# DEPARTMENT OF EDUCATION

## THE BARBITURATES

With particular reference to their use in anesthesia

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### INTRODUCTORY

The oldest of the barbiturates is *barbital,* which was introduced into medicine in 1903, under the name of "veronal." Barbital is what is termed an official drug (is listed in the U. S. Pharmacopoeia). The second oldest barbiturate is *phenobarbital,* which was introduced into therapeutics under the trade name of "luminal." Phenobarbital is also an "official U.S.P. drug."

During the following years, many other barbiturates were marketed for clinical use, their chief claim to preference being their shorter duration of action than that of barbital and phenobarbital. Among these later drugs is *pentobarbital,* which is the only member of that "less long-acting" group that is an "official U.S.P. drug." The trade preparation "nembutal" is chemically identical with U.S.P. pentobarbital sodium.

The latest advance in this field has been the introduction of a series of ultra-short-acting compounds called *thiobarbiturates.* Their chemical differentiation is that "the oxygen on the urea carbon in the barbituric acid molecule has been replaced by sulphur" (the C O of the urea is replaced by C S). The thiobarbiturate accepted by the Council on Pharmacy and Chemistry for inclusion in the N. N. R. (1940) is *pentothal* (sodium thiothal).

**Classification of some of the barbiturates, according to the duration of their hypnotic action**

The following designations, "long-acting," "moderate duration of action" and "short-acting," refer to the relative length of duration of effect which follows an average soporific dose, administered orally.

| *Long-acting Barbiturates* | Average adult hypnotic dose (Goodman and Gilman) |
|---|---|
| Barbital (veronal) | 4½ - 7¾ grains (0.3 to 0.5 gm.) |
| Phenobarbital (luminal) | 1½ - 3 " (0.1 to 0.2 gm.) |
| Alurate | 1 - 2 " (0.065 to 0.13 gm.) |
| Dial | 1½ - 4½ " (0.1 to 0.3 gm.) |
| Neonal | ¾ - 1½ " (0.05 to 0.1 gm.) |
| Nostal | 1½ - 4½ " (0.1 to 0.3 gm.) |
| Ipral | |
| *Those of Moderate Duration* | |
| Amytal | 1½ - 4½ grains (0.1 to 0.3 gm.) |
| Pentobarbital (nembutal) | 1½ - 3 " (0.1 to 0.2 gm.) |
| Ortal | 3 - 6 " (0.2 to 0.4 gm.) |
| Pernoston | 3 " ( to 0.2 gm.) |
| Phanodorn | 1½ - 3 " (0.1 to 0.2 gm.) |
| Sandoptal | 3 - 6 " (0.2 to 0.4 gm.) |

*Short-acting*

| | | | | | |
|---|---|---|---|---|---|
| Evipal | 3¾ - 6 | grains | (0.25 | to 0.4 | gm.) |
| Seconal | 1½ - 3 | " | (0.1 | to 0.2 | gm.) |

The designation "ultra-short-acting" refers to the effect which follows an average anesthetis dose of the following named drugs, administered intravenously.

*Ultra-short-acting barbiturates*

Evipal
Pentothal (sodium thiothal)
Thio-ethymal (thiethamyl)

**In therapeutics**, the barbiturates are used more for the production of sleep than for any other purpose. They are not analgesic and therefore do not produce sedation in the presence of pain. When pain is present and hypnosis is desired, the shorter acting members are combined with salicylates (acetyl salicylic acid (aspirin) or sodium salicylate) whose *analgesic* action potentiates the *hypnotic* action of the barbiturate. When barbiturates are given in conjunction with these analgesics, only about one-third the hypnotic dose is administered. When there is no pain, analgesics (salicylates) do not potentiate the hypnotic action of the barbiturates.

**In anesthetic practice**, barbiturates are used for premedication, for basal supplement to anesthesia, for surgical anesthesia and less often, for obstetrical analgesia. Preanesthetic use usually consists of oral administration of one of the *longer-acting* members the night before the operation, to produce sleep, followed the next day (one hour before anesthesia) by morphine and atropine.

**For general anesthesia**, the preparations preferred are the *ultra-short-acting* thiobarbiturates or barbiturates (pentothal or evipal), administered intravenously. Since these agents depend upon the action of the liver for their destruction in the body, pentothal (or evipal) intravenous anesthesia should not be administered to patients with impaired hepatic function.

**Pentothal vs. evipal:**

According to some authorities, sodium pentothal gives a smoother and more prolonged anesthesia than evipal. With sodium pentothal, there is no tonic or clonic contraction of the muscles (twitching and spasm of the muscles of the extremities) such as not infrequently occur with evipal. Jactitation is rare with pentothal sodium, which is more powerful and rapid in action than evipal, and affords speedier recovery.

**Methods of elimination from the system:**

The barbiturates depend upon two different functions for elimination from systemic activity. One group, notably alurate and barbital (and somewhat less so, phenobarbital), are excreted from the body almost unchanged, by the kidneys. Another group, notably pentobarbital, pentothal and evipal, are almost completely destroyed in the liver. Some of the barbiturates (notably phenobarbital) are partly detoxified by the liver and partly excreted unchanged, by the kidneys. While one cannot predict from the mere chemical structure of a barbiturate what its route of elimination will be, in a general way it may be noted that those barbiturates with short alkyl radicals

are apt to be stable and, therefore, excreted in the urine, whereas the thiobarbiturates as a whole, and the barbiturates with complex cyclic radicals (like evipal), are less stable and almost completely destroyed in the liver.

From the foregoing it is apparent that when barbiturates are given in anesthetic doses parenterally, the duration of action and toxicity are especially dependent upon:

(a) the ability of the liver to destroy those which are *destroyed in* the body (pentothal, evipal, phenobarbital)

(b) the ability of the kidney to excrete those which are *eliminated from* (rather than destroyed in) the body (barbital, phenobarbital, alurate).

## GENERAL PHARMACOLOGICAL EFFECTS

**Effects upon the respiratory system:**

In anesthetic doses, the barbiturates are directly depressant to the medullary respiratory center, and apparently also, in lesser degree, depressant to the carotid sinus mechanism. Both the depth and rate of breathing are decreased. The rhythm may be irregular. Death from poisoning by the barbiturates is due to respiratory failure.

**Effects upon the circulatory system:**

Large doses of barbiturates depress the central vasomotor center, with consequent peripheral vasodilation and hypotension. Excessive concentrations may dilate and injure capillaries to such an extent that shock ensues. A sharp fall in blood pressure may follow too rapid administration of a safe dosage of barbiturate, but the hypotension is transitory if the dose is not too large. The barbiturates do not appear to damage the myocardium, or to seriously alter cardiac rhythm.

**Effects upon the nervous system:**

The barbiturates are depressant to the cerebrospinal axis. Any degree of depression may be obtained, from light sedation to deep coma, according to the reflex excitability of the individual's nervous system, the barbiturate used, the dosage and the route of administration.

Untoward respiratory phenomena accompanying barbiturate intravenous anesthesia, such as laryngeal spasm (contraction of the adductor muscles with consequent closure of the glottis) sneezing or hiccoughing, are apparently due to over-activity of the parasympathetics as a result of their stimulation caused by the barbiturates (pentothal, evipal, nembutal, sodium amytal), hence the practice which is now quite generally followed, of preceding each intravenous barbiturate anesthesia by prophylactic premedication with atropine, which annuls parasympathetic effects.

**Effect upon metabolic rate:**

In anesthetic dosage, the barbiturates reduce the metabolic rate, and decrease oxygen consumption.

**Effects upon the glandular system:**

The barbiturates have no direct effect on normal renal function. Normal hepatic function, likewise, is unimpaired; but if the liver is damaged, large doses of barbiturates may further injure it.

**Allergic idiosyncrasy:**

Some of the idiosyncrasies to barbiturates manifest themselves in reactions which are allergic in nature. They occur in persons who tend to have asthma, urticaria, angioneurotic edema, et cetera. They manifest themselves as localized swellings of the eyelids, cheeks or lips, erythematous dermatitis, and bulbous cutaneous lesions.

**Natural idiosyncrasy** may manifest itself in the form of "hangover," excitement or pain. In some persons therapeutic doses of barbiturates produce excitement rather than depression, the patient appearing to be inebriated. Like other non-analgesic hypnotic drugs, barbiturates given in hypnotic dosage in the presence of pain may cause restlessness and excitement.

## INTRAVENOUS BARBITURATE SURGICAL ANESTHESIA

**Indications:**

For selected operations of brief duration, in which profound muscular relaxation is not required, the ultra-short-acting barbiturates (sodium pentothal and evipal) are employed intravenously. The classical recommendations for their use are: reduction of fractures, dilation and curettage, cystoscopy, prostatic resection, changing painful dressings, removal of sutures, encephalography, procedures of short duration in the oral cavity, brief manipulations of simple fractures, treatment of accidental wounds, et cetera.

Some surgeons use intravenous barbiturate anesthesia in general surgery, as well as eye, ear, nose and throat (excepting tonsillectomy, the latter being less well suited because of the deep anesthesia required under this drug before the region of the pharynx is affected). In this connection, it is to be noted that when adequate airway cannot be maintained by proper position of the head, insertion of a nasopharyngeal airway (instead of a pharyngeal airway) should be resorted to, because of the pharyngeal reflex which is present except in deep anesthesia; or endotracheal intubation should be effected. Cyanosis should never be tolerated by an anesthetist.

Lundy considers intravenous sodium pentothal anesthesia particularly useful for short operations such as: manipulation of a stiff joint, reduction of a fracture or dislocation, changing a cast on sensitive patient, removal of packs and drains or application of a clamp to a colonic stoma, as well as for removal of tissue from the breast for microscopic examination.

**Contraindications:**

There is not complete agreement as to what constitutes contraindication to the use of intravenous barbiturate anesthesia. The classic examples of contraindication are: cirrhosis of the liver, jaundice, shock, hypotension, asthma, pulmonary disease and marked debilitation. It seems obvious that patients with impaired renal function should not be administered those barbiturates which depend upon renal excretion for elimination of the drug from the system (barbital, phenobarbital, alurate); and that patients with impaired hepatic function should not be administered those barbiturates which depend upon the liver for their detoxification within the body (pentothal, evipal, phenobarbital, pentobarbital).

Untoward responses attributable to the barbiturates are especially likely to occur in patients with fever, hyperthyroidism, diabetes mellitus, severe anemia and congestive heart failure, although these conditions do not present

obligatory contraindication to their use and excellent results are sometimes obtained from their judicious administration.

Hypotension is not in itself a contraindication to sodium pentothal anesthesia, series of cases in which it was so administered, failing to yield indications of resultant cardiac damage.

Many operators consider sodium pentothal intravenous anesthesia undesirable for children under twelve years of age, because of their susceptibility to respiratory depression and the difficulty of maintaining a patent airway, and the difficulty of venipuncture in children because of their small veins.

Lundy proposes the following contraindications to intravenous sodium pentothal:

Marked cardiac disease with decompensation (not including angina pectoris) especially in the presence of orthopnea.
Marked limitation of intercostal excursions.
If erythrocytes number less than two million per cubic centimeter.
If dyspnea may be expected to develop during or following operation.
If there is reason to believe that the respiratory passage is or may become obstructed.
A full stomach, because in view of the increased throat reflexes due to sodium pentothal, regurgitation of material into the throat may be expected, with consequent laryngeal spasm.
Patients who vomit continuously (as in the case of intestinal obstruction), because of the possibility of fatal laryngeal spasm.

NOTE: Very infrequently a patient will be encountered who reacts so unfavorably to even small amounts of sodium pentothal administered intravenously (acute attack of tremor, sneezing, coughing, vomiting, or respiratory failure) that operation may have to be postponed.

Sneezing alone is common, most often during operations on the eye. Sneezing occurs during the early part of induction, and as a rule stops when as much as 0.5 gram of pentothal sodium has been administered. The same dose has been used to control hiccup.

## PRELIMINARY TO ADMINISTRATION OF INTRAVENOUS BARBITURATE SURGICAL ANESTHESIA

By reason of the idiosyncrasy which some individuals exhibit to barbiturates, it is recommended that the night before operation, one of the barbiturates (nembutal, 1½ to 3 grains) be administered to a patient who is scheduled for intravenous barbiturate anesthesia the following day. The object of this is not only to provide the patient with a peaceful night's rest, but also to furnish the anesthetist and the surgeon with valuable data as to the patient's reaction to barbiturates.

It is essential that patients who are to receive intravenous pentothal anesthesia have an empty stomach, otherwise they may vomit at the beginning of the surgical stage of anesthesia, with consequent danger of aspiration of vomitus.

The value of premedication in sodium pentothal anesthesia has been amply demonstrated. In operations associated with any great amount of pain, materially larger doses are required to produce the desired effects if preliminary medication is omitted, and in the attempt to keep the patient quiet, overdosage

is likely to result. Not less than thirty minutes before anesthesia, the patient should be given premedication with a narcotic (morphine, or preferably pantopon) *and atropine. Preoperative administration of atropine is essential,* to prevent excessive bronchial and pharyngeal secretions and to avoid laryngeal spasm consequent to barbiturate-excited hyperactivity of the parasympathetics. The dosage of morphine should be less than that used prior to inhalation anesthesia. The recommended dosage for premedication preceding intravenous barbiturate anesthesia is ⅛ to ⅙ grain, plus 1/150 grain atropine sulphate.

## PREPARING AND ADMINISTERING A 2½ PER CENT SOLUTION OF PENTOTHAL SODIUM

**For contemplated anesthesia of one-half hour or longer duration,** aspirate into a 50 cc. syringe that is fitted with a 17 gauge "solution needle," the contents of a 40 cc. ampule of sterile distilled water (or the contents of two 20 cc. ampules). Eject this solvent into an ampule containing 1 gram (15½ grains) of pentothal sodium, plus its buffer of 60 milligrams of anhydrous sodium carbonate. Aspirate and eject the solution back and forth several times between the syringe and the ampule, to insure complete solution. Detach "solution needle" from syringe. In its place, couple to the syringe the rubber connector tubing that has previously been attached to an assembly consisting of a 3-way stop-cock (turned to "loading" position), and its attached "administrative needle" and 2 cc. syringe.

Aspirate the air from rubber tubing into the 2 cc. syringe, turn stop-cock to the "open" position, and completely eject the air from stop-cock assembly through the administrative needle into the atmosphere. Then turn stop-cock to "neutral" position until actual venipuncture is to be effected. During such interim period, the needle should be protected against contamination by covering it with alcohol-soaked sterile gauze.

When ready for venipuncture, turn stop-cock to "open" position, aspirate about ½ cc. of blood into the 2 cc. syringe to verify patency of the venipuncture, turn stop-cock to "loading" position (establishing communication between small syringe and large syringe). Load administrative 2 cc. syringe with solution from the connected 50 cc. syringe. Turn stop-cock to "open" position, and begin to inject solution slowly into the vein.

**For contemplated anesthesia of short duration** (less than one-half hour) and *for anti-convulsive use,* contents of an ampule containing 20 cc. of sterile distilled water are aspirated into a 20 cc. syringe fitted with 17 gauge solution needle, and then ejected into ampule containing 0.5 gram (7½ grains) of pentothal sodium plus its buffer of 30 milligrams anhydrous sodium carbonate. The resultant solution is aspirated and ejected back and forth several times to insure complete solution.

**Caution:**

In assembling the described outfit, it is important that the administrative needle and the 2 cc. syringe be *firmly* attached to the stop-cock. A loose assembly at those points may result in an embarrassing disconnection during administration. The rubber connecting tube must also be *firmly* attached to syringe and stop-cock, to avoid aspiration of air into the apparatus and consequent possible injection into the vein.

Be sure that syringes are so mounted that their calibrations are on top, where they may be clearly read during administration.

**Note:**

If a *long* operation is contemplated, and the surgeon requests intravenous barbiturate anesthesia, it is recommended that glucose-saline be administered during the narcosis. In such case, anesthesia is induced in the regular manner. Upon reaching the full surgical stage, the 2 cc. syringe is detached from the assembly, and is quickly replaced by the adapter-connection from the glucose-saline apparatus, whereupon administration of the glucose-saline proceeds through the stop-cock aperture which previously received the nozzle of the 2 cc. syringe. For the balance of the procedure, glucose-saline is administered through that connection, succeeding dosages of the anesthetic being administered *from the 50 cc. syringe* that is a part of the administrative assembly. When need for such additional anesthetic is indicated, stop-cock is turned to its third position (turned to the lever's extreme clockwise position) which interrupts communication between the glucose-saline solution and the administrative needle, and establishes instead, communication between the 50 cc. syringe and the needle. One to 2 cc. of the anesthetic solution is slowly injected from the 50 cc. syringe, whereupon the stop-cock is returned to the "open" position and administration of glucose-saline is resumed until additional administration of the anesthetic becomes indicated.

**Caution:**

Left-over sodium pentothal solution must not be used after it has stood for four hours.

## DETAILED TECHNIQUE OF ADMINISTRATION FOR INTRAVENOUS SURGICAL ANESTHESIA

Administrative unit is assembled consisting of:—

50 cc. syringe containing the anesthetic solution
Connecting rubber tube
21 gauge 1¼" needle, for venipuncture and administration
17 gauge needle for preparation of solution
3-way stop-cock in "neutral" position
2 cc. syringe

The patient is placed on the table and the routine recording is made of blood pressure, pulse, respiration, et cetera. The three-way stop-cock is verified at "neutral" position. The arm is anchored to arm-board with ½ inch adhesive tape. The 50 cc. syringe is strapped to arm-board beside patient's arm. The 2 cc. syringe is held by the anesthetist during draping of patient (its needle protected by alcohol-soaked cotton sponge). Tourniquet is applied close to (not more than two inches above) the site of venipuncture, to anchor the vein and make it possible to put the vein on tension so that it may be entered easily. Skin overlying the vein is cleansed and venipuncture is effected. Veins generally selected for this procedure are those located:

(a) At the antecubital fossa region (accessory cephalic, cephalic, median cephalic, median antibrachial, median basilic, accessory median, basilic).

(b) On the dorsal aspect of the hand (dorsal metacarpals, dorsal venous network).
(c) On the dorsal aspect of the wrist and forearm (cephalic, basilic).
(d) At the radial region of the wrist.

The size of needle generally used for venipuncture is 21 gauge. If the vein to be entered is small (its lumen scarcely larger than the diameter of the needle), the bevel of the needle should be turned down (the bevel of the needle to be on the under side, parallel to the upper and lower walls of the vein). If entry to a small vein is undertaken with a large needle with its bevel turned up, a hematoma may form above the vein because of partial injection outside the upper venous wall that encloses only a part of the bevel opening, or a hematoma may be formed under the vein by reason of a perforation of the venous wall resulting from the effort to adjust the needle in a vein which upon removal of tourniquet partially collapses and occludes lumen of the needle. (See Figs. 2 and 3, Lundy and Osterberg.)

If the lumen of the vein to be entered is amply large with reference to the size of the needle, it is immaterial whether the bevel is turned up or down when introduced through the skin and venous wall. (See Fig. 1, Lundy and Osterberg.)

The site of venipuncture should be on the side of the patient opposite to that of the operation, where the anesthetist will be away from the operative field and in position to observe the patient's respiration.

In some extreme cases venipuncture is difficult unless moist heat is applied, to dilate and engorge with blood the veins selected. This is effected in the case of an upper extremity vein by enveloping the entire hand, wrist, forearm and arm to a point above the elbow, in a warm, moist Turkish towel, and covering it all with a wrapping of oilskin or rubber, and placing hot water bottles around it. When a vein in the ankle is to be used, the entire foot, ankle and leg to the knee should be so heat wrapped. After such treatment, with the extremity in a dependent position for twenty to thirty minutes, application of the tourniquet causes the veins to stand out prominently. The application of moist heat as above set forth, fails to accomplish its purpose if it is applied to the elbow only, and does not embrace within it the forearm, wrist and hand as well.

To effect the venipuncture, tourniquet is applied, the skin over the filled vein which is to be entered is stretched by the anesthetist's left thumb and forefinger, the needle is inserted into the vein while suction is being made by the syringe so that as soon as venipuncture is accomplished blood appears in the syringe. About 0.5 cc. of blood is aspirated into the syringe to demonstrate the efficiency of the venipuncture. The tourniquet is released and the anesthetic solution injected as needed.

**Note:**

Should the anesthetic solution be injected before the tourniquet is released, the releasing of the tourniquet permits a sudden rush of the accumulated dosage of the anesthetic solution to the vasomotor and respiratory centers, with consequent danger from such overdosage.

If a vein at the elbow is used, the patient's hand is clenched in order to keep the vein filled.

If uncertainty exists as to whether the needle is in a vein or in an artery, the syringe is disconnected and the character of the flow of the blood is observed (spurting if arterial). *Intra-arterial* injection of sodium pentothal brings signs of anesthesia to the anesthetist so late, that in the meantime overdosage may have been administered. Pain in the arm or a burning sensation in the hand is a warning symptom, as is also delayed induction.

If the veins at the elbow are thrombosed and it is therefore necessary to use a vein in the hand, the arm should be rubbed from the wrist toward the elbow. If possible, the site of injection in these cases should be above rather than below the thrombosed veins.

If a vein at the ankle is to be used for intravenous anesthesia, it is important to know whether or not varicosities are present. If they are, the vein must be massaged frequently from the ankle toward the knee, to speed the passage of the drug from the point of injection into the general circulation; otherwise an overdose may be administered while manifestation of approaching signs of anesthesia is being awaited.

After venipuncture has been effected and the tourniquet removed, the 3-way stopcock is turned to "loading" position; the 2 cc. syringe is filled with the anesthetic mixture; the stop-cock is turned to "administrative" position and injection is started at *a very slow* continuous rate (about ½ cc. of 2½ per cent solution during each fifteen seconds), the patient being requested to count slowly or to tell the anesthetist when he begins to feel drowsy. During injection, the patient is observed carefully for appearance of thickened or slurring speech, yawning and loss of consciousness. Upon development of these signs (which usually appear within from one-half to three minutes) injection is discontinued for the moment, the jaw is held upward and forward and the administration is interrupted for a period of thirty seconds, during which time the effect of the anesthetic is observed for appearance of "eyelid sign," muscular relaxation and automatic rhythmic respiration.

Unconsciousness occurs before muscular relaxation. (Note: In intravenous sodium pentothal anesthesia, the pharyngeal reflex is not abolished except under deep anesthesia.)

Upon development of the proper signs of anesthesia, a previously marked nasal catheter is inserted, and oxygen insufflated at the rate of 1500 to 2000 cc. per minute, increasing the flow if color signs indicate.

If the succeeding procedures are to be genito-urinary, the cystoscope may be introduced at this point. If, however, a surgical incision is to be made, the surgeon first tests sensibility of the patient by pricking the skin before making the incision. If there is any indication of sensation, the anesthetist slowly injects a few more minims of the solution, until the patient is under surgical anesthesia.

NOTE: It is to be borne in mind that the amount necessary to induce anesthesia varies greatly in individuals. Similarly, the amount necessary to maintain surgical anesthesia varies greatly with individuals. A large patient may require actually less for a long anesthesia, than some small individual for a short procedure. There is no set dosage based upon the weight of the patient—merely the general statement of a maximal dosage of 1 gram, beyond which it is recommended that other supplementary agents be resorted to if additional anesthesia is necessary.

The administration of intravenous anesthesia should be always slow, with a "resting" period after each period of fractional administration. This interruption following each administration is to enable the development of the effect of each dosage, before additional anesthetic is administered. It is to be remembered that these drugs have a cumulative action, as evidenced by the fact that the longer the operation continues, the less of the drug is required to maintain anesthesia.

It is important that extreme caution regarding the speed of injection be exercised. The patient to whom pentothal sodium is being administered has no active warning mechanism of defense, such as is initiated by the irritating action of ether. From one to two minutes (rather than the sometimes suggested twenty to thirty seconds) for the induction of anesthesia is recommended—or at least that a pause be made for thirty seconds after injection of 4 cc. of a 2½ per cent solution, to demonstrate the depth of anesthesia produced (to permit the complete effect to manifest itself). The 2½ per cent solution is recommended rather than a 5 per cent solution, to facilitate slow dosage and to avoid the rare occurrence of phlebitis, or of sloughing of tissue and irritation at the site of injection.

After the surgical stage of anesthesia has been reached, the patient responds very quickly to slight changes in the depth of anesthesia. Therefore the patient's progress must be watched closely for alterations in the depth of narcosis, and the accompanying need for lightening or deepening of the anesthesia. Indications for further injection are: slight movements of the extremities, phonation, reflex movements due to pain stimuli, or increase in depth and rate of respiration. Should the patient move or groan during the operation, surgery is not necessarily interrupted, but additional dosage is administered. Dosage during anesthesia is 1 cc. to 2 cc. of 2½ per cent solution, administered very slowly when indicated, pausing after each such injection, that the result of its cumulative effect may demonstrate itself. *(A very minute* quantity should be administered about every thirty seconds during the procedure, to keep the syringe open and free from clotting.)

A good guide to the depth of anesthesia is the degree of relaxation of the jaw, but the best single guide for depth of anesthesia is the depth of respiration. During deep anesthesia, respirations are shallow. During light narcosis, respirations are full. There are no dependable eye signs. All signs are subject to swift changes, which are associated with the rapid destruction of the drug in the body. Because of this rapid destruction, minute to minute control is possible, when the anesthetic is given in small intermittent doses.

Usually blood pressure is lowered very little during anesthesia; respiration is unchanged; the pulse rate is increased very slightly (an experimental series showed average increase of about 8 beats per minute).

If during administration accidental movement of the needle results in extravenous injection into the tissues (evidenced by localized edematous swelling), the needle is withdrawn and venipuncture re-effected. Following the anesthesia, saline solution is injected subcutaneously into the area of swelling to dilute the concentration of the barbiturate solution which has been accidentally infiltrated, or moist heat should be applied for five to ten hours.

## RECOVERY

When the surgeon starts closing the fascia, the needle may be removed. In a large percentage of cases, the patient will react soon after reaching his room. This reaction is usually quiet, resembling a person awakening from natural sleep.

To lighten narcosis after the operation, inject 3 cc. metrazol intravenously, immediately following the "deanesthetization" or "hyperventilation," if indicated. Thereafter, 1 to 2 cc. may be given intramuscularly or subcutaneously at half-hour intervals for several doses, to help guard against postoperative pulmonary complications. The upper limit of dosage of metrazol has been reached, however, when transient excitation occurs.

## RESUSCITATIVE:

(1) For circulatory collapse and respiratory failure during the operation, 1 to 3 cc. of metrazol are injected intravenously and oxygen plus carbon dioxide is administered endotracheally.

(2) Picrotoxin is a physiological antagonist to the barbiturates. It is administered intravenously 1 milligram (1/65 grain) per minute (1 cc. of a 1:1000 isotonic saline solution per minute) until "return of the desired reflexes."

While dramatic results have been reported from the use of picrotoxin in barbiturate intoxication, and while an individual poisoned with a barbiturate is tolerant to dosages of picrotoxin that might be fatal to a normal individual, it is to be borne in mind that picrotoxin is a highly toxic substance.

(3) Coramine, while of particular value in overcoming respiratory depression caused by morphine and by volatile anesthetic, and particularly effective in overcoming the depressant action of avertin, is said to be less effective than either metrazol or picrotoxin in rousing patients from barbiturate depression.

## ANTI-CONVULSANT USE OF BARBITURATES

Intravenous administration of the barbiturates is of great value in symptomatic control of convulsions occurring in tetanus, eclampsia, status epilepticus, and cerebral hemorrhage. It is also effective in combating *convulsions occurring during general anesthesia,* as well as those caused by cocaine, strychnine, metrazol, picrotoxin, coramine and overdosage of insulin. Only barely enough should be injected to control the seizures, however, administered fractionally while the respirations and degree of muscular relaxation are carefully watched.

Usually the "ultra short acting" or the "moderate duration of action" barbiturates are selected for this purpose, and are given intravenously. The amount injected (at a slow rate, never faster than 30 to 60 milligrams (½ to 1 grain) per minute) is more important than the particular barbiturate employed. Usual doses for intravenous administration to control convulsions are:

| | |
|---|---|
| Sodium pentothal: | 1 cc. of a 2½ per cent solution each 15 seconds, until seizure is controlled (3 to 7 cc. usually suffice). |

| | |
|---|---|
| Sodium pentobarbital: (nembutal) | 0.3 to 0.5 gram (4½ to 7½ grains) |
| Sodium phenobarbital: (luminal) | 0.3 to 0.7 gram (4½ to 10½ grains) |
| Sodium amytal: | 0.4 to 0.8 gram (6 to 12 grains) |

## SODIUM PENTOTHAL RECTALLY FOR BASAL ANESTHESIA

Sodium pentothal by rectal instillation has been used as a basal anesthetic. The stated dosage is 1 gram (15½ grains) for each fifty pounds of body weight, dissolved in from ½ to 1 oz. (15 to 30 cc.) of distilled water, instilled into the rectum fifteen minutes before taking patient to the operating room—patient to be attended from the time of administration, to prevent asphyxial complication from the relaxed jaw and tongue that ensue. Premeditation consists of 1/150 grain atropine sulphate (without opiate) administered hypodermically one-half hour before operation.

Sodium pentothal rectal basal narcosis is not recommended (a) when involvement of the trachea, edema of glottis or other condition exists which may embarrass respiration; (b) when there is heart impairment with decompensation; or (c) when any of the severe primary anemias exist.

**REFERENCES:**


Burstein, C. L., and Rovenstine, E. A., "Clinical Experiences with Newer Analeptics, *Anesthesia & Analgesia,*" May-June, 1937, p. 151.

Burstein, C. L., and Rovenstine, E. A., "Respiratory Parasympathetic Action of Some Shorter Acting Barbituric Acid Derivatives," *J. Pharmacol. & Exper. Therap.,* May, 1938, p. 42.

Carraway, B. M., "Pentothal Sodium with Nasal Oxygen," *Anesthesia & Analgesia,* September-October, 1939.

Carraway, C. N., "Pentothal Sodium Oxygen Anesthesia in Major Surgery," *Southern Surgeon,* May, 1940, p. 312.

Goodman, Louis and Gilman, Alfred, "Pharmacological Basis of Therapeutics," The MacMillan Company, 1941.

Lundy, John S., "Clinical Anesthesia," W. B. Saunders Company, 1942.

Lundy, John S., and Osterberg, Arnold E., "Intravenous Administration of Fluids, Including Blood Transfusion," *Surgery,* October, 1937, p. 590.

Mallinson, F. Barnett, "Pentothal Sodium in Intravenous Anesthesia," *The Lancet,* Nov. 6. 1937, p. 1070.

Palmer, E. Payne, "Basic Intravenous Anesthesia with Sodium Ethyl Thiobarbiturate," *Southern Medical Journal,* March, 1939, p. 290.

Porter, Arthur R., Jr., "Intravenous Anesthesia," *Memphis Medical Journal,* January, 1940.

Ruth, Henry S., Tovell, Ralph M., Milligan, Alexander D., and Charleroy, Durant K., "Pentothal Sodium," *J.A.M.A.,* Nov. 18, 1939, p. 1864.

Searles, Paul W., "Intravenous Anesthesia," *J.A.M.A.,* January 10, 1942, p. 117.

Sollman, Torald, "A Manual of Pharmacology," W. B. Saunders Co., 1942.

Tovell, Ralph M., and Garofalo, Mario, "An Evaluation of Intravenous Anesthesia," *New York State Journal of Medicine,* Nov. 1, 1939, p. 2026.

Tucker, Arthur, O., "Intravenous Anesthesia with Pentothal Sodium in General Surgery," *Northwest Medicine*, July, 1939, p. 246.

Weinstein, M. L., and Light, G. A., "The Use of Pentothal Sodium Rectally as a Basal Anesthetic," *Anesthesia and Analgesia*, March-April, 1943.

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# SPINAL ANESTHESIA

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**FOREWORD**

Most of the material in the notes presented has been compiled from the following authorities:

"Present Scientific Status of Spinal Anesthesia"
Prof. Co Tui, M.D., New York, N. Y.
*Anesthesia and Analgesia*, Volume 17, Nos. 3 and 4, (May-June and July-August) 1938

"The Physiology of Anesthesia"
by Henry K. Beecher

"Spinal Anesthesia"
by Charles H. Evans

"Spinal Anesthesia"
by Meyer Saklad, *American Journal of Surgery*, Vol. 34, No. 3 (Dec.), 1936

## ANATOMY

**Vertebral Column**

The vertebral column is a strong, flexible column formed by a series of bones called vertebrae. It is about 70 centimeters long in the adult male. Each vertebra consists of two parts:

1. Ventral solid portion, or body
2. Dorsal portion, or arch, formed by the pedicles and the laminae, and has seven processes (four articular, two transverse and one spinous).

There are twenty-six vertebrae in the adult, as follows:

| | | |
|---|---|---|
| Cervical | 7 | |
| Thoracic | 12 | |
| Lumbar | 5 | |
| Sacral | 1 | (5 bones in children) |
| Coccygeal | 1 | (4 in children) |

Viewed from the side the vertebral column presents four curves which are alternately concave and convex. In the *horizontal position*

the cervical curve is convex
the thoracic curve is concave
the lumbar curve is convex
the pelvic curve is concave