sputum is raised. Rales and rhonchi are heard throughout the chest, and breath sounds are diminished. Patient may develop a shocklike state, with clammy skin, low blood pressure, and feeble rapid heart action.

(2) Protective mask offers adequate protection. Treatment is rest, oxygen therapy, cautious use of IV therapy, codeine for cough control, and antibiotic therapy to prevent secondary infections. Do not use expectorants or atropine. Patients who survive the first 48 hours usually recover.

e. Blood agents (cyanides). Hydrocyanic acid (AC) and cyanogen chloride (CK) are the important agents in this group. AC is a colorless, highly volatile liquid that is highly soluble and stable in water. It has a faint odor like peach kernels or bitter almonds. It is nonpersistent. CK is a colorless, highly volatile liquid that is slightly soluble in water but dissolves readily in organic solvents. It has a pungent, biting odor and is nonpersistent.

(1) Symptoms produced by AC depend upon the concentration of the agent and duration of exposure. Typically, either death occurs rapidly or recovery takes place within a few minutes after removal from the toxic area. Moderate exposure causes vertigo, nausea, and headaches followed by convulsions and coma. Severe exposure causes an increase in the depth of respiration within a few seconds, cessation of regular respiration within 1 minute, occasional shallow gasps, and finally cessation of heart action within a few minutes.

(2) Symptoms of CK are immediate intense irritation of the nose, throat, and eyes, with coughing, tightness in the chest, and tearing. The patient may become dizzy and increasingly dyspneic. Unconsciousness is followed by failing respiration and death within a few minutes. Convulsions, retching, and involuntary urination and defecation may occur. If effects are not fatal, signs and symptoms of pulmonary edema may develop: persistent cough with frothy sputum, rales in the chest, severe dyspnea, and marked cyanosis.

(3) Mask immediately. Crush 2 ampules of amyl nitrite and insert into the region of the eyelenses of the mask. Repeat every 4-5 minutes until a total of 8 ampules have been used or normal respiration has resumed. Give artificial respiration if patient is not breathing. Second step in emergency treatment is IV administration of 10 ml. of 3% sodium nitrite over a 1-minute period plus 50 ml. of a 25% solution of sodium thiosulfate given slowly IV. Further treatment is symptomatic. Recovery from AC or CK may disclose residual C.N.S. damage with irrationality, altered reflexes, and unsteady gait that may last for weeks, months, or be permanent.

f. Incapacitating agents. Agents producing a temporary disabling condition that persists for hours to days after exposure to the agent has ceased.

(1) Signs and symptoms produced by incapacitating agents.

Signs and symptoms	Possible etiology
Restlessness, dizziness, or giddiness; failure to obey orders, confusion, erratic behavior, stumbling or staggering, vomiting.	Anticholinergics, indoles, cannabinols. Anxiety reaction. Other intoxications (e.g., alcohol, bromides, barbiturates, lead).
Dryness of mouth, tachycardia at rest, elevated temperature, flushing of face; blurred vision, pupillary dilation; slurred or nonsensical speech, hallucinatory behavior, disrobing, mumbling and picking behavior, stupor and coma.	Anticholinergics (e.g., BZ).
Inappropriate smiling or laughing, irrational fear, distractability, difficulty expressing self, perceptual distortions; labile increase in pupil size, heart rate, B.P.; stomach cramps and vomiting may occur.	Indoles (e.g., LSD). (Schizophrenic psychosis may mimic in some respects.)
Euphoric, relaxed, unconcerned daydreaming attitude, easy laughter; hypotension and dizziness on sudden standing.	Cannabinols (e.g., marihuana).
Tremor, clinging or pleading, crying; clear answers, decrease in disturbance with reassurance; history of nervousness or immaturity, phobias.	Anxiety reaction.

(2) General treatment consists of close observation, restraint and confinement as required, supportive care with fluids, and appropriate clothing. Underlying medical problems should be treated as needed. If the specific agent can be identified, treat appropriately.

g. Vomiting agents. Produce a strong pepperlike irritation in the upper respiratory tract with irritation and tearing of the eyes. Principal agents of this group are DA, DM, and DC that are usually dispersed by heat as fine particulate smoke. When concentrated, DM smoke is canary yellow,

DA and DC smokes are white. All are colorless when diluted with air.

(1) Vomiting agents produce a feeling of pain and fullness in the nose and sinuses accompanied by severe headache, intense burning in the throat, tightness and pain in the chest, irritation and tearing of the eyes, uncontrollable coughing, violent and persistent sneezing, runny nose, and ropy saliva flow from the mouth. Nausea and vomiting are prominent and mental depression may occur. Onset of symptoms may be delayed several minutes after exposure. Mild exposure symptoms resemble those of a severe cold.

(2) Most individuals recover promptly after removal from the contaminated area. The few that don't can receive symptomatic relief by inhaling chloroform vapors either directly from a bottle or by pouring a few drops into the cupped palms and breathing. Chloroform is inhaled until the symptoms or irritation subside and is repeated when the symptoms become severe again. Do not use to the point of anesthesia. Aspirin may be given to relieve the headache and general discomfort.

h. Irritant agents (CS, CN, CA). CS has a pungent pepperlike odor. It is faster acting, about 10 times more potent, and less toxic than CN. CN has an apple blossom odor, and CA has a sour fruit odor.

(1) With CS there is marked burning pain and tearing of the eyes, runny nose, coughing, and dyspnea. Following heavy exposure there may be nausea and vomiting. Warm moist skin, especially on the face, neck, ears, and body folds, is susceptible to irritation by CS. CS causes a stinging burning sensation even at moderately low concentration. Higher concentrations may cause an irritant dermatitis with edema and (rarely) blisters. An increase in the stinging is usually noted upon leaving the contaminated area, but usually subsides in 5-10 minutes. CN and CA cause basically the same reaction as CS, but require a higher concentration and are more toxic.

(2) When it is safe to do so, remove mask and blot eyes. Do not rub the eyes. Flush the eyes with copious amounts of water. To prevent skin reaction, rinse the body with water or 5 or 10% sodium bicarbonate in water. Delayed erythema (irritant dermatitis) may be treated with a bland shake lotion. Most persons affected by irritant agents require no medical treatment. Severe reactions of the eyes or skin may take days or weeks to heal depending on their severity.

CHAPTER 15

SHOCK

15-1. SHOCK. A breakdown of effective circulation at the cellular level and/or failure of the peripheral circulatory system. Failure causes tissue perfusion to become inadaquate to feed the body cells.

15-2. CAUSES. Different types of shock result from different kinds of failure in the circulatory system.

a. Hypovolemic shock (peripheral resistance). Caused by hemorrhage, burns (loss of plasma), and/or decreased body water and electrolytes (vomiting and bowel obstruction or diarrhea).

b. Cardiogenic shock (resistance to heart muscle, pump failure). Caused by myocardial infarction, cardiac arrhythmias, and congestive heart failure. Pump failure of the heart causes a reduction in blood flow and then blood backs up behind the heart, causing an increase in venous pressure.

c. Neurogenic shock. Caused by spinal injuries, spinal anesthesia, trauma, manipulation of fractures, and some head wounds. There is a failure of arterial resistance with a pooling of blood in dilated capillary vessels. Cardiac activity increases in an attempt to increase the blood volume to preserve capillary pressure.

d. Septic shock. Caused by wound infection, peritonitis, meningitis, etc. Septic shock is usually caused by gram-negative bacteria causing a septicemia (invasion of the blood by pathogenic bacteria or their toxins). Hypovolemia develops as a result of pooling of blood in the capillaries and a loss of fluid from the vascular space as a result of a generalized increase in capillary permeability. There is also a possibility of a direct toxic effect on the heart with depressed cardiac function. Peripheral resistance is usually decreased but can increase as shock worsens.

e. Anaphylactic shock. Acute, often explosive, systemic reaction characterized by urticaria, respiratory distress, vascular collapse, and occasionally vomiting, cramps, diarrhea.

(1) Signs and symptoms. Usually occurs in 1-15 minutes; patient becomes agitated, uneasy, and flushed. Palpitations, paresthesia, pruritus, throbbing in the ears, coughing, sneezing and difficulty in breathing, followed by dizziness, disorientation, collapse, coma, and death.

(2) Treatment.

(a) Epinephrine solution, 1:1,000, 0.4-1 ml., IV stat. Repeat every 5-10 min p.r.n.

(b) Recumbent position, elevate legs, establish airway (tracheostomy if necessary).

(c) Diphenhydramine HCl, 5-20 mg. IV p.r.n.

(d) Aminophylline solution, 250-500 mg. IV slowly for severe asthma without shock.

(e) IV fluids to correct hypovolemia if present.

(f) Hydrocortisone sodium succinate, 100-250 mg. IV over 30 seconds for hypotension control if needed.

(g) +for injected antigen (e.g., vaccination) a constricting band (rarely a tourniquet) should be applied proximal to the injection site. An additional 0.1-0.2 ml. epinephrine (1:1,000) may be injected into the site to reduce systemic absorption.

(h) +oxygen should be utilized if available at 4-6 liters/minute.

(i) Definitive care p.r.n. and continue observation for 24 hours.

15-3. SIGNS AND SYMPTOMS OF SHOCK.

a. Shock chart.

Degree of Shock	Blood Volume Loss	B.P. (approx)	Pulse	Temp	Color	Circu-lation	Thirst	Mental State
Mild	Up to 20%	Up to 20% Increase	Normal	Cool	Pale	Slowing	Normal	Clear Distinct
Moderate	20-40%	Decrease 20-40%	In-creased	Cool	Pale	Slowing	Definite	Clear With Apathy
Severe	40% or More	Decreased Below 40%	Weak to Absent	Cold	Ashen to Cya-notic	Very Sluggish	Severe	Apathetic to Comatose

b. The patient appears anxious and looks tired. Later he appears apathetic or exhausted. If bleeding continues, the patient will go into a coma and die.

c. The skin usually feels cool, is pale and mottled, and nail beds blanch easily.

d. The pulse and blood pressure are not totally accurate.

(1) Decreased blood pressure is always significant.

(2) In a healthy adult, blood pressure may remain normal until large volumes of blood are lost.

(3) Respirations, heart beat, and pulse are usually increased, but this increase may not occur in the prone position. If the patient is in shock and you sit him up, the systolic blood pressure will show a decrease of up to 15 mm. and you will observe an increase of 15 beats or more in the pulse.

15-4. TREATMENT.

a. Hemorrhagic shock - low peripheral vein pressure. You can

expect early collapse of the usual IV routes; venous cutdown may be indicated.

b. Primary therapy for hypovolemic and hemorrhagic shock.

(1) Standard IV fluids listed in order of effectiveness.

(a) Whole blood - administer with crystalloid solutions.

(b) Plasma - administer with crystalloid solutions.

(c) Serum albumin - administer with crystalloid solutions.

(d) Dextran - should administer with crystalloid solutions.

(e) Lactated Ringer's solution (crystalloid).

(f) Normal saline (crystalloid).

(g) D5W - use alone only if nothing else is available (crystalloid).

(2) To insure adequate IV fluids you should monitor the urinary output.

(3) Keep patient warm and dry and place in the shock position unless contraindicated, e.g., head wounds, chest wounds.

(4) Analgesics such as morphine should be given for pain as necessary.

(5) Broad spectrum antibiotic treatment should be started as soon as possible as a prophylaxis for large wounds or burns.

CHAPTER 16

EMERGENCY WAR SURGERY

16-1. PRIORITIES OF TREATMENT.

a. The following priorities for surgical intervention are recommended. Injuries are dealt with on an individual basis.

b. Follow the rule of ABC.

A - Airway. Insure it is clear.

B - Breathing. Insure patient is able to breath, e.g., no sucking chest wounds, etc.

C - Circulation. Insure heart is beating and there is adequate circulating blood volume.

c. First priority.

(1) Asphyxia, respiratory obstruction from mechanical causes, sucking chest wounds, tension pneumothorax, and maxillofacial wounds in which asphyxia exists or is likely to develop.

(2) Shock caused by major external hemorrhage, major internal hemorrhage, visceral injuries, massive muscle damage, major fractures, multiple wounds, and severe burns over 20% of the body.

d. Second priority.

(1) Visceral injuries, including perforations of the gastrointestinal tract, wounds of the biliary and pancreatic systems, wounds of the genitourinary tract, and thoracic wounds without asphyxia.

(2) Vascular injuries requiring repair. All injuries in which the use of a tourniquet is necessary fall into this group.

(3) Closed cerebral injuries with increasing loss of conciousness.

(4) Burns of 20% of certain locations; hands, feet, genitalia, and perineum.

e. Third priority.

(1) Brain and spinal injuries in which decompression is required.

(2) Soft-tissue wounds in which debridement is necessary but in which muscle damage is less than major.

(3) Lesser fractures and dislocations.

(4) Injuries of the eye.

(5) Maxillofacial injuries without asphyxia.

(6) Burns of other locations under 20%.

16-2. SOFT TISSUE INJURIES.

a. In the following surgical procedures we will assume that the medic knows how to prepare a patient for surgery and set up for sterile procedures.

b. The primary objective in the treatment of soft tissue injuries is localization or isolation of the deleterious effects of the injury. To best accomplish this objective, remove all foreign substances and devitalized tissue and maintain an adequate blood supply to the injured part. This can be achieved by a two-step procedure.

(1) Step one is a thorough debridement of the injured area, accomplished as early as possible after the injury (when delay is unavoidable, systemic antibiotics should be started). The wound is left open, with few exceptions, to granulate.

(2) Step two is a delayed primary closure (DPC) within 4-10 days after injury. The wound must be kept clean during this time and antibiotics are usualy indicated. The indication for a DPC is the clean appearance of the wound during this time.

c. Antibiotic wound therapy. Should be started prior to debridement.

(1) Penicillin (aqueous) - 10 million units IV q.8h. x 3 days then reevaluate.

(2) Kanamycin - 500 mg. IM q.12h. x 3 days then reevaluate.

(3) Tetanus toxoid - 0.5 cc. IM or SQ once (test for allergy only if not previously immunized).

d. Wound debridement.

(1) An incision is made in the skin and fascia long enough to give good exposure. Good exposure is required for accurate evaluation. Incisions are made over both the entry and exit wound along the longitudinal axis of extremities (S-shaped crossing joint creases). Avoid making an incision over superficial bones. When excising skin only, cut 2-3 cm. from the wound edge.

(2) Skin, fascia, and muscle should be separated to give adequate exposure. Muscles should be separated into their groups and each muscle group debrided separately.

(3) Distinguishing tissue viability. Use the four Cs: color, consistency, contractility, and circulation; color being the least desirable.

	Viable	Dead or Dying
Color	Bright reddish brown	Dark, cyanotic
Consistency	Springy	Mushy

Contractility	Contracts when pinched or cut	Does not contract when pinched or cut
Circulation	Bleeds when cut	Does not bleed when cut

(4) Steps of debridement. All devitalized muscle must be removed; if not, the chance of infection is greater. It is better to take good muscle tissue and have some deformity than to leave devitalized muscle and have infection. The preferred method of debridement is to cut along one side of a muscle group in strips or in blocks and not piecemeal or in small bunches.

(a) Remove all blood clots, foreign material, and debris from the wound during exploration of the wound with a gloved finger.

(b) Vital structures like major nerves and blood vessels must be protected from damage.

(c) All procedures must be carried out gently with precision and skill.

(d) Major blood vessels must be repaired promptly.

(e) All foreign bodies must be removed, including small detached bone fragments, but time should not be wasted looking for elusive metallic fragments that would require more extensive dissection.

(f) Tendons usually do not require extensive debridement. Trim loose frayed edges and ends. Repair should not be performed during initial treatment.

(g) Hemostasis must be precise.

(h) Repeated irrigations of the wound with physiologic salt solution during the operation will keep the wound clean and free of foreign material. This step cannot be overemphasized.

(i) When debridement is complete, all blood vessels, nerves, and tendons should be covered with soft tissue to prevent drying and maceration.

(j) Joint synovium should be closed or at least the joint capsule. The skin and subcutaneous tissue is left open in any case.

(k) Dependent drainage of deep wounds must be employed.

(l) Liberal fasciotomy of an extremity is often an additional precaution that allows for postoperative swelling. Use when the five Ps are present distal to an injury or wound (pain, pallor, pulselessness, puffiness, and paresthesia).

(m) DO NOT dress the wound with an occlusive dressing, but place a few wide strips of fine-mesh gauze between the walls of the wound; place fluffed gauze in the pocket that is formed, then dress the wound to protect but not constrict.

(n) All wounds will be left open with the exception of

wounds of the face, sucking chest wounds, head wounds, wounds of the joint capsule or synovial membrane, and wounds of the peritoneum.

(o) Immobilization and correct positioning of the injured part promotes healing, and these measures should be used even if no fracture is present.

16-3. VASCULAR INJURIES. Although a vascular injury is extremely serious, you must consider the equipment available, other injuries to the patient, and other casualties.

a. Accurate diagnosis of a vascular injury may not be possible until exploration is undertaken, but the following signs and symptoms may be used as evidence of arterial damage:

(1) Extremity may be pale, waxy, mottled, cyanotic, and cold.

(2) Pulse may be absent, but the presence of a pulse does not rule out arterial injury.

(3) Analgesia, loss of voluntary motion of extremity, muscle spasm or contracture may be present.

(4) External hemorrhage, like bright red spurting blood, may or may not be present.

(5) The affected limb may be larger than the intact limb.

b. There is no set time when a vascular injury must be repaired to insure saving the limb, but the longer the time lag, the greater the failure rate. The best results are obtained within 6 to 10 hours of the injury.

c. You probably will not be able to undertake major vascular repairs, but you should have the equipment to handle arterial lacerations caused by low velocity missiles or sharp instruments.

(1) Clamps of a noncrushing type should be applied to the injured artery, the first proximal to the injury and the second distal.

(2) Keep the artery moist with a saline solution.

(3) All debridement accomplished by the standard technique should be completed before arterial repair is begun.

(4) Run a Fogarty balloon catheter distally in the artery to determine the patency. This will also clear any distal thrombus.

(5) Use a continuous suture of 5-0 or 6-0 synthetic suture with a fine curved, noncutting swaged needle.

(6) Release the clamps and observe for leaks.

(7) Dress the wound as a soft tissue injury.

d. When the muscle tissue is of questionable viability after arterial continuity has been restored, the patient is observed for:

(1) A decrease in urinary output.

(2) Increasing pain toxicity, confusion, and fever.

(3) Increase in pulse rate.

(4) Evidence of clostridial myositis.

e. If this evidence is present, excision of necrotic muscle tissue or early amputation may be called for. It is usually safe to hold off on amputation for up to 5 days until a line of demarcation is established.

16-4. BONE AND JOINT INJURIES.

a. For all open bone and joint injuries, the following principles apply:

(1) Initial determination of the extent of the wound and the structures involved.

(2) Generous extensile incision and removal of foreign material, debridement, and removal of small bone chips.

(3) Arthrotomy.

(4) Vascular repair and fasciotomy.

(5) Wound is left open for delayed primary closure.

(6) Bulky nonocclusive dressing and immobilization of fractures, nonfractures, and joint injuries.

(7) Documentation of everything observed.

b. War wound therapy is indicated in all open bone or joint injuries.

16-5. PERIPHERAL NERVE INJURIES.

a. The field medic does not have the equipment or the expertise to perform nerve repair. Nor is it really necessary.

b. Closed nerve injuries are never surgically explored. Open injuries of nerves are handled as any other soft-tissue injury with the nerve left intact and covered with muscle tissue to prevent exposure.

16-6. AMPUTATIONS.

a. Amputations are performed to save life and are done at the lowest level possible. All attempts should be made to save the knee and elbow joints even if this means having a short stump.

b. Indications for amputation are:

(1) Massive gas gangrene (clostridial myositis).

(2) Overwhelming local infection that endangers life despite antibiotic therapy and surgical measures.

(3) Established death of a limb.

(4) Massive injuries in which structures of a limb are obviously nonviable.

(5) Secondary hemorrhage in the presence of severe infection.

(6) Extremities with severe involvement of skin, muscle, and bone with anesthetic terminus and irreparable nerve damage.

c. Under combat conditions the most acceptable type of amputation is the open circular technique.

(1) A circumferential incision is made through the skin and deep fascia at the lowest viable level. This layer is allowed to retract.

(2) The muscle bundles are exposed and then divided circumferentially at the new level of the skin edge. The muscle bundles will retract promptly exposing the bone.

(3) Upward pressure is placed on the proximal muscle stump and the bone is then transected at a still higher level. The surgical wound will have the appearance of an inverted cone.

(4) Blood vessels are isolated, clamped, and ligated as they are encountered. Bone wax is applied to the open end of the bone to prevent oozing.

(5) Major nerves are transected at the highest level possible.

(6) Never close an amputation primarily.

(7) Cold injuries are not indications for emergency amputation. Wait until the edges demarcate.

d. A layer of fine mesh gauze is placed over the wound and the recess is packed loosely with fluffed gauze. A stockinette is then applied over the stump securing the stockinette above the stump using liquid adhesive. The stump is then wrapped with ace wraps using compression decreasing proximally and 5 to 6 pounds of traction is applied. Continued traction will result in secondary skin closure over the stump.

16-7. REGIONAL INJURIES.

a. Craniocerebral injuries. Serious injuries to the head require more extensive surgery than can be done in the field. There are some expedient measures, however, that can be taken to give the patient a chance. These are:

(1) Prophylactic antibiotic therapy.

(2) Grossly devitalized and contaminated soft tissue and bone should be removed, along with any foreign material, visible on inspection, superficial to the dura. The dura should not be attacked.

(3) Gently irrigate the wound with physiologic salt solution and ligate all bleeding vessels. Gelfoam can be used to control oozing.

(4) If possible, the scalp wound should be loosely approximated to provide temporary coverage.

(5) Sterile petroleum-impregnated gauze should be laid over the wound. A thick gauze dressing should be placed over that and held in place by a bandage.

(6) High priority should be given for evacuation.

(7) Mark the medical record prominently and call attention to the incompleteness of treatment.

b. Spinal cord injuries.

(1) The primary aim of early surgical treatment of open spinal cord injuries is the prevention of localized or general infection including meningeal infections.

(2) The patient is placed on a frame made with two stretchers. He is sandwiched face down between the stretchers with holes cut out of the stretchers to expose the injury, the genitals, and the face.

(3) General debridement is then performed, with special care given to isolating the spinal wound from an abdominal wound when present.

(4) If dura is visualized and appears lacerated, place gelfoam over area and close overlying muscles and skin with sutures.

(5) Prophylactic antibiotic therapy should be initiated.

c. Maxillofacial injuries.

(1) The primary concern in facial injuries is the maintenance of a patent airway.

(2) Once an airway is opened, minimal debridement is performed and the wound is closed primarily.

(3) Prophylactic antibiotic therapy should be initiated.

(4) Fractures are handled in the best way possible. The main thing is to immobilize the fracture.

d. Eye injuries.

(1) Conjunctival foreign body.

(a) Pull eyelid away from eye.

(b) Pass a sterile wet cotton applicator across the conjunctival surface. Touching the object with the wet applicator makes it stick to the applicator.

(2) Corneal foreign body.

(a) Place a fluorescein strip in the corner of the eye, then examine the cornea with the aid of a magnifying device and strong illumination.

(b) Remove the foreign body with a sterile wet cotton applicator.

(c) Apply an antibiotic opthalmic ointment.

(d) Reexamine the eye for secondary infections 24 hours later.

(3) Lacerations of eyelid.

(a) Lid laceration not involving the lid margin can be sutured like any other laceration.

(b) If the lid margin is lacerated, the patient should be evacuated for specialized care to prevent permanent notching.

(4) Laceration of conjunctiva.

(a) Superficial lacerations of the conjunctiva do not require sutures.

(b) Apply broad-spectrum antibiotic opthalmic ointment until the laceration heals.

(5) Deep laceration or puncture wounds of the eye, foreign bodies that can't be removed, or vitreous hemorrhage (blood in the vitreous body may obscure a retinal detachment).

(a) Apply anesthetic drops to the eye.

(b) Bandage both eyes lightly and cover injured eye with an eye shield.

(c) Evacuate as soon as possible.

e. Ear injuries.

(1) You are limited to surgical repair of the external ear.

(2) Perform minimal debridement.

(3) Close lacerations in layers, being careful to realign the cartilage.

(4) Initiate prophylactic antibiotic therapy.

f. Neck injuries. Wounds of the neck are very serious and usually complicated.

(1) Establish and maintain a patent airway.

(2) Carefully debride the wound.

(3) Initiate prophylactic antibiotic therapy.

g. Chest injuries.

(1) The treatment of chest wounds is based upon the following special principles of management.

(a) Normal pleural and pericardial pressures must be maintained.

(b) The pleural space must be kept empty.

(c) The bronchial tree must be kept clean.

(d) Ventilation sufficient for adequate oxygenation and removal of carbon dioxide must be assured.

(e) The amount of hemorrhage must be estimated and blood replaced as necessary.

(2) Pneumothorax.

(a) Seal the wound(s) airtight.

(b) Place a chest tube anteriorly in the second interspace.

(c) Hook the chest tube into a closed drainage system with a waterseal.

(3) Hemothorax.

(a) Seal the wound(s) airtight.

(b) Place a chest tube through the chest wall in the midaxillary line for the removal of blood and fluid.

(4) Cardiac tamponade (fluid buildup in the pericardial sack causing muffled heart sounds and added pressure on the heart).

(a) Pericardium must be aspirated.

1. Insert cardiac needle in the angle between the xiphisternum and the costal margin.

2. Pass the needle upward and backward at a 45-degree angle into the pericardium.

3. Remove only enough fluid to improve the patient's blood pressure and pulse.

(b) Continue to monitor the patient's heart sounds, pulse, and blood pressure.

(5) Severe flail chest.

(a) Immediately intubate.

(b) Place a chest tube in the same way as with pneumothorax.

(c) Initiate positive pressure breathing.

(d) For lesser degrees of flail chest, strap the affected side with a firm dressing.

h. Abdominal injuries. The only abdominal wound we will discuss is evisceration.

(1) Stabilize the patient.

(2) Initiate prophylactic antibiotic therapy.

(3) Remove bowels from abdominal cavity and check for nicks and cuts.

(4) Suture or tag any nicks or cuts.

(5) Irrigate the abdominal cavity with sterile saline solution and remove all foreign material.

(6) Replace all good bowel into the abdominal cavity leaving the sutured and/or tagged bowel outside.

(7) Close the abdominal cavity partially and in layers leaving the tagged and sutured bowels outside on a sterile dressing to drain.

(8) Keep the patient NPO.

(9) Evacuate as soon as possible.

CHAPTER 17

ANESTHESIA

17-1. CHOICE OF ANESTHESIA.

a. In a general hospital 70-75 percent of surgery is performed under general anesthesia and the remainder under regional or local anesthesia. Operating outside a hospital these percentages should be turned around.

b. General anesthesia carries a risk with it no matter how simple the surgical procedure. Local anesthesia is often preferable to general anesthesia for the following reasons: The technique is simple and minimal equipment is required; there is less bleeding, nausea, and vomiting and less disturbance to body functions; it can be used when general anesthesia is contraindicated (e.g., recent ingestion of food by the patient); less postoperative observation and patient care are required; and there is a much lower incidence of pulmonary complications.

c. Regional anesthesia (regional block) produces complete sensory block; it prevents nerve impulses from passing by injecting the anesthetic solution around the nerve trunk at a distance from the area to be anesthetized. Regional blocks can be used almost anywhere in the body, but we will confine the blocks to dental and the upper extremities.

17-2. LOCAL ANESTHETICS.

a. Doses of local anesthetics for topical use:

Drug	Concentration	Duration	Maximal Dose
Cocaine	4%	30 min	200 mg.
Lidocaine (Xylocaine)	2-4%	15 min	200 mg.
Tetracaine (Pontocaine)	0.5%	45 min	50 mg.
Benzocaine	2-10%	Several hours	

b. Doses of local anesthetics for infiltration and nerve blocks:

Drug	Concentration	Duration	Maximal Dose
Procaine (Novocain)	2-4%	1/2 hr	1,000 mg.
Lidocaine (Xylocaine)	1-2%	1-2 hr	500 mg.
Mepivacaine (Carbocaine)	1-2%	1-2 hr	500 mg.
Tetracaine (Pontocaine)	0.1-0.25%	2-3 hr	75 mg.
Chloroprocaine (Nesacaine)	1-2%		1,000 mg.
Piperocaine (Metycaine)	1-2%		750 mg.
Hexylcaine (Cyclaine)	1-2%		500 mg.
Prilocaine (Citanest)	1-2%		500 mg.
Bupivacaine (Marcaine)	0.5%	5-7 hr	200 mg.
Etidocaine (Duranest)	0.5-1%	4-6 hr	300 mg.

c. Local anesthetic drugs (except cocaine) dilate the blood vessels, causing an increased rate of absorption and decreased duration of anesthetic action. A vasoconstrictor drug (epinephrine) may be added to injectable local anesthetic solutions to prolong and increase the anesthetic effect. Epinephrine counteracts the depressing action of local anesthetics on the heart and circulation. Epinephrine is used in concentrations of 1:100,000 (1 mg./100 ml.) or 1:200,000 (1 mg./200 ml.).

Stronger solutions should not be used because they may cause tissue damage due to ischemia.

Contraindications to adding epinephrine to local anesthetics are:

(1) Patients with history of hypertension, thyrotoxicosis, diabetes, or heart disease.

(2) Surgery on fingers or toes because severe vasospasm and ischemia of the extremities may occur.

d. Local anesthetics are used either topically or by infiltrating (injecting) the anesthesia directly around the area of surgery.

17-3. REGIONAL NERVE BLOCKS.

a. Nerve blocks are extremely effective, but in order to succeed with a nerve block you must know the anatomy of the area you want to block.

b. Premedication should be given before a nerve block is performed. Often premedication will make a block successful, especially if the patient interprets touch and motion as pain.

(1) 100 mg. (1 1/2 gr.) of phenobarbital by mouth can be given 1 1/2 to 2 hours before the block is performed.

(2) 50 to 100 mg. of phenobarbital can be given IV just before the block is performed.

(3) An alternate would be 1/8 to 1/4 gr. morphine prior to the block.

c. Axillary block of the brachial plexus.

(1) Indications. Surgery or setting fractures of the arm, forearm, and hand.

(2) Contraindications. Local infection or inflammation of the axillary nodes.

(3) Axillary blocks are used because of ease and accuracy of placement of the needle as well as the minimal incidence of complications. Additional advantages are that the axillary block can be repeated if necessary during the course of a lengthy operation and it is easily applied to a child or a somewhat uncooperative patient.

(4) The brachial plexus, axillary artery, and axillary vein are enclosed in a neurovascular compartment in the axilla. Solution injected into this sheath is limited and can spread only up or down, parallel to the neurovascular bundle.

(5) Technique. The axilla should be shaved and the arm abducted 90 degrees with the forearm flexed at a right angle and lying flat on a table. A pneumatic tourniquet (B.P. cuff) is placed just below the axilla to direct the local anesthetic toward the supraclavicular region.

The tourniquet is removed after the injection is completed. Standing at the patient's side, palpate the axillary artery as high as

possible and fix it with your index finger against the humerus. Using a 23-gage needle (or smaller; larger needles can cause hematomas if the artery is punctured), raise a skin wheal. Insert the needle at a 45-degree angle in the direction of the artery until pulsations of the axillary artery are transmitted to the needle.

This is most often preceded by a palpable click as the needle penetrates the deep fascia forming the axillary sheath. If there is paresthesia radiating down the arm to the fingers or if you aspirate blood, you are in the right area. If you aspirate blood, withdraw the needle slowly until the aspiration of blood stops. In either case you can then inject 30-40 ml. of 1% lidocaine with 1:200,000 epinephrine.

The intercostobrachial nerve that innervates the skin of the upper half of the medial and posterior side of the arm is sometimes missed but can be anesthetized by a subcutaneous injection of 3 ml. of 1% lidocaine and 1:200,000 epinephrine over the axillary artery.

AXILLARY BLOCK OF THE BRACHIAL PLEXUS.

d. Nerve block of the wrist.

(1) Indications. Surgery or setting fractures of the hand or fingers.

(2) There are three major nerves that innervate the hand and fingers: the radial nerve, the median nerve, and the ulnar nerve. To completely block the hand and fingers, all three nerves must be blocked.

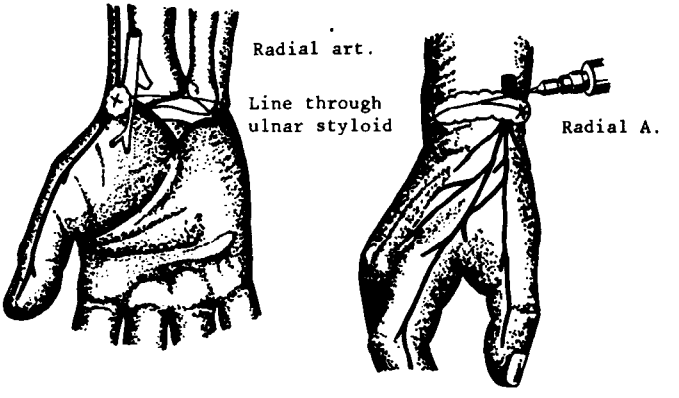
(3) For these blocks use the principle "No paresthesia no anesthesia."

(4) No more than 50 mg. of anesthesia should be used for the entire block.

(a) The radial nerve innervates the thumb and the back of the first three fingers. It is anesthetized by subcutaneous infiltration at the dorsolateral aspect of the wrist, using slow careful movement of the needle to insure an even distribution of the anesthetic solution.

1. Technique. Form a skin wheal, using a 22-gage needle (or smaller) at the point shown in the drawing. Working through the skin wheal with the syringe parallel to the nerve, elicit paresthesia (an electric shocklike sensation) in the thumb and the back of the first three fingers. When paresthesia is achieved, aspirate to insure you are not in a blood vessel, then inject 10 ml. of 1% lidocaine in a ring fashion. Begin lateral to the radial artery and extend the ring to the center of the back of the hand using slow, careful movement to insure even distribution. No

more than 20 cc. of 1% lidocaine should be used for the entire procedure.

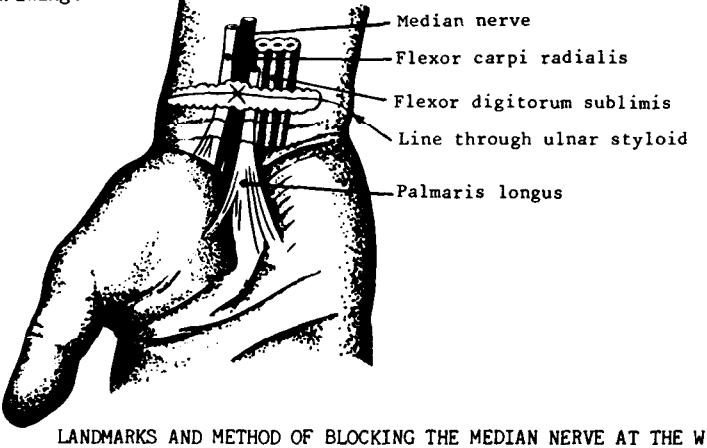


LANDMARKS AND METHODS OF BLOCKING THE RADIAL NERVE AT THE WRIST.

2. Complications. IV injection and/or hematoma of the joint.

(b) Median nerve innervates the palm of the hand, the index finger, the middle finger, and the radial side of the ring finger.

1. Technique. Locate the palmaris longus ligament and form a skin wheal, using a 22-gage needle (or smaller), just to the radial side of the palmaris longus. Working through the skin wheal, attempt to elicit paresthesia in the palm of the hand and fingers. When paresthesia is achieved, aspirate, then inject 5 ml. of 1% lidocaine. Then begin at the wheal and using slow, careful movements to insure even distribution, inject in a line right and left of the median nerve as depicted in the drawing.



LANDMARKS AND METHOD OF BLOCKING THE MEDIAN NERVE AT THE WRIST.

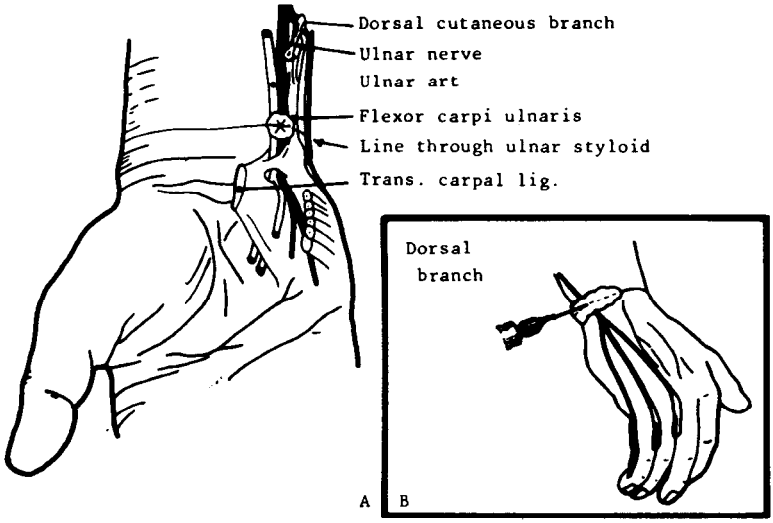
The injection to the right and left might not be necessary, but

occasionally there are collateral nerves that have moved down into the palm, and this will anesthetize them also.

2. Complications. IV injection and/or hematoma.

(c) Ulnar nerve innervates the ulnar side of the ring finger, the little finger, the ulnar side of the palm, and the back of the little and ring fingers.

1. Technique. Locate the flexor carpi ulnaris (see drawing) by palpation on a line through the ulnar styloid. Using a 22-gage needle, raise a skin wheal just lateral to the flexor carpi ulnaris. Working through the skin wheal, introduce the needle in the direction of and parallel to the nerve. After achieving paresthesia and aspiration, inject 5 ml. of 1% lidocaine with 1:200,000 epinephrine.



LANDMARKS AND METHODS OF BLOCKING THE ULNAR NERVE AT THE WRIST.

A. Volar Branch B. Dorsal Branch.

Once this is done begin at the skin wheal and extend the anesthesia dorsally in a ring fashion to the center of the back of the hand, using slow careful movement to insure even distribution of the anesthesia in the subcutaneous layer.

2. Complications. IV injection and/or hematoma.

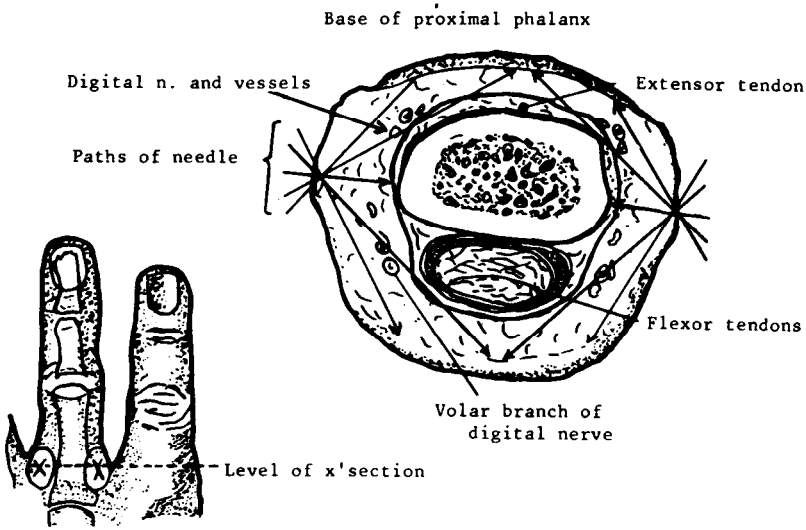
e. Digital block (fingers & toes).

(1) No premedication is necessary.

(2) Do not use vasoconstrictor agents (epinephrine).

(3) Do not exceed 8 cc. of anesthesia per digit.

(a) Technique. Raise a skin wheal on the dorsolateral sides of the digit at the interdigital folds (see drawing).



LANDMARKS AND METHOD OF BLOCKING DIGITS.

Working through the wheals in a fan-shaped method, place a ring of local anesthetic around the digit (see drawing). Massage the digit where the anesthesia was deposited to facilitate spread of the solution.

(b) Repeat the block if analgesia is inadequate.

(c) Complications. IV injection and/or hematoma.

17-4. GENERAL ANESTHESIA.

a. Ideally, the patient should have a complete physical and history done at least a day before surgery. Special examinations and laboratory work should be done as needed. The patient should have a good night's sleep and be placed N.P.O. 6-8 hours prior to surgery. The operation should be explained to the patient to help calm his fears. Finally, the patient should receive the proper premedication.

b. Premedication.

(1) Produces psychic sedation (relaxes and calms the patient, making administration of anesthesia easier).

(2) Reduces metabolic rate and decreases reflex irritability.

(3) Reduces quantity of anesthetic drug necessary.

(4) Minimizes or abolishes secretions of saliva and mucus.

(5) There are a wide range of sedatives, narcotic analgesics,

tranquilizers, and belladonna compounds (atropine and scopolamine) that can be used as preanesthesia medication. You must determine which is best for your situation. A good example is:

(a) Adult premedication.

1. Place patient N.P.O. 6-8 hours preoperatively.

2. 100 mg. pentobarbital P.O. at bedtime.

3. 100 mg. pentobarbital IM 2 hours preoperatively.

4. 0.5 mg. atropine SQ 1 hour preoperatively.

(b) Child premedication.

Age	Weight		Pentobarbital or Secobarbital	Morphine	Atropine or Scopolamine
Newborn	7 lb	3.2 kg.	----	----	0.1 mg.
6 months	16 lb	7.3 kg.	----	----	0.1 mg.
1 year	22 lb	10 kg.	35 mg.	1 mg.	0.2 mg.
2 years	26.5 lb	12 kg.	50 mg.	1.2 mg.	0.3 mg.
4 years	33 lb	15 kg.	65 mg.	1.5 mg.	0.3 mg.
6 years	44 lb	20 kg.	75 mg.	2 mg.	0.4 mg.
8 years	55 lb	25 kg.	90 mg.	2.5 mg.	0.4 mg.
10 years	66 lb	30 kg.	100 mg.	3 mg.	0.4 mg.
12 years	88 lb	40 kg.	100 mg.	4 mg.	0.4 mg.

1. N.P.O. 6-8 hours preoperatively.

2. _____ mg. pentobarbital, IM 2 hours preoperatively.

3. _____ mg. atropine, SQ 1 hour preoperatively.

c. Ether anesthesia. Used for all types of surgery, particularly that requiring muscle relaxation. It is probably the safest of the inhalation anesthesias. Induction of ether anesthesia is prolonged because of its irritating effects. To shorten the induction period the patient can be preanesthetized ("knocked down") with a nonirritating rapid-acting drug such as sodium pentothal.

(1) Advantages.

(a) Reliable signs of anesthesia depth.

(b) Stimulation of respiration.

(c) Bronchodilation.

(d) Does not depress circulation.

(e) Good muscle relaxation.

(f) Relatively nontoxic and safe. (Death rate is lower than any other anesthesia.)

(2) Disadvantages.

(a) Prolonged induction and recovery.

(b) Irritating action causes secretions of mucus from upper airway.

(c) Emetic action is dangerous in patients with full stomach. (Aspiration pneumonia.)

d. Sodium pentothal. Used for minor procedures of approximately 30 minutes or less. Can also be used as a "knock down" for ether anesthesia.

(1) Technique. Slowly inject the drug through an existing IV. Do not exceed 2 cc. in the first 15 seconds; then stop and wait (patient will be narcotized in 30-40 seconds). Having the patient count will let you know how it is affecting him. Slowly inject 1/2 to 1 cc. from time to time as required.

(2) Disadvantage.

(a) The anesthesia is noncontrollable.

(b) Laryngeal spasm may develop.

(c) The necessary effective dose is difficult to estimate.

(d) A severe respiratory depression ensues.

(e) Pentothal is a barbiturate that does not possess any analgesic properties.

(f) The muscular relaxation is not satisfactory.

(3) Signs of anesthesia. No reliable signs of anesthesia exist. The anesthetist must attempt to maintain the patient between the zones of decreased reflex activity and respiratory and circulatory failure.

(4) Complications.

(a) Respiratory failure.

(b) Hypotension.

(c) Laryngeal spasm.

(d) Slough of skin. Solutions of the sodium salts of barbiturates are alkaline and cause damage to tissues in event of seepage.

(e) Phlebothrombosis.

(f) Prolonged somnolence.

(g) Operations of undetermined length. Large amounts of the drug may be necessary to complete the operation. This causes a marked depression of respiration and circulation from cumulative effects.

(h) Shock from trauma or hemorrhage. Irreversible

respiratory failure or enhancement of hypotension may occur.

(5) Precautions.

(a) The limit should be approximately 1 gram of the drug for an adult.

(b) Be positive that the drug is completely dissolved and that the solution is clear before performing venipuncture. Undissolved particles act as foreign bodies in the solution and may cause "reactions."

(c) Inject the solution slowly. Do not inject more than 6 cc. of a 2-1/2% solution at any one time at the onset.

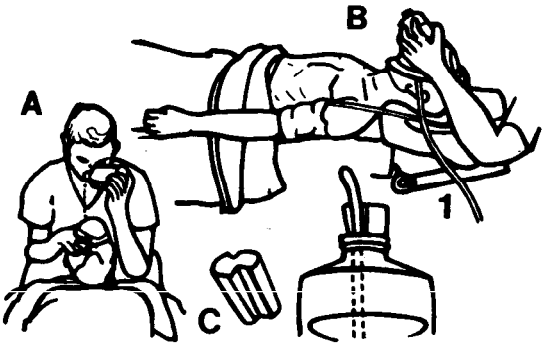
e. Open drop method of inhalation anesthesia. The simplest method requiring the least equipment.

(1) Make a wire frame in a cup shape to fit over the nose and mouth. Pad and tape the bottom edges to make a better fit and protect the patient's face. Place one or two unfolded 4 X 4s over the top to completely cover the frame and tape the edges down. Cut two notches in the cork going into the ether container, one for air to enter the container and one for the wick that will drop the anesthesia on the mask.

(2) By regulating the amount of anesthesia dripped on the mask, you can regulate the depth of anesthesia.

(3) Oxygen can be fed into the mask by running a small tube under the edge of the mask; however, the higher the flow of oxygen the lower the concentration of anesthesia.

(4) Condensation of water vapors on the gauze interferes with vaporization of the anesthesia. The colder the gauze the more rapid the condensation of moisture in the expired air. Replace the gauze as required to correct the impaired vaporization.



TECHNIQUE OF "OPEN DROP" ANESTHESIA. A - Method of supporting the head with the arms. B - Lateral view showing support of head and insufflation of oxygen (1) beneath the mask. C - Cork cut and wick in place to drip ether.

f. Stages and signs of anesthesia. Anesthesia is divided into four

stages, and the third or surgical stage is subdivided into four planes.

STAGE I - ANALGESIA

STAGE II - DELIRIUM

STAGE III - SURGICAL

Plane 1

Plane 2

Plane 3

Plane 4

STAGE IV - RESPIRATORY PARALYSIS

(1) STAGE I. The Stage of Analgesia is that period from the beginning of induction to the loss of consciousness.

(a) Analgesia is the loss of the sense of pain without the loss of consciousness or sense of touch. Pain sense is progressively depressed during this stage. The point of pain abolition is known as total analgesia, and the approach to total analgesia is relative analgesia. The danger and difficulty in achieving and maintaining total analgesia is its proximity to the second stage. It is sometimes attempted, however, in dentistry, obstetrics, and to a small extent in minor surgery.

(b) False anesthesia as a manifestation of hysteria may occur in this stage. The signs may indicate quiet surgical anesthesia, i.e., regular rhythmic respiration with apparent loss of eyelid reflex. Starting the preparation or the operation at this point may precipitate fatal ventricular fibrillation. The only way of differentiating between false anesthesia and true surgical anesthesia is the length of time elapsed since induction. Three or four minutes may be long enough to reach Stage III with cyclopropane and pentothal, but it is not when using ether. When in doubt, wait much longer than you would otherwise wait before starting a procedure.

(c) "Brain anesthesia" is another phenomenon that may be encountered. The brain has a very rich blood supply and high partial pressure of the agent may cause the brain to become saturated with the first few respirations giving the appearance of surgical anesthesia. Subsequently, the agent will diffuse out of the brain almost as rapidly as it diffused in, and the signs will become a more accurate index.

(2) STAGE II. This is the Stage of Delirium or excitement stage and represents the period of the earliest loss of consciousness. The hazards of the second stage are physical injury and ventricular fibrillation.

(a) The higher cerebral or voluntary control centers are abolished, leaving the secondary centers free. Response to stimulation or to dreams the patient may be having is exaggerated and is frequently expressed in violent physical activity. This violence may be initiated by external stimulation such as instruments being knocked together, talking, moving the patient or the operating table, etc. The excitement will be

more pronounced in patients who are afraid. (Who isn't afraid when coming to the operating room?)

(b) The stages of anesthesia are the same whether the patient is going to sleep or waking up. Emergence delirium is less frequently violent than that of induction because of several factors. First, external stimulation is seldom as great; and second, postoperative surgical depression limits the amount of activity. Remember that nonshocking procedures done under short-acting drugs leave the patient potentially as active during emergence as during induction.

(c) Ventricular fibrillation occurs most frequently in the group from 5 to 35 years of age, but may occur at any age. This danger also increases in proportion to the degree of fear--probably due to increased adrenalin output accompanying fear.

(d) Management of the second stage consists of:

1. Reducing nervous irritability by use of adequate premedication.

2. Proper restraint of the patient.

3. Avoidance of external stimuli.

4. Rapid, smooth induction.

(3) STAGE III. The Surgical Stage.

(a) Plane 1. Entrance into Plane 1 is marked by the appearance of full, rhythmic, and mechanical respiration. The tidal volume and respiratory rate are increased depending on the efficiency of respiration in the preceding stages. If the first and second stages have been uneventful, the increase in volume is about 25% above normal. If the course has been stormy with consequent carbon dioxide retention, the volume may be twice normal. If hypermea has preceded this stage, it is possible

1. Inspiration is shorter and slightly quicker than expiration, and there is a pause at the end of expiration.

2. Premedication has a direct bearing on the rate and volume throughout the anesthesia. Other things being equal, the minute volume is decreased in proportion to the threshold elevation by the preanesthetic drug.

3. Response to reflex stimulation is still present and minute volume is also directly proportionate to the amount of stimulation from the operative field.

(b) Plane 2. The tidal volume is usually somewhat decreased while the rate may be either decreased or increased. As the rate increases, the pause at the end of expiration becomes shorter so that both phases are more nearly equal in length. The response to reflex stimulation from the operative site is somewhat less than in Plane 1.

(c) Plane 3. Entrance into this plane is marked by beginning paralysis of the intercostal muscles. The first evidence of this paralysis is a delayed thoracic inspiratory effort. That is, the diaphragm begins its excursion before the intercostals cause thoracic expansion. This phenomenon can be felt before it is visible. The pause between inspiration and expiration becomes progressively longer at the expense of inspiration. Inspiration becomes a quick jerky movement. The progressive intercostal paralysis gradually decreases the tidal volume with progression downward.

The lower border of Plane 3 is marked by the completion of intercostal paralysis. The bony thorax is stationary, and there is decided retraction of the intercostal spaces with each inspiration. It should be remembered that intercostal retraction also occurs with respiratory obstruction.

(d) Plane 4. At this point the diaphragmatic excursion is greater than at any other period of anesthesia. The resistance to its descent, which is normally provided by the expansion of the bony thorax, is absent; therefore, it becomes a quick jerky movement. This movement, long before intercostal paralysis is complete, is annoying to the surgeon working in the abdomen. He may complain that the patient is "pushing" and may attempt, to alleviate the condition by deepening the anesthesia, resulting in aggravation on the part of the surgeon and consternation on the part of the anesthetist when the patient suddenly stops breathing.

Diaphragmatic paralysis begins, and there is a marked decrease in tidal volume, progressing rapidly as diaphragmatic paralysis increases. Inspiration becomes more shallow and gasping, and the rhythm is very irregular.

(4) STAGE IV. Complete diaphragmatic paralysis or cessation of respiration marks the entrance into Stage IV, and death ensues within 1 to 5 minutes unless corrective measures are instituted immediately.

(5) Eye signs. It is the degree of activity of the motor muscles of the eyeball that serves as an anesthetic guide, not the type of activity. Preanesthetic medication may retard eyeball activity, but it does not destroy its value as an anesthetic guide. The protruding eyeball is usually not as active as the normal one.

(a) Stage I. Eyeball activity is normal or under voluntary control.

(b) Stage II. The motor muscles undergo a period of excitation activity. The mechanism is not completely understood, but it is believed that it is the result of the impulses "running riot" in the central nervous system. These "berserk impulses" result in the stimulation of first one nucleus then another. This is manifested in the hyperactivity of the eyeball in Stage II.

(c) Stage III.

1. Plane 1. The hyperactivity is still present upon entrance into Plane 1 and decreases progressively as anesthesia is carried downward. This may be explained on the basis of progressive depression of the central nervous system with consequent diminution of stimulation of the various centers.

2. Plane 2. Complete cessation of activity marks entrance into Plane 2. From this point on down, the eyes should be fixed concentrically because the muscles are paralyzed and flaccid. Eccentric fixation should suggest the possibility of hypoxia.

(d) Reflexes.

1. Conjunctiva palpebral. Present in Stages I and II. Absent in Stage III, Plane 1. The eyelids close when the tip of the finger brushes the margin of the upper lid.

2. Lid. Present in Stages I and II. Absent in Stage III, Plane 1. Tested by gently raising the upper eyelid with the finger. If the reflex is present, the lid will attempt to close either at once or after a few seconds' exposure. If it is absent, no effort to close the lid will occur.

(6) Muscular reflexes.

(a) Vomiting occurs at the extreme lower border of Stage II.

(b) Swallowing occurs at the extreme upper border of Plane 1.

(c) Jaw sign is tested by pushing the jaw forward and up from the angle. In light anesthesia there will be a marked change in respiration in response. The response will not be marked in mid Plane 2, and in lower Plane 2 there should be no change in respiration.

(d) Pharyngeal reflex is abolished in mid Plane 1.

(e) Laryngeal reflex response to direct stimulation is abolished at the junction of Plane 1 and Plane 2. The response to reflex stimulation is abolished in mid Plane 2.

(f) Reflex response to skin traumatism is usually abolished by anesthesia in the upper half of Plane 1.

(g) Skeletal muscles are relaxed in the following order:

1. Small - Plane 1

2. Large - Plane 2

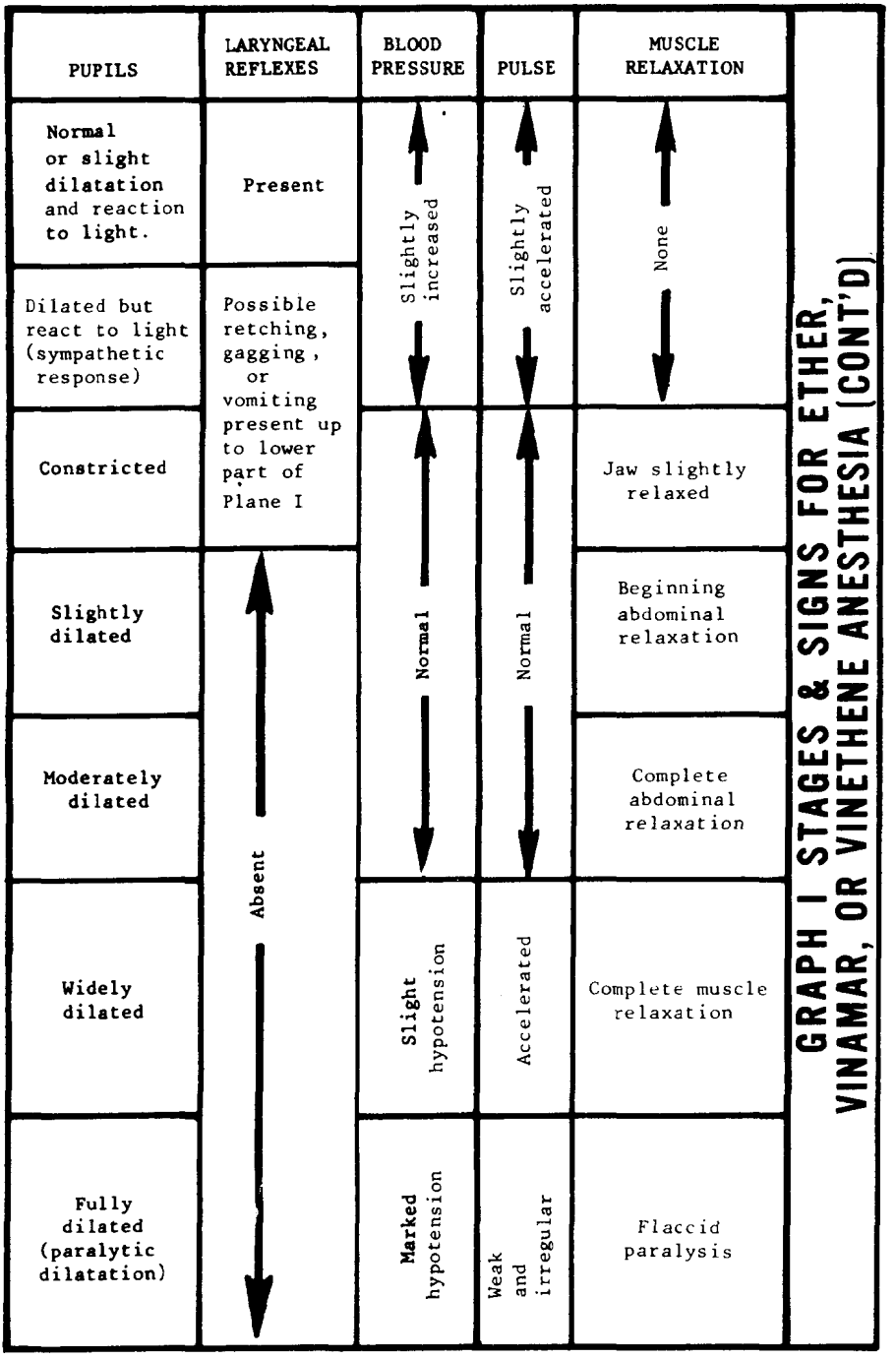
3. Abdominal - Mid Plane 2

4. Diaphragm - Plane 4

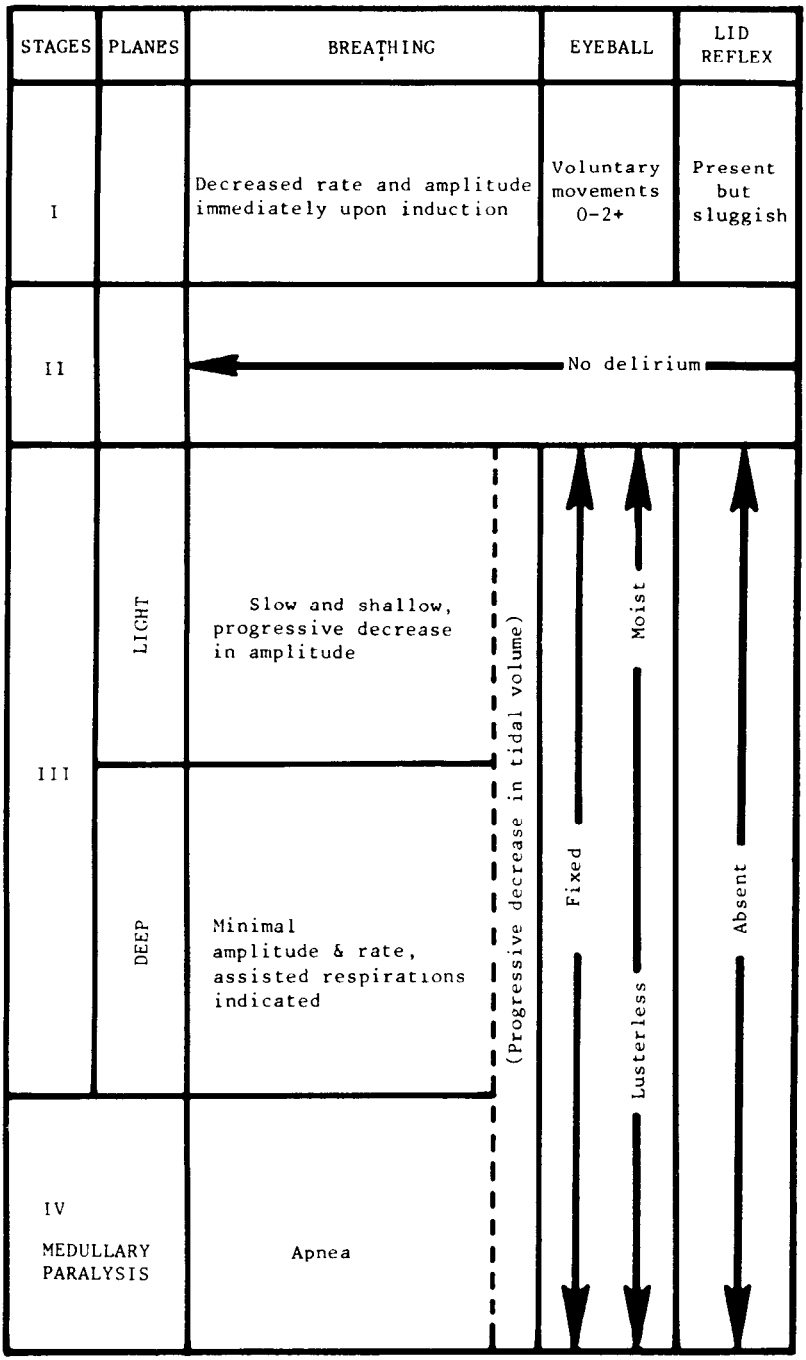
(h) Smooth muscle tone (intestinal tract and blood vessels) is lost in lower Plane 3.

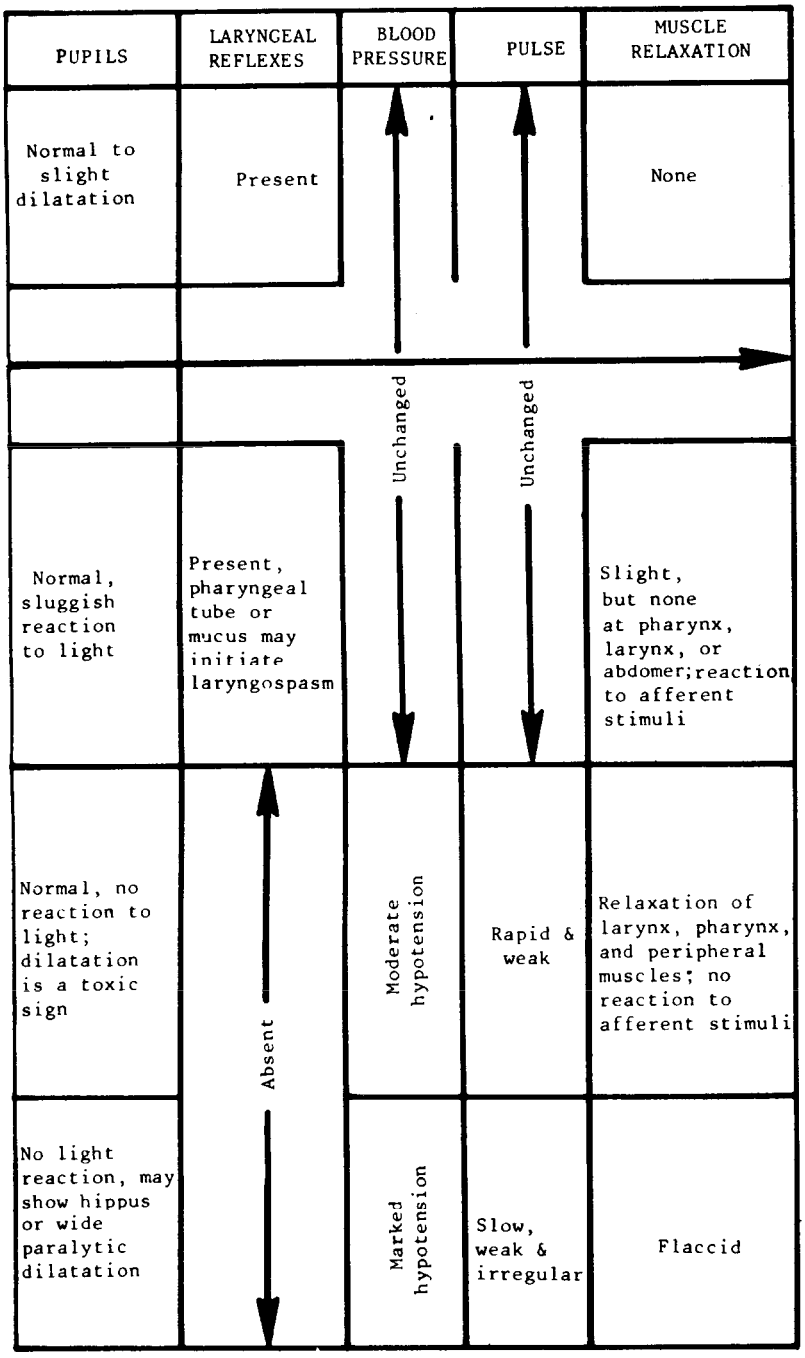
GRAPH I STAGES AND SIGNS FOR ETHER, VINAMAR, VINETHENE ANESTHESIA

STAGES	PLANES	BREATHING	EYEBALL	LID REFLEX
I		Regular, inspiration slightly greater than expiration and increased rate	Voluntary movement 0-4+ and moist	Present
II		Irregular in rate and amplitude	Involuntary movement 0-4+ and moist	
	1.	Rhythmical and exaggerated respiration	Slight movement then centrally fixed and moist	Absent
III	2.	Inspiration and expiration equal with decreasing amplitude	Fixed	
	3.	Beginning intercostal paralysis with lessening amplitude; inspiration less than expiration	Lusterless	
	4.	Intercostal paralysis complete; shallow, jerky with tracheal tug and prolonged expiration		
IV MEDULLARY PARALYSIS		Apnea		

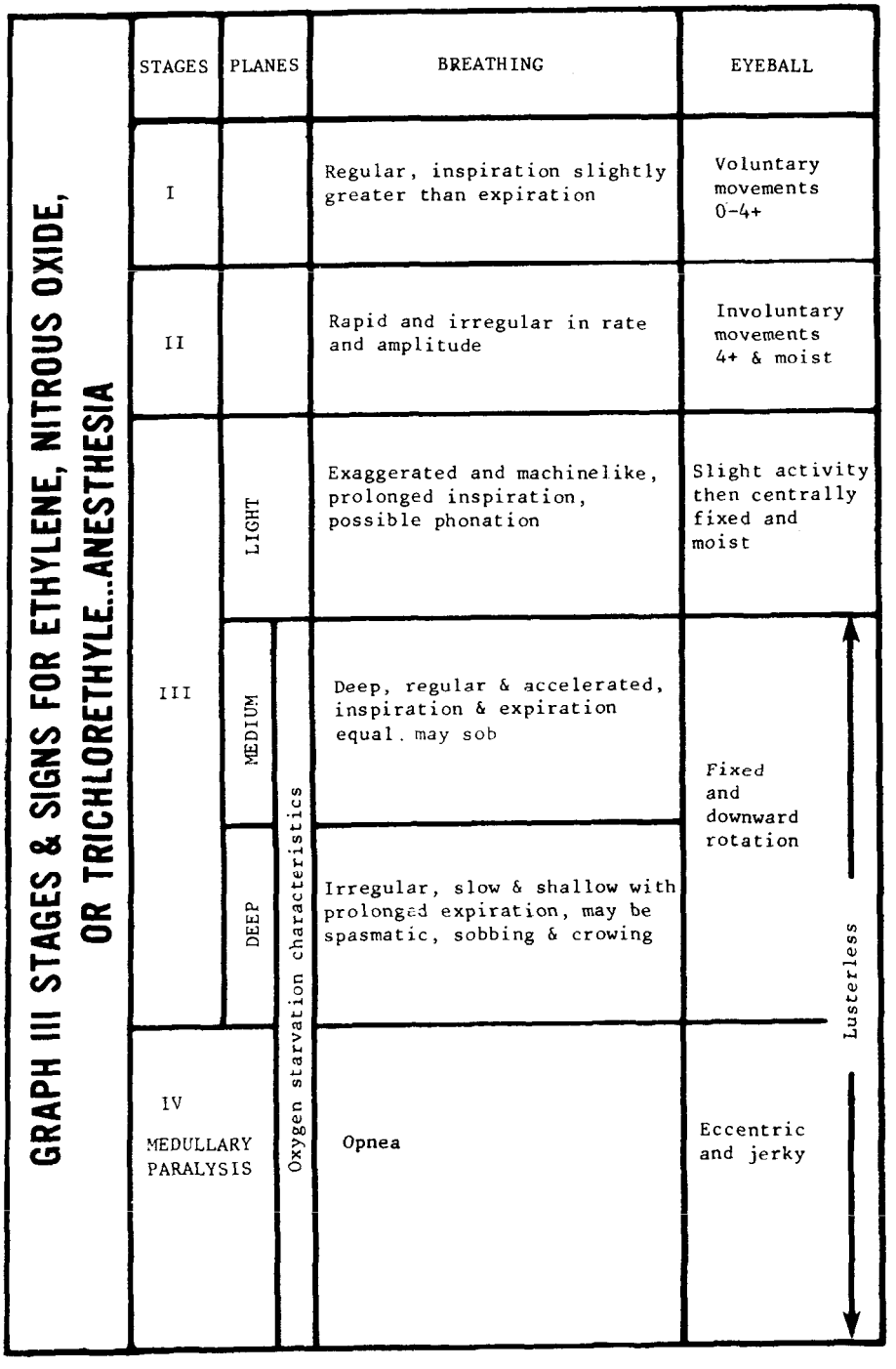

PUPILS
LARYNGEAL REFLEXES
BLOOD PRESSURE
PULSE
MUSCLE RELAXATION
Normal or slight dilatation and reaction to light.
Present
Slightly increased
Slightly accelerated
None
Dilated but react to light (sympathetic response)
Possible retching, gagging, or vomiting present up to lower part of Plane I
Constricted
Jaw slightly relaxed
Slightly dilated
Beginning abdominal relaxation
Moderately dilated
Complete abdominal relaxation
Normal
Normal
Absent
Widely dilated
Slight hypotension
Accelerated
Complete muscle relaxation
Fully dilated (paralytic dilatation)
Marked hypotension
Weak and irregular
Flaccid paralysis
GRAPH I STAGES & SIGNS FOR ETHER, VINAMAR, OR VINETHENE ANESTHESIA (CONT'D)

GRAPH II STAGES + SIGNS FOR SODIUM PENTOTHAL





GRAPH II STAGES + SIGNS FOR SODIUM PENTOTHAL


GRAPH III STAGES & SIGNS FOR ETHYLENE, NITROUS OXIDE, OR TRICHLORETHYLE...ANESTHESIA
STAGES
PLANES
BREATHING
EYEBALL
I
Regular, inspiration slightly greater than expiration
Voluntary movements 0-4+
II
Rapid and irregular in rate and amplitude
Involuntary movements 4+ & moist
III
LIGHT
Exaggerated and machinelike, prolonged inspiration, possible phonation
Slight activity then centrally fixed and moist
MEDIUM
Deep, regular & accelerated, inspiration & expiration equal, may sob
Fixed and downward rotation
DEEP
Irregular, slow & shallow with prolonged expiration, may be spasmatic, sobbing & crowing
Lusterless
IV
MEDULLARY PARALYSIS
Opnea
Eccentric and jerky
Oxygen starvation characteristics

GRAPH III STAGES & SIGNS FOR ETHYLENE, NITROUS OXIDE, OR TRICHLORETHYLE...ANESTHESIA (CONT'D)

LID REFLEX	PUPILS	LARYNGEAL REFLEXES	BLOOD PRESS	PULSE
Reflex present	Constricted or dilated	Present	Normal	Normal
Reflex present, lids - resistant	Dilated (sympathetic response)	Swallowing with tendency to retching gagging, or vomiting	Unchanged	Slightly accelerated
Reflex - faintly present & lids slightly resistant	Small and sluggish to light			
Reflex - absent, lids open	Small to moderate, NO light reaction	Absent	Slight hypertension	
Reflex absent and lids open and stiff	Dilated (danger sign)	Absent reflex with tendency to gasping, retching and vomiting		Increasing rate
	Maximum dilatation, may become irregular		Marked hypertension	Weak and irregular

GRAPH III STAGES & SIGNS FOR ETHYLENE,NITROUS OXIDE, OR TRICHLORETHYLE...ANESTHESIA (CONT'D)

MUSCLE RELAXATION	CENTRAL NERVOUS DEPRESSION (EEG) cps = cycles per sec. mvs = microvolts
None	Intermediate frequency, 8-13 cycles per sec; low voltage, less than 50 microvolts
Exaggerated reflex and rigidity	Low frequency, 4-6 cps; low voltages, less than 50 microvolts
None	Mixed wave forms 4-6 cps, and 40-70 mvs, superimposed upon slow frequency 2-3 cps, 100-150 microvolts
Slight	
Absent with rigidity & spasm	Continuation of mixed wave patterns with burst suppression, rhythmicity is lost; frequencies are relatively slow 3-5 cps, but the amplitude remains high, over 200 mvs
Spastic	

CHAPTER 18

IV THERAPY (FLUIDS AND ELECTROLYTES, BASICS)

18-1. GENERAL. Assuming you will be deployed and not have the capabilities to determine serum electrolytes, the following information is presented to keep you and your patient out of trouble. First, let's consider the composition of some common IV fluids (see table below).

Solution	Na	K	Cl	HCO_3	Ca	Mg	Calories	CH_2O gm
Ringer's lactate	130	4	109	(28)	3	-	-	-
Normal saline	154	-	154	-	-	-	-	-
D5W	-	-	-	-	-	-	200	50
D5NS	154	-	154	-	-	-	200	50
D5 .2NS	34	-	30	-	-	-	200	50
D5 .45NS	77	-	74	-	-	-	200	50
D10W	-	-	-	-	-	-	400	100
Ringer's solution	147	4	155	-	4	-	-	-

Na = Sodium, K = Potassium, Cl = Chlorine, HCO_3 = Bicarbonate, Ca = Calcium, Mg = Magnesium, CH_2O = Carbohydrates

18-2. COMMON PROBLEMS.

a. Now, what type of solution would you use for daily maintenance of an N.P.O. patient? Considering the daily requirements of Na (70 mEq.), K (40-60 mEq.), CHO (150-200 gm) and water to be 2 liters, the following should be given:

1,000 cc. D10W + 20 mEq. KCl over 12 hours
500 cc. D10W + 10 mEq. KCl over 6 hours
500 cc. D5NS + 10 mEq. KCl over 6 hours

b. Daily fluid requirement for infants and children according to body weight.

0-10 kg. - 100 cc./kg.

11-20 kg. - $\frac{100 \text{ cc./kg.}}{10}$ + 50 cc./kg.

21 kg. and over - $\frac{100 \text{ cc./kg.}}{20}$ + 50 cc./kg. + 25 cc.

c. Next, how would you replace fluid removed by an NG tube - in addition to daily maintenance requirements? Electrolytes common to gastric secretions are Na (40 mEq. per liter), K (10 mEq./L.), and Cl (140 mEq./L.). An appropriate replacement would be daily maintenance plus 1 liter per liter loss replacement of D5 .2NS + 20 mEq. KCl.

d. For the last common problem, consider replacement of fluid lost by diarrhea. Electrolytes common to diarrheal fluid are Na (50 mEq./L.), K (35 mEq./L.), Cl (40 mEq./L.) and HCO_3 (45 mEq./L.). Appropriate fluid for diarrheal losses would be daily maintenance plus liter for liter replacement with 1,000 cc. D5W + 35 mEq. KCl + 45 mEq. $NaHCO_3$.

18-3. ADJUSTMENT FOR INCREASED BODY TEMPERATURE, ENVIRONMENTAL TEMPERATURE, AND HYPERVENTILATION.

Fever	Environmental Temperature	Respiratory Rate	Additional Fluid Allowance
101°F. or less	85°F. or less	35 or less	None
101-103°F.	85-95°F.	Over 35	500 cc. H_2O
Over 103°F.	95°F. or less	-	1,000 cc. H_2O

18-4. BURNS - FLUID THERAPY.

a. Brooke Formula - first 24 hours.

(1) Colloids (plasma, plasmanate, or dextran) .5 ml./kg./% body surface burned.

(2) Electrolyte solution (Lactated Ringer's) 1.5 ml./kg./% body surface burned.

(3) H_2O requirement (D5W) 2,000 cc. for adults - for children correspondingly less.

ROUGH GUIDE FOR H_2O REQUIREMENT IN CHILDREN:

During first 2 yrs - 120 cc./kg.
2d - 5th yr - 100 cc./kg.
5th - 8th yr - 80 cc./kg.
8th - 12th yr - 50 cc./kg.

BURNS COVERING MORE THAN 50% OF THE BODY SURFACE ARE CALCULATED AS 50% OR EXCESS FLUID WILL BE GIVEN!!!

b. In the second 24 hours about one-half the colloid and electrolyte requirement of the first 24 hours is needed.