- Restrict aircraft cabin altitude as follows:

2000 ft AGL	4000 ft AGL	6000 ft AGL
Moderate to severe CHF	Mild CHF	MI 8–24 weeks previous
Acute MI (within 8 weeks)		Stable angina
Cyanosis with right ventricular failure		
Unstable angina		

Note: AGL = above ground level. 1000 ft = 304.8 m.

HYPOTENSION

EFFECTS OF AIR TRANSPORT

- Redistribution of blood flow
- Increased hypoxia

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize blood pressure as much as possible (with fluid) before transport
- See "Shock," in chapter 14, "General Emergencies and Major Trauma," in the adult clinical guidelines (First Nations and Inuit Health Branch 2000)
- Give high-flow oxygen, and keep oxygen saturations ≥95% (monitor frequently with pulse oximeter, if available)
- Monitor ABCs, vital signs, intake and output closely
- Insert Foley catheter
- Have appropriate equipment and supplies available (e.g., cardiac arrest board, airways, BVM device, IV supplies, suction, air sickness supplies)
- Position client supine with head flat or in Trendelenberg position if necessary (but do not use this position if shock is cardiogenic in nature)
- Position client's head toward the tail of the aircraft if hypovolemia is present
- Restrict aircraft cabin altitude to 2000 ft AGL

ANEMIA

EFFECTS OF AIR TRANSPORT

- Hypoxia

Healthy adult males with normal hemoglobin levels will tolerate an altitude of approximately 6000 ft (1829 m) without symptoms or signs of hypoxia; however, oxygen saturation will be about 90% to 93%.

Various factors will influence an anemic individual's "safe" altitude, including acute or chronic onset of the condition, compensatory mechanisms in play, associated underlying lung or heart disease, oxygen-carrying capacity of the blood and presence of sickle cell anemia.

Anemic clients (hemoglobin < 90 g/L) have reduced oxygen-carrying capacity. The body compensates to some extent by increasing cardiac output and ventilation. These compensatory mechanisms are more efficient when the anemia is chronic rather than acute.

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Give humidified oxygen, and keep oxygen saturations ≥95% (monitor with pulse oximeter, if available)
- Start IV therapy with normal saline (run at maintenance rate)
- Monitor client's overall clinical condition closely: ABCs, vital signs, oxygen saturations
- Position client with head toward the nose of the aircraft
- Restrict aircraft cabin altitude to 3000 ft AGL (2000 feet AGL for clients with sickle cell anemia)

GASTROINTESTINAL SYSTEM

NAUSEA AND VOMITING (MOTION SICKNESS)

EFFECTS OF AIR TRANSPORT

– Gravitational forces
– Air turbulence

SYMPTOMS

– Apprehension
– Perspiration of forehead and hands
– Pallor
– Excessive salivation
– Feelings of heat and cold
– Dizziness
– Headache
– Nausea and vomiting

PREVENTION

– Have client sit upright in the aircraft, if it is safe to do so
– Keep cabin well ventilated and cool
– Instruct client to focus on distant objects (e.g., the horizon)
– Advise client to avoid unnecessary head motion and to move slowly

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

– Protect the airway at all times
– Ensure that suction is available
– Place client in upright position if it is safe to do so
– Advise client to keep head still and eyes closed
– Encourage client to gain sense of position (by looking out the window)
– Keep cabin temperature cool
– Give oxygen intermittently
– Have emesis cups or bags readily available
– An antiemetic (e.g., dimenhydrinate) may be used

BOWEL OBSTRUCTION OR PARALYTIC ILEUS

EFFECTS OF AIR TRANSPORT

– Gas expansion resulting in increased intra-abdominal distension, pain and vomiting

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

– Prepare to protect and support airway should vomiting occur (e.g., oropharyngeal airway, suction)
– Start IV therapy with normal saline; run at a rate adequate to maintain hydration, unless the client is being treated for shock
– Give nothing by mouth (NPO)
– Decompress stomach using a nasogastric tube to straight drainage or low suction; do not clamp
– Monitor client's clinical status closely: ABCs, vital signs, pulse oximetry (if available)
– Watch for increasing abdominal distension
– An antiemetic (e.g., dimenhydrinate) may be used
– Give analgesia as needed (discuss with a physician beforehand, if possible)
– Position client with head elevated and toward the nose of the aircraft
– Restrict aircraft cabin altitude to 2000–4000 ft AGL

ABDOMINAL INJURIES (BLUNT TRAUMA OR PENETRATING WOUND)

The most prominent signs and symptoms of blunt trauma injury to the abdominal organs tend to be those related to intra-abdominal bleeding, namely shock. In addition, when the contents of organs damaged by blunt trauma enter the abdominal cavity, signs and symptoms of peritoneal irritation occur (i.e., rebound tenderness, rigidity of the abdominal musculature, vomiting and abdominal distension).

A penetrating abdominal wound is one in which the abdominal wall and the peritoneum have been pierced or torn. Signs and symptoms of shock may also be present, but are usually not as marked as in severe hemorrhage from a solid intra-abdominal organ.

EFFECTS OF AIR TRANSPORT

- Hypoxia
- Gas expansion resulting in increased intra-abdominal distension, pain and vomiting

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Administer oxygen as required, especially if the client is in shock or there are associated chest wounds
- Start IV therapy with normal saline, preferably through two large-bore needles; run at maintenance rate unless the client is being treated for shock
- Do not attempt to replace intra-abdominal contents (e.g., bowel) into the abdominal cavity
- Cover wound with a sterile dressing and keep the dressing wet with normal saline
- Give nothing by mouth (NPO)
- Insert a nasogastric tube with low suction, as well as a rectal tube if required
- Insert a Foley catheter, and maintain careful record of intake and output
- Give IV antibiotics as ordered by physician; consider tetanus prophylaxis for a penetrating wound
- Give analgesia as needed (see note below about narcotic analgesia)
- Monitor client's clinical status closely: ABCs, vital signs, pulse oximetry (if available)
- Watch for increasing abdominal distension
- Monitor respiratory status (especially if there are associated chest wounds)
- Position client with head slightly elevated and toward the nose of the aircraft and with knees bent to prevent tension on the abdomen
- Restrict aircraft cabin altitude to 2000–4000 ft AGL

ACUTE SURGICAL ABDOMEN (INCLUDING APPENDICITIS)

EFFECTS OF AIR TRANSPORT

- Hypoxia
- Gas expansion resulting in increased intra-abdominal distension, pain and vomiting

Gas-forming bacteria in an inflamed appendix may result in distension of the appendix. The appendix may rupture if aircraft cabin altitude is not restricted.

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Administer oxygen as required, especially if the client is in shock
- Start IV therapy with normal saline, preferably through two large-bore needles; run at maintenance rate unless the client is being treated for shock
- Give nothing by mouth (NPO)
- Insert a nasogastric tube with low suction, as well as a rectal tube if required
- Insert a Foley catheter, and maintain careful record of intake and output
- Give IV antibiotics as ordered by physician
- Give analgesia as needed (see note below about narcotic analgesia)
- Position client supine with head slightly elevated and toward the nose of the aircraft and with knees bent to prevent tension on the abdomen and to keep any peritoneal contamination localized; avoid sudden movements and jolts
- Restrict aircraft cabin altitude to 2000–4000 ft AGL

USE OF NARCOTIC ANALGESIA

Narcotic analgesia may mask the physical signs of peritoneal irritation and may interfere with the client's evaluation at a treatment facility. There is some controversy about the use of pain control in the presence of acute abdomen. Some recent literature supports the use of narcotics, which may help to make the client more comfortable and capable of participating in the examination. The client's condition and comfort level, as well as the time lapse before transfer can be completed, are factors to consider in the decision to administer a narcotic.

If possible, consult with a physician before administering narcotics.

MUSCULOSKELETAL SYSTEM

FRACTURES

EFFECTS OF AIR TRANSPORT

- Increased pain
- Increased swelling

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- All fractures should be immobilized with splints (see illustrations in Appendix 4-2, “Splinting for Transport,” below, this chapter)
- Do not use air splints
- Elevate limb to minimize swelling
- Assess neurovascular function in the affected extremity frequently
- Position client with head toward the nose of the aircraft
- Restrict aircraft cabin altitude to 4000 ft AGL

NEUROLOGICAL SYSTEM (CNS)

Before transport, the originating facility must carefully document the sensory and motor functioning of any client with head, neck or spinal trauma.

HEAD TRAUMA

EFFECTS OF AIR TRANSPORT

- Increased hypoxia
- Gas expansion and swelling of brain, leading to increased intracranial pressure
- Vomiting and potential airway compromise
- Seizure activity through the mechanism of “flicker vertigo” (caused by photic stimuli such as sunlight, propeller movement or aircraft strobe lights)

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs:
  - Secure airway and hyperventilate as indicated
  - Immobilize C spine
  - Give oxygen, and keep oxygen saturations ≥95%
  - Ventilate if required
- Establish two large-bore IV lines with normal saline, to keep vein open, unless there are other injuries requiring volume replacement
- Keep head of bed (or spine board) elevated, and position the head in the midline to promote venous drainage
- Limit external stimuli: keep cabin quiet and lighting low, and protect the client’s hearing and vision (cover eyes, use head sets, close window blinds)
- Manage increased intracranial pressure as indicated (use medication as directed by physician)
- Monitor client’s clinical status closely: ABCs, vital signs, level of consciousness (using Glasgow Coma Scale)
- Monitor for seizure activity
- Give anticonvulsants (e.g., lorazepam) as necessary to control seizures
- If the client is unconscious, close the eyes or apply artificial tears to prevent corneal drying
- Position client with head toward the nose of the aircraft
- Use pressurized aircraft whenever possible
- Restrict aircraft cabin altitude to 2000 ft AGL (or to sea level if pneumoencephalopathy is a possibility)

CEREBROVASCULAR ACCIDENT (STROKE)

EFFECTS OF AIR TRANSPORT

- Increased hypoxia
- Gas expansion and swelling of brain, leading to increased intracranial pressure
- Vomiting and potential airway compromise
- Seizure activity through the mechanism of “flicker vertigo”(caused by photic stimuli such as sunlight, propeller movement or aircraft strobe lights)

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs
  - Secure airway
  - Give oxygen, and keep oxygen saturations ≥95%
  - Ventilate if required
- Start IV therapy with normal saline, and run at a maintenance rate
- Elevate head 30 degrees if the airway is intact
- Limit external stimuli: keep cabin quiet and lighting low, and protect the client’s hearing and vision (cover eyes, use head sets, close window blinds)
- Monitor client’s clinical status closely: ABCs, vital signs, level of consciousness (using Glasgow Coma Scale)
- Monitor for seizure activity
- Give anticonvulsants as required to control seizures
- An antiemetic (e.g., dimenhydrinate) may be used
- If the client is unconscious, close the eyes or apply artificial tears to prevent corneal drying
- Position client with head toward the nose of the aircraft
- Restrict aircraft cabin altitude to 2000 ft AGL

SEIZURE DISORDERS

EFFECTS OF AIR TRANSPORT

- Hypoxia
- Anxiety
- Seizure activity through the mechanism of “flicker vertigo”(caused by photic stimuli such as sunlight, propeller movement or aircraft strobe lights)

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- If possible, transport should be delayed until after seizures are controlled
- Stabilize ABCs
  - Secure airway
  - Give oxygen, and keep oxygen saturations ≥95%
  - Ventilate if required
- Start IV therapy with normal saline to keep vein open, unless there is another reason for volume resuscitation
- Ensure that suction is available
- Position client to avoid photic stimuli from sunlight, propeller movement or aircraft strobe lights
- Limit external stimuli: keep cabin quiet and lighting low, and protect the client’s hearing and vision (cover eyes, use head sets, close window blinds)
- Monitor client’s clinical status closely: ABCs, vital signs, level of consciousness (using Glasgow Coma Scale)
- Monitor for seizure activity
- Protect client from injury if acute seizure activity occurs
- Give anticonvulsants as required to control seizures
- Record details of seizures:
  - time of onset and duration
  - describe events in chronological order
  - note focal onset, aura, loss of consciousness, tonic–clonic movements, incontinence, post-seizure behavior (e.g., deep sleep) and other complaints (e.g., headache)
- Position client with head toward the nose of the aircraft
- Restrict aircraft cabin altitude to 4000–5000 ft unless a head injury or other condition is present that dictates a lower altitude

SPINAL CORD INJURY

EFFECTS OF AIR TRANSPORT

- Excessive movement
- Gravitational forces
- Swelling of neurological tissues

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs
- Secure airway
- Intubation should be carried out before transport if the airway is unstable or compromised; this procedure is not within the CHN's scope of practice and must be performed by authorized emergency transport personnel (e.g., physician, emergency flight nurse or paramedic)
- Ensure that the client is totally immobilized on a spine board before moving him or her
- Immobilization must be effected so as to prevent lateral movement and sliding downward on the spine board
- Give oxygen as required to keep oxygen saturations ≥95%
- Start IV therapy with normal saline to keep vein open, unless there is another reason for volume replacement (e.g., concomitant injuries)
- Insert Foley catheter
- Insert nasogastric tube (paralytic ileus is a common complication)
- Monitor ABCs, vital signs, level of consciousness (using Glasgow Coma Scale) and neurological status closely
- Give analgesia as needed (discuss with a physician beforehand, if possible)
- Narcotics must be used with care to prevent respiratory depression (have naloxone available)
- An antiemetic (e.g., dimenhydrinate) may be used
- Have all necessary equipment and supplies (e.g., suction, Ambu bag, airways, oxygen and IV supplies) ready for immediate use
- Reassure and support client as necessary
- Position the client supine with head toward the nose of the aircraft
- Restrict aircraft cabin altitude to 4000 ft AGL

THE SKIN (INTEGUMENTARY SYSTEM)

BURNS

EFFECTS OF AIR TRANSPORT

- Increased fluid loss
- Increased swelling
- Excessive heat loss
- Potential hypoxia (hypoxic, hypemic and histotoxic hypoxia are all associated with smoke inhalation)

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs
- Secure airway before transport, especially if there is potential for or evidence of inhalation burns
- Give humidified oxygen and ventilatory support, with airway or bag-valve mask (BVM) device, as needed
- Start IV therapy with normal saline for volume resuscitation and to maintain urine output
- Burn formula for volume resuscitation: 2–4 mL/kg for each percentage point of body surface area burned; give half the volume in the first 8 hours after burn injury and the remainder over the next 16 hours
- Cover burns with sterile or clean dry dressings for transport
- Maintain clean environment to reduce risk of infection
- For electrical burns, adhere to spinal immobilization principles (because of strong tetanic contractions caused by electrical current)
- For chemical burns, irrigate copiously before transport
- Monitor ABCs, vital signs, neurovascular status of limbs and chest movements

Remember that oxygen saturations may not be accurate in the presence of carbon monoxide toxicity!

- Maintain body heat using warmed IV fluids and a warm cabin environment
- Monitor temperature
- Position client with head elevated and toward the nose of the aircraft
- Restrict aircraft cabin altitude to 4000 ft AGL

PSYCHIATRY

ANXIETY PSYCHOSIS

EFFECTS OF AIR TRANSPORT

- Increased anxiety and fear
- Violent or combative behavior

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

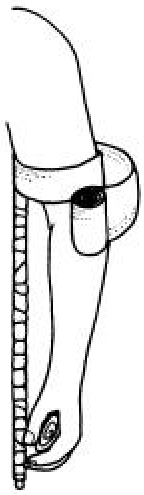
- Provide reassurance
- Administer chemical or physical restraints only if ordered by a physician
- Consider additional resources, such as a police escort

APPENDIX 4–1: SUGGESTED CABIN ALTITUDE RESTRICTIONS

Client's Condition	Maximum Cabin Altitude (feet AGL)*
Head, eyes, ears, nose and throat	
Maxillofacial injury	1000
Eye disorders or trauma	2000
Barotitis or otitis media	4000
Respiratory system	
Epiglottis or croup	3000
Respiratory insufficiency or hypoxemia	2000
Pneumothorax	2000
Chronic obstructive pulmonary disease	2000–4000
Asthma	2000–4000
Inhalation burns (client not intubated)	2000
Cardiovascular system	
Stable angina or MI 8–24 weeks ago	6000
Unstable angina, acute MI	2000
Congestive heart failure (mild)	4000
Congestive heart failure (moderate to severe)	2000
Anemia	3000
Sickle cell anemia	2000
Gastrointestinal system	
Bowel obstruction	2000–4000
Abdominal trauma	2000–4000
Other GI problems	4000
Musculoskeletal system	
Fractures	4000
Central nervous system	
Head trauma: open skull fracture, basal skull fracture (where pneumoencephalus is possible)	Sea level
Closed head injury (where pneumoencephalus is not suspected)	2000
Cerebrovascular accident (stroke)	2000
Intracranial problems (e.g., bleeding, infection)	2000
Seizure disorders (unrelated to head injury)	4000–5000
Spinal cord injury	4000
Skin (integumentary system)	
Burns (not including inhalation injury)	4000
Trauma	
Major trauma with potential for shock or entrapped gas	2000
Miscellaneous	
Anaphylactic shock	2000
Gas gangrene	2000
Decompression illness	Sea level

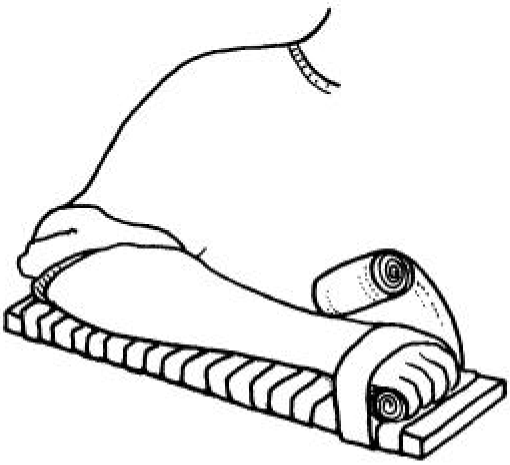
Note: AGL = above ground level.
*1000 ft = 304.8 m.

APPENDIX 4–2: SPLINTING FOR TRANSPORT

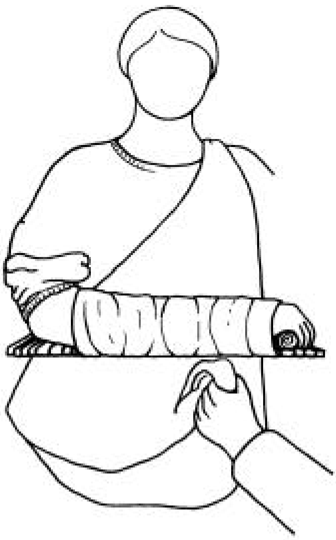


Fracture or dislocation of the elbow

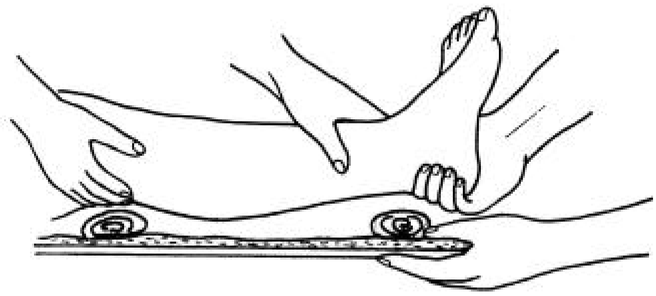
Fracture or dislocation of the elbow



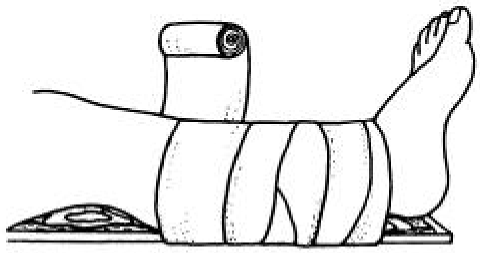
Fracture of the forearm



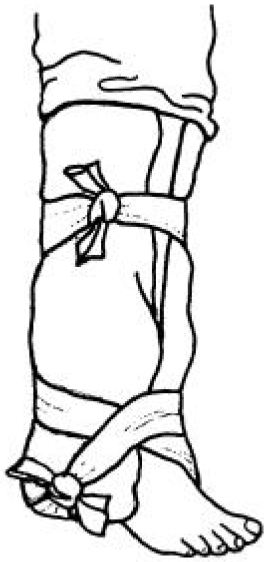
Fracture of the forearm



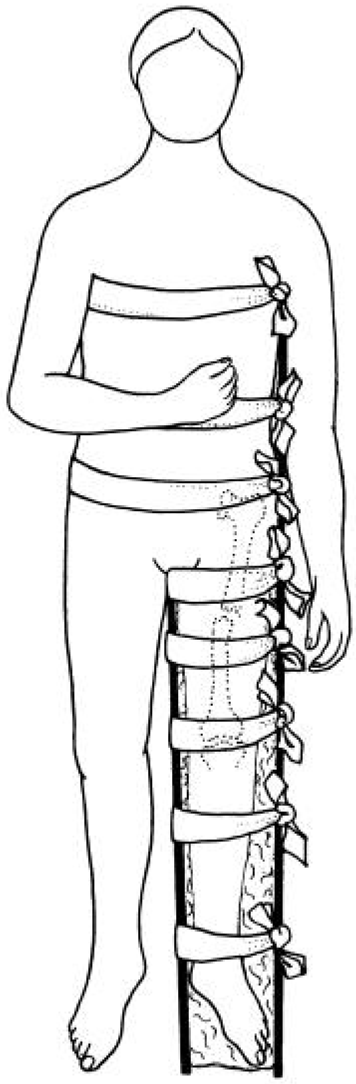
Fracture of the lower leg: board splint



Fracture of the lower leg: board splint



Fracture of the lower leg or ankle: pillow splint



Improvised splint for fracture of the upper leg

CHAPTER 5 — OBSTETRICS AND CARE OF INFANTS AND CHILDREN

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OBSTETRIC CARE

Generally a woman in her ninth month of pregnancy (or beyond the 240th day) is advised *not to fly* unless there is an urgent or semi-urgent need to do so.

However, for safety reasons, deliveries are not routinely done in semi-isolated or isolated northern communities. In most regions, women are referred out of the community for the duration of their pregnancy at 36–38 weeks' gestation or sooner if they are at higher risk.

INDICATIONS FOR EMERGENCY MEDICAL EVACUATIONS

Complications of pregnancy:

- Prelabor rupture of the membrane
- Pregnancy-induced hypertension (PIH)
- Antenatal bleeding (abruption, placenta previa or incomplete abortion)
- Preterm labor

Complications of labor and delivery:

- Prolapsed cord
- Abnormal fetal positions and abnormal delivery (e.g., breech — footling, frank or full; face or brow delivery; shoulder dystocia; transverse lie; cephalo-pelvic disproportion)

Labor — imminent delivery:

- Delivery during transport is not safe; it is best to remain in the community facility if delivery is imminent

Complications of postpartum period:

- Postpartum hemorrhage
- Postpartum infection (e.g., endometritis)

AVIATION FACTORS AFFECTING REPRODUCTIVE CONDITIONS

- Reduced partial pressure of oxygen
- Reduced atmospheric pressure
- Decreased presence of water vapor (dehydration)
- Gravitational forces

EFFECTS OF AIR TRANSPORT

- Maternal and fetal hypoxia (clients with compromised utero-placental perfusion are at increased risk)
- Uterine contractions may be stimulated as gas expands in the bowels during ascent (according to Boyle's law)
- Decreasing atmospheric pressure with increasing altitude causes the breasts to expand, stimulating release of oxytocin and enhancing labor
- Gravitational forces may enhance labor, pulling the fetus "down," if the client's head is positioned toward the nose of the aircraft
- Acceleration forces may adversely affect utero-placental perfusion

Pre-eclamptic clients have increased pulmonary permeability, which, in association with hypoxia and decreased barometric pressure, can lead to pulmonary edema.

GENERAL CONSIDERATIONS IN TRANSPORT OF OBSTETRIC CLIENTS

- Give oxygen, and keep oxygen saturations ≥95%
- Start IV therapy with normal saline; run at a rate adequate to maintain hydration
- Give nothing by mouth (NPO)
- Keep cabin quiet and temperature warm
- An antiemetic (e.g., dimenhydrinate) may be used
- Allow for frequent voiding or insert a Foley catheter if transfer time is long (> 1 hour); chart hourly urinary output
- Monitor maternal and fetal condition (including fetal heart rate by Doppler ultrasonography) every 15 minutes
- Position client in left lateral decubitus position, with head elevated and toward the tail of the aircraft
- Restrict aircraft cabin altitude to 4000 ft above ground level (AGL)
- Be prepared for emergency delivery with delivery kit and warmed isolette (if available)

See also "Imminent Delivery," below, this chapter

PRE-ECLAMPSIA AND ECLAMPSIA

EFFECTS OF AIR TRANSPORT

- Maternal and fetal hypoxia
- Expansion of breast or uterine tissue may increase the release of oxytocin, thereby enhancing labor
- Gravitational forces may enhance labor

MANAGEMENT

See "General Considerations in Transport of Obstetric Clients," above, this chapter.

ADDITIONAL CONSIDERATIONS FOR TRANSPORT

- Monitor closely for seizure activity
- Suction and pharyngeal airway should be immediately available in case seizures occur
- Monitor symptoms, blood pressure, heart rate, respirations, deep tendon reflexes and fetal heart rate every 10–15 minutes during transit; watch for hyper-reflexia, vision defects, headache and pain in right upper quadrant
- Ensure that anticonvulsants (e.g., lorazepam), antihypertensive medications (e.g., hydralazine) and medications to reduce neurological excitement (e.g., magnesium sulphate) are available; discuss specific orders for use of these drugs with a physician before transport

PRETERM (PREMATURE) LABOR

EFFECTS OF AIR TRANSPORT

- Maternal and fetal hypoxia
- Expansion of breast or uterine tissue may increase the release of oxytocin, thereby enhancing labor
- Gravitational forces may enhance labor

MANAGEMENT

See "General Considerations in Transport of Obstetric Clients," above, this chapter.

ADDITIONAL CONSIDERATIONS FOR TRANSPORT

- Consider IV therapy (500-mL bolus of D5W or D/NS over 30 minutes) to slow or stop preterm (premature) labor
- Discuss with a physician, before the transport, the use of medications to slow or stop labor (e.g., tocolytics)
- Discuss with a physician the use of medications to mature fetal lungs (steroids)
- Monitor fetal heart rate, uterine activity, and maternal blood pressure and pulse every 10–15 minutes.
- If delivery becomes inevitable, follow the emergency delivery protocol; *see "Imminent Delivery," below, this chapter*
- Avoid the use of depressant narcotic analgesics

PRELABOR RUPTURE OF THE MEMBRANES

EFFECTS OF AIR TRANSPORT

- Maternal and fetal hypoxia
- Expansion of breast or uterine tissue may increase the release of oxytocin, thereby enhancing labor

MANAGEMENT

See "General Considerations in Transport of Obstetric Clients," above, this chapter.

ADDITIONAL CONSIDERATIONS FOR TRANSPORT

- Discuss the use of IV antibiotics with a physician before the transport
- Monitor fetal heart rate, uterine activity, maternal blood pressure and pulse every 10–15 minutes
- If delivery becomes inevitable, follow the emergency delivery protocol; *see "Imminent Delivery," below, this chapter*
- Avoid the use of depressant narcotic analgesics

ANTEPARTUM AND POSTPARTUM HEMORRHAGE

EFFECTS OF AIR TRANSPORT

- Maternal and fetal hypoxia
- Expansion of breast or uterine tissue may increase the release of oxytocin, thereby enhancing labor in an antepartum client
- Gravitational forces may enhance labor in an antepartum client

MANAGEMENT

See "General Considerations in Transport of Obstetric Clients," above, this chapter.

ADDITIONAL CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs before transport!
- Establish two large-bore IV lines, and ensure adequate volume resuscitation with normal saline or Ringer's lactate; bring an ample supply of IV replacement fluids
- If client is in shock, treat accordingly; see "Shock," in chapter 14, "General Emergencies and Major Trauma," in *Clinical Practice Guidelines for Nurses in Primary Care* (First Nations and Inuit Health Branch 2000)
- Monitor fetal heart rate, uterine activity, and maternal blood pressure, pulse and respiratory rate every 10–15 minutes
- Monitor intake and output and blood losses closely; count pads to assess amount of bleeding, and save any clots or tissue that may be expelled

IMMINENT DELIVERY

Optimal treatment is to transfer the mother to hospital before delivery. The most important question is whether the client can be transported to the hospital in time. A decision to transfer depends upon local facilities, travel time and risks associated with traveling. The final decision should be made just before departure on the basis of contractions, parity, descent of the presenting part, cervical dilatation and response to attempted treatment for preterm labor. It is always safer to perform an imminent delivery before moving the client, rather than during transport, especially if the labor is preterm.

In addition to the emergency resuscitation kit, assemble equipment and supplies that may be required in transit, if emergency delivery is required. Suggested items:

- Obstetric pack and instrument pack
- Transport incubator and extra power supply (if available)
- Blankets and thermal insulating plastic body envelope (if available)
- Oxygen masks, including infant size; pediatric and infant oral airways; and bag-valve mask (BVM) device
- Pulse oximeter (if available)
- Blood glucometer
- Spare cylinders of oxygen with appropriate fittings, including flow and pressure gauges
- Monitoring equipment with extra batteries and Doppler device for fetal heart monitoring
- Suction and gavage tubes
- IV sets and extra supply of IV solutions
- Adequate supply of any medications ordered by a physician and medications for resuscitation
- Flashlight with extra batteries
- Antiseptic cleaning agent (e.g., povidone–iodine)
- Bowl or kidney basin
- Sterile gauze
- Infant resuscitation equipment

In the event that resuscitation of the infant is required in flight, the following equipment and supplies should also be available:

- Radiant heaters
- Blood pressure machine with neonatal blood pressure cuffs
- Infant oropharyngeal airways
- Infant bag-valve mask (BVM) device and face mask
- Suction equipment
- Oxygen with oxygen analyzer
- Means of monitoring an infant's temperature
- Glucometer
- Transport incubator and functioning battery

Drugs for resuscitation:

- 10% and 25% dextrose solutions
- normal saline
- sodium bicarbonate
- naloxone
- epinephrine
- atropine
- antibiotics (ampicillin and gentamicin)
- 10% calcium chloride

EMERGENCY DELIVERY

If delivery in transit appears possible or inevitable, be prepared to take the following actions:

- Reassure the mother-to-be
- Position client comfortably, with buttocks slightly raised off the stretcher
- Place a rubber or plastic sheet under the buttocks, and remove any tight clothing
- Ensure that a functioning IV line with normal saline or Ringer’s lactate is in place; a second IV line may be advisable if there is an increased risk of postpartum hemorrhage (e.g., multiparity or previous history of this condition)
- Arrange equipment for immediate use
- Have oxygen ready for use (if not already in use)
- Draw up any medications that may be required (e.g. oxytocin)
- Wash perineal area
- Drape client
- Wear mask and sterile gloves, and possibly a sterile gown
- During delivery, let the natural efforts of the mother deliver the baby

Ordinarily the baby will deliver unassisted, head first. Avoid excessive tearing of the vaginal walls by controlling the delivery of the head — don’t let it “pop out,” but rather ease it out slowly and allow the tissue to stretch. As soon as the head is delivered, feel around the baby’s neck to determine if the cord is wrapped around and constricting the trachea. Deliver one shoulder at a time; the rest of the body will follow naturally. Do not use traction on the baby until delivery of the shoulder, to avoid injury to the neck and brachial plexus.

Once the baby is delivered:

- Position baby on his or her back in a neutral position
- Dry off the baby and discard wet linen
- Suction mouth and then nose
- Place in warm linen or blankets to maintain body temperature
- Stimulate baby (e.g., by rubbing back)
- Establish respirations as soon as possible by use of suction, oxygen and manual stimulation
- After the cord stops pulsating, draw a sample of cord blood, double-clamp the cord at 3 inches (8 cm) and 5 inches (12 cm) from the baby’s abdomen; check to ensure that the clamps are secure and that no bleeding is evident; cut cord
- Assist with delivery of the placenta, but do so without pulling on the cord
- Wrap the placenta in a plastic bag or blanket and save for examination to ensure it is intact
- Gently massage the mother’s fundus to keep it firm and to control bleeding after the placenta is delivered or if the placenta is retained
- In cases where uterine contraction is slow, with continued bleeding, encourage the mother to breast-feed the infant (if the infant is healthy and breast-feeding is the planned method of feeding)
- Administer oxytocin 10 units IM or IV
- Continue to observe the mother for hemorrhage and the baby for respiratory distress
- Reassure and support the client

NEONATAL CARE

TRANSPORT OF THE ILL NEWBORN

If an ill newborn must be evacuated to a facility offering a higher level of care, it is usually preferable to await the arrival of an appropriate critical care transfer team, who will stabilize the infant. It is dangerous to expose the infant, particularly if premature, to the additional stresses of transport, especially aeromedical transport, before adequate stabilization.

The newborn who requires resuscitation is particularly vulnerable. *See "Neonatal Resuscitation," below, this chapter.*

MANAGEMENT: GENERAL CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs
- Give oxygen, and keep oxygen saturations at 93% to 94%
- Give oxygen according to percent concentration rather than flow rate (liters per minute), as would be the case for adults; have an oxygen analyzer (if available) on board to verify the amount of oxygen being administered
- Minimize oxygen demand by maintaining a neutral thermal environment and by minimizing handling and interventions
- Check frequently for any signs of respiratory distress (e.g., flared nostrils, sternal retractions, abdominal breathing, grunting on expiration or unequal chest expansion)
- Establish IV line for normal saline before transport, if possible
- Ensure that IV site is protected and visible
- If possible, use a pediatric drip set or, better, an IV infusion pump (if available), for better control of IV flow rate
- Monitor serum blood sugar, and treat hypoglycemia with a bolus of 10% glucose and an infusion of D10W
- Maintain accurate record of intake and output
- Avoid oral feeding for a sick, asphyxiated or preterm baby
- Observe infant continuously
- Do not leave infant unattended
- Handle infant gently
- Record vital signs every 15 minutes or more frequently, depending on situation:
  - Heart rate: normally 120–160 beats/minute (use pulse oximetry, if available)
  - Respiratory rate: normally 40–60 breaths/minute (airway can be kept open by slightly extending the position of the head and suctioning as necessary)
  - Axillary temperature: normally 36.5°C to 37°C
  - Blood pressure: difficult to assess in newborns without special equipment; signs of adequate perfusion include good capillary refill, good color, adequate urinary output and normal alertness; determine capillary refill time (to assess skin perfusion) by blanching area with digital pressure (normal refill time is 2–4 seconds)

MAINTENANCE OF OXYGENATION AND VENTILATION

Signs of Respiratory Distress

- Periodic breathing
- Tachypnea (respiratory rate > 60 breaths/minute)
- Grunting
- Chest wall retractions
- Nasal flaring

Common Causes of Respiratory Distress in Newborns

- Respiratory distress syndrome
- Aspiration syndrome
- Pneumonia
- Pulmonary air leak

In these situations, consult a physician.

- If there is evidence of respiratory failure, take steps immediately to provide positive pressure ventilation (PPV)
- Keep oxygen saturations in the range of 90% to 95%, measured by pulse oximetry (if available)
- Initiate PPV with infant resuscitation bag at 40–60 respirations/minute and pressure of 20–30 cm H_2O
- Effectiveness of ventilation is judged by infant's clinical response, symmetric chest movement and auscultation of air entry to both lungs
- Major cardiopulmonary failure may be prevented by early intervention with 100% oxygen and PPV

MAINTENANCE OF CIRCULATION

Adequate cardiac output is essential to maintain circulation. The best way to maintain circulation is provision of adequate fluids and electrolytes. Babies with unstable conditions are usually given nothing by mouth, and an IV infusion is started.

Conditions Necessitating IV Therapy

- Extreme prematurity
- GI anomalies (e.g., gastroschisis)
- Cardiac anomalies
- Respiratory distress syndrome
- Dehydration
- Shock

Fluid Administration Guidelines for Newborns

- Term infant: 80–100 mL/kg every 24 hours
- Preterm infant: 100–140 mL/kg every 24 hours

MAINTENANCE OF HOMEOSTASIS

The most common problem is hypoglycemia, which occurs in a variety of situations:

- Prematurity
- Restricted intrauterine growth
- Asphyxia during birth
- Hypothermia
- Diabetic mother

Use a reagent strip or blood glucose monitor to assess blood glucose level every hour. A glucose level ≥2.5 mmol/L in a term infant is abnormal.

IV administration of a 10% dextrose solution (approximately 3–4 mL/kg each hour) is indicated if the blood sugar is ≤1.5 mmol/L. Discuss with a physician.

Abnormalities such as hypocalcemia, hypomagnesium, hyponatremia and hyperkalemia can complicate homeostasis, especially if resuscitation and stabilization processes are prolonged.

MAINTENANCE OF THERMAL ENVIRONMENT

Maintenance of an optimal thermal environment is one of the most important aspects of transport of a newborn. Newborn infants have a large surface area relative to their weight, and they have less subcutaneous tissue to insulate against heat loss.

The ambient temperature at which an infant uses the least energy to maintain body temperature depends on the infant's weight, gestational age at birth and postnatal age. Prolonged cold stress results in increased oxygen consumption and abnormal glucose utilization, which can lead to hypoglycemia, hypoxemia and acidosis.

- Line incubator walls on three sides to help reduce heat loss during transport
- Place a small clear plastic shield around any small infant (excluding the head), to limit air movement and thereby prevent loss of heat by convection
- Cover the incubator with plastic sheeting, a "space blanket" or a sleeping bag during any period that the baby spends outside the vehicle (e.g., for loading and unloading) to help maintain body temperature
- Ensure that the portable incubator (if available) is in good working order and that extra batteries are available
- If necessary, check axillary temperature during transport, but the incubator should not be opened needlessly
- It is equally important to avoid hyperthermia, which may lead to increased oxygen requirements

INFECTION

If sepsis is suspected, obtain swabs from ear canal, umbilicus and tracheal secretions. Obtain blood for culture if possible. IV administration of antibiotics should not be delayed. Discuss with a physician.

Usual antibiotics are ampicillin and gentamicin.

NEONATAL RESUSCITATION

DIAGNOSIS

Try to anticipate situations in which a newborn may need resuscitation. The following situations represent some of the predisposing factors.

History of Maternal Perinatal Complications

- Preterm labor
- Placental abnormalities: placenta previa, abruptio placentae or cord compression
- Amniotic fluid abnormalities: polyhydramnios or oligohydramnios
- Infectious process: maternal fever
- Infectious agents (maternal source): group B *Streptococcus*, gram-negative bacteria, viruses (e.g., HSV, toxoplasmosis, CMV, HIV)
- Maternal abnormalities: diabetes mellitus, size of pelvic outlet
- Neonatal abnormalities: genetic, anatomic or cardiac
- Maternal drugs: prescription or illicit

Physical Examination and Evaluation

The physical examination may have to be done while resuscitation is performed.

- Airway: Is it patent? Is foreign material (e.g., meconium) present?
- Breathing effort: Present or absent?
- Circulation: Is pulse present? What is heart rate? What is infant’s color?
- Disability: neurological status, floppy tone, absence of reflex and grimace
- Environment: heat loss
- Apgar score: should be assessed 1 and 5 minutes after birth (Table 5-1)

Table 5-1: Determination of Apgar Score*

Feature Evaluated	0 Points	1 Point	2 Points
Heart rate	0	<100 beats/min	>100 beats/min
Respiratory effort	Apnea	Irregular, shallow or gasping breaths	Vigorous, crying
Color	Pale or blue all over	Pale or blue extremities	Pink
Muscle tone	Absent	Weak, passive tone	Active movement
Reflex irritability	Absent	Grimace	Active avoidance

*Sum the scores for each feature. Maximum score = 10, minimum score = 0.

PROCEDURE FOR RESUSCITATION

1. Position the airway.
2. Suction the mouth and nasopharynx.
3. Dry the neonate and keep warm with thermal blanket or dry towel. Cover scalp.
4. Stimulate by drying the baby and rubbing his or her back.
5. Clamp and cut the cord.
6. Evaluate respirations.
7. Use blow-by method or simple face mask to deliver 100% oxygen for neonate in mild distress.

For an infant with apnea or severe respiratory depression, begin assisted breathing with bag-valve mask (BVM) and 100% oxygen; ventilate at 40–60 breaths/minute.

8. Check heart rate (apical beat) after 15–30 seconds after bagging.

If heart rate < 60 beats/minute:

9. Continue assisted ventilation (20 breaths/minute).
10. Begin chest compressions at 100/minute.
11. If no improvement after 30 seconds, continue ventilation and compressions.
12. If no improvement after a further 30 seconds, establish vascular access and give epinephrine solution (1:10 000) (**D class drug**) at 0.01–0.03 mg/kg IV or IO. Subsequent doses must be ordered by a physician.
13. Reassess heart rate and respirations.

If heart rate 60–80 beats/minute:

9. Continue assisted ventilation.
10. If no improvement after 30 more seconds of ventilation with 100% oxygen, begin chest compressions. Ratio of compressions to ventilations should be 5:1 (100 compressions to 20 ventilations).
11. Reassess heart rate and respirations each minute.

If heart rate 81–100 beats/minute and rising:

9. Give 100% oxygen by mask or blow-by method.
10. Provide tactile stimulation.
11. Reassess heart rate and respirations after 15–30 seconds. If heart rate < 100 beats/minute, begin assisted BVM ventilation with 100% oxygen.
12. Reassess heart rate after 15–30 seconds.

If heart rate > 100 beats/minute:

9. Check skin color. If peripheral cyanosis is present, give oxygen by mask or blow-by method.
10. Reassess heart rate after 1 minute.

TRANSPORT OF THE INFANT WITH A SURGICAL EMERGENCY

EFFECTS OF AIR TRANSPORT

- Gas expansion resulting in increased distension and perhaps pain and vomiting
- Gravitational forces
- Reduced water vapor (leading to dehydration)

OMPHALOCELE

Omphalocele is a protrusion of the intestine through a large defect in the abdominal wall, covered by a thin transparent membrane. Water and heat is lost from the exposed bowels.

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

Objectives:

- Preserve sterility of exposed viscera
- Prevent mesenteric vascular obstruction through kinking and friction on the viscera
- Prevent heat loss
- Decompress the intestine

Actions required:

- Ensure airway is secure before transport
- Give oxygen, and keep saturations > 93% to 94%
- Start IV therapy with normal saline (maintenance amounts); D10W is also commonly used for neonates; discuss choice of this IV fluid with a physician
- Do not give the infant a pacifier or oral feeding
- Insert an orogastric tube, attached to straight drainage, to prevent further abdominal distension
- Using sterile technique, cover the bowel with Vaseline gauze or sterile gauze that has been moistened with warm saline
- Next, apply a layer of plastic wrap circumferentially around the infant's abdomen and trunk to prevent water and heat loss; the dressing should support the bowel
- Finally, add a third layer of tin foil to enhance conservation of heat and water
- Monitor temperature and serum blood sugar regularly
- Transport infant supine or on the right side, with head elevated 30 degrees and toward the nose of the aircraft
- Restrict aircraft cabin altitude to 2000 ft above ground level (AGL)

ESOPHAGEAL ATRESIA (WITH OR WITHOUT TRACHEOESOPHAGEAL FISTULA)

Esophageal atresia is the congenital absence or closure of the esophagus. In approximately 85% of cases, there is also a fistula between the trachea and the distal esophagus. Aspiration may occur because of overflow from the blind esophageal pouch or through the fistula. Polyhydramnios may have been present antenatally.

Signs of this diagnosis:

- Excessive salivation or persistent regurgitation
- Obstruction in the upper thoracic esophagus when attempts are made to pass a nasogastric tube (the tube might turn on itself and come out of the mouth)

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Ensure airway is secure before transport
- Suction must be available
- Give oxygen, and keep oxygen saturations at 93% to 94%
- Start IV therapy with normal saline (maintenance amounts); D10W is also commonly used for neonates; discuss choice of this IV fluid with a physician
- Pass a no. 10 French catheter through the mouth and nose into the esophageal pouch and suction frequently (as required)
- Do not give the infant a pacifier or oral feeding
- Monitor temperature and serum blood sugar
- Transport infant supine or on the right side, with head elevated 30 degrees and toward the nose of the aircraft
- Restrict aircraft cabin altitude to 2000 ft AGL

DIAPHRAGMATIC HERNIA

In this condition incomplete development of the diaphragm allows the intra-abdominal contents to herniate into the chest. Respiratory distress occurs early, with a shifting of heart sounds to the opposite side of the chest and depressed breath sounds on the affected side. The trachea is deviated to the opposite side. Bowel sounds are occasionally heard in the chest, and the abdomen may be scaphoid. The mother may have a history of polyhydramnios.

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Manage airway as soon as possible after birth to minimize entrance of air into the stomach
- Assisted ventilation is usually required; respiratory distress worsens with bagging
- Before transport, infant should be intubated; this procedure is not within the CHN's scope of practice and should be performed by authorized emergency transport personnel (e.g., physician, emergency flight nurse or paramedic)
- Give oxygen, and keep oxygen saturations at 93% to 94%
- Start IV therapy with normal saline (maintenance amounts); D10W is also commonly used for neonates; discuss choice of this IV fluid with a physician
- Insert an orogastric tube to straight drainage, and suction tube frequently with syringe
- Monitor temperature and blood sugar
- Transport infant supine or on the right side, with head elevated 30 degrees and toward the nose of the aircraft
- Restrict aircraft cabin altitude to 2000 feet AGL

CARE OF INFANTS AND CHILDREN

GENERAL GUIDELINES

If possible, have a parent or another family member accompany the infant or child. The escort may be apprehensive about the child, so he or she will also require attention and support throughout the transport. Involve the escort in the care of the child as much as possible.

Because children often cannot verbalize their complaints, and because the status of the condition may change rapidly, undertake a careful pre-transport assessment to establish a baseline for later comparison en route.

Assemble sufficient supplies of appropriate nourishment, clothing, disposable diapers and equipment for any anticipated complications related to the condition.

Provide the infant with either a seat, a seat belt or a bassinet that is properly secured on a stretcher or a seat. The child may be held by an adult during a flight, secured with a stretcher strap but not with the same belt as the adult's. Infants up to the age of 2 years (legal limit) may be held in the adult's arms.

Awaken the infant during descent and have him or her nurse, drink from an infant cup or eat some food, unless he or she is being kept NPO for medical reasons. Older children can be given gum or can be encouraged to yawn to prevent barotitis media.

If the reason for air evacuation is respiratory, discuss the infant's needs with the pilot to enable choice of the best altitude that safety will permit.

INCREASED INTRACRANIAL PRESSURE

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs before transport
- Secure the airway before transport and consider immobilization of cervical spine if head injury is suspected
- Give oxygen, and keep saturations ≥95%
- Assist ventilation with bag-valve mask (BM) device if necessary
- Start IV therapy with normal saline to keep vein open, unless volume resuscitation for other injuries is necessary
- Monitor vital signs, including temperature and neurological status (with Pediatric Glasgow Coma Scale) frequently
- Watch for changes in level of consciousness, pupil reaction, headache, reduction in heart rate (down to 40–60/minute), decreased or intermittent (Cheyne–Stokes) respiration, increase in blood pressure, vomiting, seizures or paralysis; be prepared for intervention as indicated
- Monitor blood sugar and manage hypoglycemia
- Keep cabin quiet and dimly lit to prevent stimulation
- Avoid, to the extent possible, stimuli that might increase intracranial pressure, such as suctioning, coughing, Valsalva maneuver and position changes
- Give medications and fluids as necessary; discuss use of medications with a physician before transport (generally IV and oral fluids are restricted to 60% of maintenance requirements)
- Position the infant or child on a stretcher with head elevated by 30 degrees and toward the nose of the aircraft; avoid neck flexion
- Restrict aircraft cabin altitude to 2000 ft AGL

ACUTE RESPIRATORY DISTRESS

Rapid diagnosis and treatment are important to avoid cardiorespiratory arrest.

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs before transport
- Establish a secure airway before transport; ventilate as necessary
- Give as much oxygen as possible, and keep oxygen saturations ≥95%
- If child is in moderate to severe distress, restrict oral fluids and start IV therapy with normal saline; run at a rate adequate to maintain hydration; remember that a lot of fluid can be lost through the respiratory tract if the child is tachypneic and febrile
- Keep the child in a comfortable position, allowing him or her to assume the position of choice
- Keep stresses to a minimum
- If the child is feverish, attempt to reduce body temperature by administering antipyretics and removing heat sources

VENTILATION

If ventilation is to be carried out manually, use enough pressure to observe chest movements. Use chest movement as a guide to the adequacy of ventilation. Table 5-2 presents average ventilation rates at various ages.

Table 5-2: Average Ventilation Rates

Age	Rate (breaths/min)
Neonate	40–60
Young infant	25–30
Toddler, preschool-age	20–25
School age, pre-adolescent	20–25
Adolescent	12–16

Once started, manual ventilation should be continued during transport, even if the child is starting to breathe on his or her own. It may be safer to ventilate than to allow the child to breathe on his or her own without knowing whether ventilation is adequate.

If the child is adequately ventilated but is excessively restless, check bladder and other vital signs.

NEAR-DROWNING

Do not attempt to evacuate the child until vital signs have been established.

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs before transport
- Establish a secure airway before transport; ventilate as necessary
- Immobilize the cervical spine before transport
- Give as much oxygen as possible, and keep oxygen saturations ≥95%
- Start IV therapy with normal saline; run at a rate sufficient to maintain adequate blood pressure and heart rate
- If unable to establish IV line, consider intraosseous access; *for procedure, see Appendix 5-1, "Intraosseous Access," below, this chapter*
- *Monitor temperature, as well as all vital signs, frequently*
- Monitor serum blood sugar, and treat hypoglycemia as necessary
- Suction should be available and used as required
- Position the client supine, with head toward nose of aircraft
- Restrict aircraft cabin altitude to 5000 feet AGL
- If near-drowning occurred in cold water, treat as required for hypothermia

See "Hypothermia," in chapter 14, "General Emergencies and Major Trauma," in Clinical Practice Guidelines for Nurses in Primary Care (First Nations and Inuit Health Branch 2000).

CHILD WITH MULTIPLE INJURIES

EFFECTS OF AIR TRANSPORT

- Increased hypoxemia
- Gas expansion and tissue swelling may increase intracranial pressure
- Vomiting and potential airway compromise

MANAGEMENT: CONSIDERATIONS FOR TRANSPORT

- Stabilize ABCs before transport
- Treat major respiratory emergencies (e.g., pneumothorax, hemothorax, flail chest or open chest wound) before transport
- Establish a secure airway, and ensure adequate ventilation
- Immobilize the cervical spine and place child on spine board
- Give high-flow oxygen, and keep oxygen saturations ≥95%
- Establish two large-bore IV lines and initiate volume replacement as required with normal saline or Ringer's lactate
- If unable to establish IV line, consider intraosseous access; for procedure, *see Appendix 5-1, "Intraosseous Access," below, this chapter*
- Control bleeding, and apply pressure dressings as necessary
- Perform neurological assessment frequently, and treat emerging problems as necessary
- Protect from hypothermia (with warm blankets and warm IV fluids)
- Monitor vital signs, neurological status and bleeding continuously
- Minimize the risk of infection by cleaning or debriding open wounds and administering antibiotics as prescribed by consulting physician
- Consider inserting a nasogastric or orogastric tube to prevent gastric distension
- Consider inserting a urinary catheter (unless contrainidicated because of urethral trauma); maintain accurate record of intake and output
- Anticipate potential problems and be prepared for immediate treatment
- Prevent heat loss and hypothermia
- Position child supine, with head toward the nose of the aircraft
- Restrict aircraft cabin altitude to 2000 feet AGL

APPENDIX 5-1: INTRAOSSEOUS ACCESS

GENERAL

PURPOSE

- Used to administer IV fluids and medications when attempts at IV access have failed
- For use in emergency situations only

INDICATIONS

Attempt intraosseous access in the following situations in children ≤6 years of age, when venous access cannot be achieved within three attempts or 60–90 seconds, whichever comes first:

- Multisystem trauma with associated shock or severe hypovolemia (or both)
- Severe dehydration associated with vascular collapse or loss of consciousness (or both)
- Unresponsive child in need of immediate drug and fluid resuscitation: burns, status asthmaticus, sepsis, near-drowning, cardiac arrest, anaphylaxis

CONTRAINDICATIONS

- Pelvic fracture
- Fracture in the extremity proximal to or in the bone chosen for the intraosseous access

SITES

PREFERRED

- Anterolateral (flat) surface of the proximal tibia, 1–3 cm (one finger's breadth) below and just medial to the tibial tuberosity

OTHER POSSIBILITY

- Distal tibia, 1–3 cm above the medial malleolus on the surface of the tibia near the ankle (believed by some to be the best site in older children because of the greater thickness of the proximal tibia relative to the distal tibia)

PROCEDURE

1. Practice universal precautions against contamination with child's body substances (e.g., gloves, possibly goggles, safe disposal of needle).
2. Assemble necessary equipment.
3. Immobilize the child well, but avoid restraints if at all possible.
4. Place the child in the supine position and externally rotate the leg to display the medial aspect of the extremity.
5. Identify the landmarks for needle insertion.
6. Cleanse the puncture site.
7. If the child is conscious, use local anesthesia.
8. Use an intraosseous needle or, in a small child, an 18-gauge butterfly needle.
9. Angle the needle away from the joint. Insert the needle at a 60° angle, 2 cm below the tibial tuberosity, through the skin and subcutaneous tissue.
10. When the needle reaches the bone, exert firm downward pressure, rotating the needle in a clockwise–anticlockwise manner. Be careful not to bend the needle.
11. When the needle reaches the marrow space, the resistance will drop (indicated by a "pop").
12. Attach a 10-mL syringe, and aspirate some blood and marrow to determine if the needle is correctly positioned (other indicators of correct positioning: the needle will stand upright by itself, IV fluid flows freely, no signs of subcutaneous infiltration are apparent).
13. Secure needle with tape.
14. Use as you would a regular IV line. For example, fluids can be infused quickly for resuscitation of a child who is in shock.

CHAPTER 6 — EQUIPMENT AND SUPPLIES

Table of Contents

GENERAL GUIDELINES

In recognition of the differing needs of various regions and zones, the following lists encompass suggested items and are generally those basic supplies and equipment that will be required in any situation. Individual lists may be developed and maintained at the unit and zone level to meet the specific needs of each respective area.

The responsibility for maintaining and monitoring equipment and supplies for emergency use should be clearly stated and assigned. This delegation includes maintaining sterility of those articles requiring it. Emergency bags or kits used during medevacs should be compact, waterproof, always ready for use and stored in a secure location.

BASIC INTERFACILITY TRANSPORT EQUIPMENT

- Stretcher with appropriate linen and securement straps
- Spinal immobilization equipment:
  - Spine board
  - Cervical collars (all sizes)
  - Straps
  - Head immobilizer
  - Cardiac arrest board
- Oxygen tanks, with regulator, wrench and adapters
- 100% bag-valve mask (BVM) devices with easy-seal masks for adults and children
- Oral airways for neonates, children and adults (complete set of sizes)
- Oxygen delivery devices for adults and children
- Portable suction device with extra drainage collection unit
- Suction accessories, including tonsil-tip catheters
- Backup portable suction device
- Stethoscope and sphygmomanometer (adult and pediatric)
- Thermometer
- IV supplies: IV catheters, intraosseous needles, IV tubing, IV start equipment, IV solutions, tape, arm board
- Pulse oximeter
- Flashlight and penlight
- Spare batteries
- Hygiene supplies: disposable towels, wet wipes, sanitary napkins, incontinence pads
- Sterile gloves, sick bags, garbage bags, tissues, towels, bedpan, urinal, kidney basin (disposable, if possible)
- Scissors
- Tongue depressors
- Safety pins
- Syringes and needles in a variety of sizes
- Sharps container
- Glucose monitoring supplies
- Dressings
  - 1 large pressure dressing (e.g., abdominal pad)
  - 6 sterile gauze pads 10 × 10 cm (4 × 4 inch)
  - 6 sterile gauze pads 7.5 × 7.5 cm (3 × 3 inch)
  - 2 sterile eye pads
  - 1 butterfly dressing
  - assorted Band-Aids
  - 1 roll of 2.5-cm (1-inch) tape
- Bandages
  - two 5-cm (2-inch) tensor bandages
  - 5-cm (2-inch) Kling stretcher gauze
  - 1 triangular sling
- Basic medications kit:
  - analgesic (e.g., meperidine, morphine)
  - 6 analgesic tablets (acetaminophen)
  - naloxone
  - 2 ampules of epinephrine (1:1000)
  - metered-dose inhaler (MDI) with bronchodilator (e.g., salbutamol)
  - glucose 25% and 50% (for IV administration) in a preloaded syringe or oral glycogel
  - nitroglycerin tablets or spray
  - antiemetic (dimenhydrinate)
  - other drugs as needed or ordered

Refer to pharmacy standards and regional policy for storage, handling, dispensing and recording of controlled substances.

OBSTETRIC SUPPLIES

- Incubator (if available)
- Reflective blankets
- Delivery instrument pack
- Fetal Doppler unit
- Neonatal bag-valve mask (BVM) resuscitator
- Neonatal suction or manual bulb aspirator
- Sterile gloves

MISCELLANEOUS SUPPLIES

- Additional client-specific equipment, supplies and medications as needed
- Survival gear (e.g., life jackets and sleeping bags), if the transport vehicle is not already equipped with such gear
- Reference materials (including policy and procedures manual) and documentation supplies (including narrative notes, Glasgow Coma Scale)

OTHER FREQUENTLY USED MEDEVAC EQUIPMENT AND SUPPLIES

OXYGEN CYLINDERS

Medical oxygen is purified and the moisture content removed; hence, the oxygen requires humidification to promote client comfort and to prevent drying of the mucous membranes.

Oxygen cylinders are never emptied to atmospheric pressure because of the possibility that ambient air might leak back into the cylinder, carrying moisture with it. Moisture will cause corrosion and may freeze in the narrow orifices of the cylinder and block them.

Precautions to be observed when handling oxygen:

- Keep oil and grease away from the cylinder
- Keep oxygen away from fire (no smoking)
- Prevent cylinder from falling over; all oxygen cylinders must be secured
- Handle cylinders and valves carefully
- Ensure that dust caps are replaced
- Inform air crew and all clients and other passengers when oxygen is being used
- Do not use electrical equipment that is not certified for aviation safety, because of the danger of sparks
- Do not use woollen or nylon blankets because of the potential for static electricity; use cotton ones instead
- Check oxygen gauges regularly

BAG-VALVE MASK (BVM) RESUSCITATOR

Purpose and Use

To provide positive pressure ventilation (PPV) and oxygen to clients who are not ventilating adequately (e.g., spontaneous breathing has stopped)

Operation

- Tilt client's head back and lift jaw forward (use jaw thrust if cervical injury is suspected)
- Apply mask firmly to face, with narrow end on bridge of nose
- Hold mask firmly against face with thumb and index finger, keeping chin and head back with other three fingers
- Inflate lungs by squeezing bag with other hand; watch chest rise
- Release and let the client exhale; bag will refill for next inflation
- Repeat every 3–5 seconds: 1 or 2 seconds for inhalation and 2 seconds for exhalation
- Slow inspiration will help prevent gastric distension and possible aspiration

General Information

- The maximum pressure from squeezing the BVM device is sufficient to overcome obstruction in the airway without damaging the lungs
- Supplemental oxygen can be supplied through oxygen input nipple located on the bottom of the bag

Cleaning Instructions

- Clean face mask with a cloth dampened with a chemical germicidal solution that will not damage rubber
- Submerge non-rebreathing valve in chemical germicidal agent that will not injure Lexan plastic; valve may be autoclaved, if desired
- Do not disassemble valve
- After cleaning, dry the valve by installing in Ambu bag and operating for a few minutes

PORTABLE SUCTION DEVICE

An example of a portable suction device is the Ambu foot bag suction pump.

Purpose and Use

– To quickly clean the mouth and throat of blood, mucus, vomitus and other liquids
– To clear the airway of an unconscious client, enabling proper resuscitation or ventilation

Operation

– Hold catheter in client's mouth and pump bellows with foot
– Continue as long as suction is needed

General Information

– The mechanical Ambu foot bag may be used until electrical suction can be instituted
– The foot bag is also used as an emergency backup for electrical suction devices
– Pumping the bellows creates sufficient suction to remove obstructing fluids
– If the trap jar overflows, it is not necessary to discontinue use, because the aspirated liquid will enter the bellows and will automatically be emptied from the bellows with the next compression
– The extra ball valve on the rubber trap jar serves as a spare in case the other one becomes clogged

Cleaning Instructions

– Dispose of the catheter and wash the "Y" tube, metal tip and trap jar in a disinfecting solution
– Because all flow is away from the client, the rest of the pump need not be sterile; however, clean water may be drawn through the pump to wash it
– If aspirated fluid has been drawn through the bellows, keep pumping until the clean water has thoroughly flushed out the bellows

INTRAVENOUS INFUSION PUMP

The infusion pump can deliver a set volume per hour (from 1 to 9999 mL). The pump communicates operating conditions and alarm situations to the operator by a liquid crystal display (LCD) panel; there is also an audible alarm.

IV problems arising from changes in atmospheric pressure are eliminated with use of an infusion pump. Where this equipment is available, the medical escort must be thoroughly familiar with its operation.

Be aware that there are many types of infusion pumps, each with its own alarm, LCD display and alarm volume range.

CARDIAC EQUIPMENT

Cardiac monitors, defibrillators and other sophisticated cardiac equipment are generally required for clients whose care is under the supervision of a facility offering higher-level care than in the community. They can be used where larger planes and appropriate attendants are available.

Cardiac Monitor

The cardiac monitor displays electrical activity during the cardiac cycle. The operation and components vary depending upon the client's medical needs and the manufacturer. The user is responsible for the safe and knowledgeable use and care of the equipment as an adjunct to client care. The user should review and be familiar with the manufacturer's operating instructions for the specific monitor. Furthermore, in the aeromedical environment, the cardiac monitor should be approved as safe for flight.

Defibrillator

The manual DC (direct current) defibrillator is a potentially dangerous machine and should be used only under the direct supervision of a physician.

Automatic external defibrillators (AEDs) are available in some regions. Follow regional guidelines and the manufacturer's operating instructions when using these devices.

TRANSPORT INCUBATOR

There are various types of transport incubators. Nurses must be cognizant of the requirements, operation and precautions of the particular incubator available to them. See Appendix 6-1 for information about the Ohio transport incubator.

APPENDIX 6-1: OHIO TRANSPORT INCUBATOR

The Ohio transport incubator is one brand of incubator that has been adapted for use in the aeromedical transport of infants. Detailed instructions for its use are set out in the operation and maintenance manual.

The Ohio transport incubator has a portable oxygen supply and a battery pack that supplies backup electrical power for transport. The incubator is affected by ambient temperature; therefore, temperature adjustments may be necessary during transport.

LOADING PROCEDURES — UNIT ON BOARD

PREPARATION

Thirty minutes before emplaning the infant:

– Remove adapter to connect to aircraft power
– Connect adapter to incubator power cord
– Connect to aircraft power source; some aircraft have 24-V DC outlets into which the incubator may be plugged directly; however, ensure that the proper adapter is available (either in your transport supplies or in the aircraft)
– Turn voltage mode selector on incubator to 24-V DC
– Turn heating indicator to "START" position
– Secure oxygen analyzer in place, if applicable
– Connect oxygen flow meter to aircraft oxygen source

Consider administering oxygen by means of an external oxygen delivery device rather than using the incubator system. It is difficult to assess the concentration of oxygen in the incubator environment.

Connect oxygen extension tubing from flow meter to desired oxygen nipple on the incubator's right side:

– For ≤ 40%, connect to 40% nipple, red flag down
– For > 40%, connect to 100% nipple, red flag down
– For > 80%, connect to 100% nipple and raise red flag on rear of unit to occlude ambient air

Place cap over nipple that is not being used.

It takes 5 minutes to reach 90% oxygen concentration with the ambient air intake covered. Therefore, a few minutes before placing the infant in the unit, turn oxygen on to desired flow. With the oxygen connected to the 100% inlet and with the air valve open, the following concentrations can be expected with various rates of flow:

Oxygen Flow (L/min)	Approximate Oxygen Concentration
3	50%
5	60%
10	85%

Check the sponge in the humidity drawer and add distilled water as necessary. To obtain humidity above 60%, connect the oxygen tubing for the Ohio incubator to a humidity bottle.

LOADING THE INCUBATOR INTO THE AIRCRAFT

– Secure infant in incubator with two pairs of Velcro straps; position feet toward cockpit
– An infant weighing more than 4.5 kg (10 lb) will not fit comfortably in the incubator
– A pair of premature twins may both fit in a single incubator
– Uncover all air circulation inlets around bassinet
– Ensure that retaining clip is in place
– Close and secure plastic hood, ensuring that no tubes are caught in the closure
– Secure IV line to aircraft, if applicable

LOADING PROCEDURES — INFANT IN UNIT

- Follow initial set-up procedure and emplaning procedures as outlined in "Loading Procedures — Unit on Board," above
- Convert oxygen flow from portable to aircraft oxygen source
- Turn portable oxygen liter flow off
- Turn portable oxygen tank off using wrench in utility drawer
- Bleed oxygen from gauge by turning T-bar to open or "down" position
- When gauge reads zero, turn T-bar to closed, "up" or free-spin position

If oxygen lines are not bled when the tank is turned off, the diaphragm in the regulator valve will be damaged.

IN TRANSIT

Regulate incubator temperature according to the infant's temperature with reference to the temperature indicator inside the hood. To increase the interior temperature, turn control knob to a higher number; to decrease, turn control knob to a lower number.

The high-temperature warning light is activated when the temperature exceeds 37.2°C (99°F) or when air flow to or from the heating system is blocked. Check and correct air flow blockage before decreasing incubator temperature (in this situation, the temperature in the infant compartment may actually be lower than required).

Regulate oxygen flow according to analyzer reading.

Check the sponge in the humidity drawer and add distilled water as necessary, usually every 20 minutes. The humidity drawer will supply 40% to 60% humidity. To achieve relative humidity above 60% add a humidity bottle to the aircraft's oxygen source.

Prevent blockage of the air circulation inlet at the infant's head.

SPECIAL CONSIDERATIONS

Fully charged battery packs will last 2 to 2½ hours at 4.4°C (40° F) ambient temperature if the incubator is cold and 4½ hours at 23.8°C (75°F) ambient temperature if the incubator is prewarmed. However, use of the battery until complete discharge can cause permanent damage and shorten battery life. It is recommended that all Ohio incubators be prewarmed by means of aircraft power.

The acid battery is not acceptable for use during aeromedical evacuations. Place a 3 × 5 inch card on the battery pack and record times when battery was used and when the unit was on aircraft power.

If the incubator is not receiving power:

- Ensure that incubator power is turned on
- Verify that correct voltage mode has been selected
- Check circuit breakers and reset if necessary (reset only once)
- Check electrical connections
- Check power source

If all of these check out, then the problem is probably with the incubator power pack, and replacement is required.

In the absence of a functioning battery or power source (with proper adapter) in the aircraft, it may be necessary to use hot water bottles or "hot packs." Extreme care must be taken not to overheat or burn the infant. Commercial "hot packs" contain sodium thiosulfate and glycerine, which combine to produce heat (in the range of 40°C) when the bag is squeezed.

UNLOADING PROCEDURES — UNIT LEFT ON BOARD

After unloading the infant:

- Turn off and disconnect all oxygen
- Unplug incubator from aircraft power source
- Return adapter to utility drawer
- Secure incubator power cord at rear of unit
- Remove oxygen analyzer and remote sensor
- Clean unit with soap and water.
- Never use alcohol or acetone on Plexiglas hood or doors
- Recharge battery using a 110- to 115-V alternating current (AC) source; this may take 24–48 hours, depending on how long the battery was used

It is recommended that once a month, the batteries be allowed to run down until the warning light shows (but no further) and then recharged.

UNLOADING PROCEDURES — INFANT IN UNIT

If the infant is to stay in the incubator during unloading, both the unit and the battery power pack must be taken off the aircraft.

Convert electrical system to battery power pack:

- Disconnect incubator from aircraft power source, remove adapter, and connect incubator to battery power pack
- Turn voltage mode selector to 12-V DC
- Return adapter to utility drawer

Convert oxygen system to portable tank:

- Turn on portable oxygen; ensure that T-bar is in closed or "up" position

If T-bar is in the open or "down" position, the sudden surge of oxygen pressure from the portable oxygen tank will throw off the calibration of the liter flow gauge and break the flow meter.

- Turn portable oxygen liter flow gauge to desired rate
- Attach portable oxygen tubing to appropriate nipple
- Turn off aircraft oxygen source
- Secure portable IV pole to incubator (if applicable), and secure bottle to pole
- Check humidity drawer and add distilled water as necessary
- Check security of infant, incubator and battery power pack before deplaning
- Remove oxygen analyzer and remote sensor; if unit is to be left on board, do not unload oxygen tables, oxygen analyzer, remote sensor or flow-through adapter

If an infant with a contagious disease or contaminated organism was carried in the incubator, special precautions must be taken during cleaning.

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Abbreviations

ABCs	airway, breathing and circulation
AC	alternating current
AEDs	Automatic external defibrillators
AGL	above ground level
ASL	above sea level
BVM	bag-valve mask
CHF	congestive heart failure
CHN	community health nurse
CMV	cytomegalovirus
CNS	central nervous system
COPD	chronic obstructive pulmonary disease
CPR	cardiopulmonary resuscitation
C spine	cervical spine
D10W	10% dextrose in water
D5W	5% dextrose in water
DC	direct current
D/NS	dextrose in normal saline
ECG	electrocardiogram or electrocardiography
EMCA	emergency medical care attendant
EMT	emergency medical technician

$F\text{iO}_2$	fraction of inspired oxygen
GI	gastrointestinal
GOX	gaseous compressed oxygen
HEENT	head, eyes, ears, nose and throat
HIV	human immunodeficiency virus
HSV	herpes simplex virus
IM	intramuscular
IO	intraosseous
IV	intravenous
LCD	liquid crystal display
MDI	metered dose inhaler
MI	myocardial infarction
NPO	nothing by mouth
$P\text{CO}_2$	partial pressure of carbon dioxide
PIH	pregnancy-induced hypertension
PPV	positive pressure ventilation
psi	pounds per square inch
RBC	red blood cells
TUC	time of useful consciousness
URTI	upper respiratory tract infection