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ELECTRICAL ANESTHESIA TECHNIQUES

R. L. WILBUR

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R. L. Wilbur

INTRODUCTION

Presently, there are many definitions and connotations of electrical sleep, electronic sleep, electrical narcosis, electronarcosis, electronic narcosis, electrical anesthesia, electroanesthesia and electronic anesthesia. This report attempts to clarify the terminology and to correlate the work of many investigators. Also the state of the art, the electronics, electrodes, and physiological responses are analyzed.

Terminology used by most investigators has not been consistent in accurately relating the results of the depth of depression of the nervous system. Therefore, in order of increasing depression, all references will be classified under the following definitions, rather than to the title employed by the author:

- ELECTRICAL SLEEP:

A state of unconsciousness whose depth of sleep is not sufficient to deaden pain or relax muscles.

- ELECTRICAL NARCOSIS:

A state of partial or total unconsciousness, but muscle tone is still present and spasms may occur from painful stimuli.

- ELECTRICAL ANESTHESIA:

A state of unconsciousness in which portions or all of the nervous system are depressed to a point where muscle tone and pain perception is removed.

SUMMARY

Depression of the central and peripheral nervous systems by the application of electrical current has received

considerable attention in recent years. Investigations conducted on canines, felines, and humans have led to encouraging results, but true electrical anesthesia, without the use of drugs and prosthetic devices, has yet to be achieved. The majority of successful results to date resulted from trial and error methods; little organization has been applied to definition of goals and techniques. Communication difficulties between investigating scientists and engineers have resulted in questionable techniques and data. This report is designed to provide basic definitions, clarify problem areas, and correlate available data in the field of electrical anesthesia.

ELECTRONICS

Definition of the electrical parameters that will produce a satisfactory depression of the nervous system best suited for surgery has not been achieved. Presently, there are two schools of thought on electrical anesthesia; these are the sinusoidal current application⁽¹⁾ and the square pulses of variable pulse duration⁽²⁾. Early investigations have been reexamined, and the techniques or electrical parameters have been modified by practically every investigator. Questionable results have terminated the early work done with the application of direct current to lower order vertebrates⁽³⁾.

The variable electric parameters that must be considered in the induction of anesthesia are:

- Frequency (Hz)
- Pulse repetition frequency (PRF)
- Pulse width (PW)
- Direct current
- Alternating current
- Sinusoidal waveshape
- Square waveshape.

At present, no single parameter seems to control the level of nervous system depression. Neither has it been determined what possible combination of the stated parameters will produce the desired depressed state. All investigators have taken an empirical approach to the problem, by randomly selecting different values of electrical parameters and recording the results.

One approach having achieved universal acceptance among the investigators, is the constant-current and variable-voltage application of current. To prevent shocks, most of the devices are isolated from ground.

Devices generating signals to meet these requirements are inexpensive to buy and are quite easily constructed. General specifications of such a generator should include:

- Variable pulse repetition frequency (PRF)
- Variable pulse width (PW)
- Variable alternating current amplitude
- Variable direct current level.

The electrical waveshapes used to induce depression of the nervous system are shown in Figure 1. Advantages and disadvantages of each will be discussed under physiological responses, where the effect is most important.

An alternating current waveform (Figure 1-a) shows a frequency range of 300 to 3200 Hz. Addition of a direct current level, 0 to 20 mA range, is shown in Figure 1-b. Bipolar square waves (Figure 1-c) nominally range from 20 to 1000 pulses/sec, 0 to 20 mA average current. Figure 1-d illustrates the movement of the baseline downward to make the pulse monopolar. Further addition of a direct current yields the waveform in Figure 1-e. Monopolar pulses superimposed on a direct current level with a 10% duty cycle (Figure 1-f) are in a 20 to 1000 pulses/sec frequency range and seem to be the most popular among present investigators (Tables I, II, III).

The above nominal values obtained by incorporating all values are used by present investigators, but are not restrictive or indicative of work by any single investigator.

These parameters will be discussed in more detail.

ELECTRODES

Electrodes used in electrical anesthesia are fabricated out of many different metals; notably silver, copper, palladium, stainless steel, and brass. Investigators, who have done extensive work in this field, prefer to use palladium as the electrode material. Palladium exhibits many of the same electrical properties of platinum but is less expensive. Palladium has the desirable property of not becoming "polarized" because of direct current application. Such polarization can cause resistance on the surface of the electrodes.

To further decrease the resistance on the interface between the electrodes

FIGURE 1. Current Waveforms Used in the Induction of Electrical Sleep, Electrical Narcosis and Electrical Anesthesia.

TABLE I. Comparison Table for Variables in Electrical Sleep

Investigator by Reference Number	Number of Testees	Animals Tested	AC Freq. (Hz/s) or PRF (p/s)	Pulse Width msec	AC Signal Only	AC Signal plus DC Level	DC Current mA	AC Current mA	Sleep Achieved	Drugs Used ?	Induction Time	Electrode Placement	Sponges or Gauze Used
9	18	Dogs	20-100 p/sec	1	X			2.5-12	Yes	No	10-30 min	Fronto Occiput	Gauze & Saline
9	1	Human	20-100 p/sec	1	X			2.5-12	No	No		All Over Head	Cotton & Saline
13	?	Humans	1-100 p/sec	0.2-0.3	X			?	Yes	No		Optic-Occiput	Gauze & Saline
14	?	Humans	1-100 p/sec	0.2-1.4	X			0.5-25	Yes	No		Bitemp Fron-Occ	Cotton & Saline

TABLE II. Comparison Table for Variables in Electrical Narcosis

Investigator by Reference Number	Number of Testees	Animals Tested	AC Freq. (Hz/s) or PRF (p/s)	Pulse Width msec	AC Signal Only	AC Signal Plus DC Level	DC Current mA	AC Current mA	Narcosis Achieved	Drugs Used ?	Induction Time	Electrode Placement	Sponges or Gauze Used
1	?	Dogs	60 Hz		X			30-300	Yes	?	30 sec	Bi-Temporal	?
7	8	Dogs	100-200 p/sec	1-2		X	20	9-12	Yes	Yes	5 min	Oral Vertex	Gauze & Saline
5	20	Dogs	700 p/sec	0.12		X	?	?	Yes	Yes	?	Oral Vertex	Sponge & Saline
5	9	Humans	700 p/sec	0.12		X	20	10	No	Yes	?	Fronto-Occiput	Sponge
5	12	Dogs	100 p/sec	2		X	?	?	Yes	Yes	?	Oral Vertex	Sponge
5	12	Dogs	700 p/sec	0.12		X	?	?	Yes	Yes	?	Oral Vertex	Sponge
15	7	Dogs	100 p/sec	1-2		X	20	1.5-30	Yes	Yes	20-60 min	Oral Occiput	Sponge & Jelly

TABLE III. Comparison Table for Variables in Electrical Anesthesia

Investigator by Reference Number	Number of Testees	Animals Tested	AC Freq. (Hz/s) or PRF (p/s)	Pulse Width msec	AC Signal Only	AC Signal Plus DC Level	DC Current mA	AC Current mA	Anesthesia Achieved	Drugs Used ?	Induction Time	Electrode Placement	Sponges or Gauze Used
18	6	Monkeys	100-300 p/sec	0.1-2	X	X	?	?	Yes	Yes	?	Fronto-Occiput	Sponge & Jelly
18	6	Monkeys	300-1000 p/sec	0.1-2	X	X	?	?	No	Yes	?	Fronto-Occiput	Sponge & Jelly
10	10	Dogs	700 Hz		X			25-50	Yes	Yes	?	Bi-Temporal	Sponge & Jelly
8	10	Rabbits	100 p/sec	2		X	15	1-2	Yes	Yes	?	Oral Anus	Sponge & Jelly
8	?	Dogs	100 p/sec	2		X	20	5	Yes	Yes	5 min	Oral Vertex	Sponge & Jelly
8	?	Cats	100 p/sec	2		X	15	1-4	Yes	Yes	?	Fronto-Anus	Sponge & Jelly
8	?	Monkeys	100 p/sec	2		X	20	10-20	Yes	Yes	?	Fronto-Occiput	Sponge & Jelly
11	34	Humans	700 Hz		X			40	Yes	Yes	1-2 min	Bi-Temporal	Gauze & Saline
16	20	Cats	100 p/sec	3	X			14-16	Yes	Yes	2.8 min	Fronto-Occiput	Subcutaneous
6	200	Dogs	3200 Hz		X			16	Yes	?	?	Fronto-Occiput	?
12	28	Humans	700 Hz		X			40-100	Yes	Yes	?	Bi-temp Front-Occ	?

and the skull, vinyl sponges, gauze or cotton pads, soaked with electrode jelly or a saline solution are placed between the electrodes and the skin. Burning of the skin at the electrode interface is a problem caused by electrode pressure and the current passing to the skull. Investigators^(4,5) have found that potassium-free electrode jellies and saline solutions were successful in nearly eliminating the burning sensation.

Experiments were conducted on direct current tolerance by utilizing 6 humans and 20 dogs⁽⁵⁾. The results showed that humans could tolerate a 20 mA direct current; whereas, a 30 mA direct current produced mild burns and discomfort. The dog experiment showed that a 50 mA direct current produced no burns on the dog's skin.

Electrode placement for successful sleep, narcosis, and anesthesia not

only varies from species to species, but also varies from sleep to general anesthesia. Three general locations, preferred by the various investigators, are frontal-occipital, bi-temporal, and head-sacrum. However, these are subject to modification, depending upon the animal used and the portion of the body that must be free for surgery.

Electrodes in dogs were generally placed in the mid-sagittal line, and were either placed oral-vertex⁽⁵⁻⁷⁾ or frontal-occipital.^(8,9) However, one investigator⁽¹⁰⁾ used the bi-temporal placement and achieved satisfactory anesthesia for surgery.

Both the bi-temporal⁽¹¹⁾ and frontal-occipital^(5,7,12) placements were used on humans with varying degrees of success. The general anesthesia was obtained with the bi-temporal placement (Table III., reference 10); however, it took a great deal more current to

induce anesthesia. Some groups failed to achieve anesthesia because of burns induced by the electrodes at a much lower current than the bi-temporal placement. It should also be noted that the electrical signals were not the same, implying that electrode placement alone does not determine the state of anesthesia.

ELECTRICAL SLEEP

Sleep induced by the application of electrical currents has been quite thoroughly investigated by a large number of Russian investigators. Their most successful attempts incorporated square waves with a 5 to 25 pulses/sec PRF, 0.2-0.5 msec PW, 10% duty cycle. The current nominally ranged from 4 to 15 mA for successful electrical sleep. Induction was achieved by starting the current at zero and increasing the current slowly until sleep was achieved; care was taken to remain below the patient's threshold of pain and discomfort. As very little electrical data (other than the above stated values) appeared in the articles, little engineering evaluation can be achieved.

Electrical sleep is being used by the Russian investigators as therapeutic agent in hypertonic illnesses, ulcers, psychiatric and neurotic cases, trauma, eczema, neurodermatitis, schizophrenia, asthma, sclerosis, and glaucoma. There appears to be no concomitant chemical therapy applied to assist in the treatment. (13,14)

Virtually all of the investigators reported primarily-"an improvement in sleep", and secondarily-"an improvement in the patient's condition". The Russians reported no deleterious side and after effects.

Israeli investigations on dogs proved successful with an initial frequency of 100 pulses/sec reduced after onset of sleep to 20 to 50 pulses/sec. The remainder of the parameters were identical to the Russian endeavors.

During electrical sleep, in both dog and man, respiration rates became slower, and the tidal volume increased with short inspirations and prolonged expiration. The pulse rate did not vary significantly, and no noticeable deleterious side effects were apparent.

No chemical premedication was administered in any of the experiments to reduce or confuse the validity of results.

ELECTRICAL NARCOSIS

Electrical narcosis is perhaps the most difficult of the three categories to evaluate because of conflicting terminology and its position between sleep and true anesthesia.

A great many investigators have achieved the depressed state of electrical narcosis and have induced the anesthetized state not by electricity but by the introduction of muscle relaxants, barbituates, narcotics and other chemical injections. (7)

Investigators working with dogs have achieved electrical narcosis with the application of square waves of frequency range 100 to 700 pulses/sec PRF, 1-2 msec PW, 10% duty cycle, superimposed on a 0 to 20 mA direct current level. The average current range of the alternating current is 1.5 to 30 mA, with the onset of narcosis occurring around 9 mA ac.

There is no specific use for electrical narcosis other than for achieving an advanced state of sedation.

Since muscle tone is still present, surgery is not possible and was not attempted in any of the investigations.

It was necessary to premedicate the dogs with thiopentone, methohexital or lidocaine to quiet them for electrode placement and intubation. However, the effect of these drugs was allowed to wear off prior to the application of current.

Studies of blood gases, blood sugar, blood pressure, temperature, cell counts, liver and renal function, and pulse were made; no appreciable changes were noted; and no serious aftereffects were noted.

The respiration rate again slowed with a concomitant increase in tidal volume, characterized by short inspirations and prolonged expirations.

The dogs are normally intubated to prevent respiratory obstruction caused by the anesthetizing current. Only one investigator⁽¹⁵⁾ was able to achieve the narcotic state without intubation, but there is no information about his method for preventing respiratory obstruction or even whether obstruction occurred.

ELECTRICAL ANESTHESIA

Electrical anesthesia, because of ability to control the anesthetic agent (current) holds promise of circumventing the three major disadvantages of chemical anesthesia; slow induction, slow recovery, and prolonged aftereffects. Electrical anesthesia should produce both an analgesic effect and an amnesia effect for successful anesthesia.

It is important at this time to present the case for electrical anesthesia, listing both the advantages and disadvantages. This will serve to define the goals of electrical anesthesia. Table IV outlines these advantages and disadvantages.

Achievement of a depressed nervous state suitable for surgery by the application of current has been attained, but not without the aid of local anesthetics, barbituates, and muscle relaxants.

Generally speaking, frequency and pulse-width data for anesthesia coincide with the sleep and narcosis data. However, the current required to anesthetize dog and man is somewhat larger

TABLE IV. Advantages and Disadvantages of Electrical Anesthesia

<u>Advantages</u>	<u>Disadvantages</u>
1. Rapid induction	1. Convulsions occur during induction if current is applied too quickly
2. Quick recovery	2. Intubation is often required
3. No deleterious aftereffects, anatomically or physiologically	3. Incomplete muscle relaxation-hypertonus
4. Relatively inexpensive	4. Skin burns occur if applied direct current is too high
5. Technique is easy to master	5. Drugs must be administered to promote muscle relaxation, prevent salivation, anesthetize surface musculature against pain around electrodes.
6. Generator is portable	6. Hypertension, tachycardia
7. Affects brain directly. No lung, liver and kidney damage.	
8. No aftereffects on pregnant subjects or resultant offspring	

than the current needed for successful narcosis and sleep (Tables II-IV). Proportionately, less current is required for cats, rabbits, and monkeys.

Anesthesia is induced by first applying the direct current, if it is used, and then gradually applying the alternating current in increments not to exceed 1 mA/5-sec in dogs⁽⁹⁾, or at a rate that does not invoke breath holding, urination, and apnea.

Once the test subject had been anesthetized, the current was maintained at the anesthetizing sustaining level, and surgery was performed. Muscle relaxants were injected in some cases, but satisfactory results were also achieved without them.

Side effects noted during the induction, surgery, and recovery phase included a rise in pulse and blood pressure, spasms, and tonic contractions where muscle relaxant was not used, hypertension and tachycardia where ganglion blocking agents were not used, and intense salivation and periodic bradycardia where a parasympatholytic agent was absent. Obviously, the side effects make successful anesthesia and further successful surgery most difficult to achieve.

The primary aftereffect of electrical anesthesia is fatigue. Some serious consequences were noted when the patients were definitely "bad risk" cases. Here, the subject's physical condition was marginal enough to cause serious complications and even death with the application of current or the concomitant medication to produce anesthesia.

Certain investigators have stated the need to superimpose the ac waveform on a dc level while others work-

ing with sinusoidal waves did not find direct current necessary for induction^(5,10,11). Studies of the requirements for electrical anesthesia with ac square pulses showed that direct current was not necessary to produce anesthesia⁽¹²⁾; neither did the presence nor absence of direct current remove any of the side effects.

GENERAL DISCUSSION

The majority of investigations described in the referenced articles are from early 20th Century experiments. Modest as the early results were, there has been very little effort expended in correlating previous results to determine the best suited approach to the achievement of the anesthetized state. Most investigators have limited their efforts to a specific frequency band, pulse width, and electrode placement, and they have taken data in hopes of arriving at a workable combination by varying the frequency.

Engineering-oriented personnel have emphasized their ability to design and build devices that will produce a limited quantity of different signals, but have usually neglected the medical use of the devices by medical investigators not versed in electronic instrument use. The physicians and veterinarians, sometimes unacquainted with engineering terminology and techniques, have at times used the devices without fully understanding the involved parameters. Therefore, communication between the engineers and medical investigators could be improved.

This lack of communication has resulted in erroneous data and questionable results in numerous instances.

Two of the most outstanding errors noted were:

- A dc milliammeter utilized to read both direct voltage and alternating current. (13)
- The type of current not specified. There is no way to determine from the investigators' procedure whether the current was dc, ac, average, RMS, peak or any combination thereof. (1,5,6,8,11,12,14-17)

It is evident from the above that reproduction of these results would be nearly impossible.

With reference to Figures, 2-5, and Tables II-IV, the parameters worth investigating (as a starting point) appear to be unipolar square pulses in the frequency range 100 to 700 pulses/

sec with pulse widths ranging from 0.1 to 2.0 msec. Electrode placement investigations should include both the frontal-occipital and bi-temporal locations, with examination of multiple electrodes, subcutaneous electrodes and configurations of each.

Compilation of electrical parameter data from the articles has been divided, according to species. Each figure associated with pulsed current application contains a domain for sleep, narcosis, and anesthesia.

The domain for anesthetizing cats is quite large (Figure 2). There is no data available on sleep and narcosis, but from the size of the domain, one

FIGURE 2. Electrical Anesthesia Domain for Cats

can infer that the brain of the cat is quite receptive to a wide range of electrical signals.

Much has been done with dogs in the depression of the nervous system. In Figure 3, there are three distinct domains, each somewhat smaller than the one for cats, and we can infer that

more specific signals are required to satisfactorily depress the nervous system.

The domains for nervous system depression in humans are much smaller than in either dogs or cats (Figure 4). The narrow domains infer a highly developed nervous system where only a specific

FIGURE 3. Nervous System Depression Domains for Dogs

FIGURE 4. Nervous System Depression Domains for Humans

signal or small range of signals serve to depress the nervous system.

Collectively, Figures 2-4 illustrate the relation of current amplitude to the depth of nervous system depression. However, very little information as to pattern can be acquired from the PRF and PW data.

The inability to form a pattern may be caused by several factors:

- Investigators have not investigated the spectrum completely.
- Investigators may have investigated other domains, but have not recorded the results because of failure.

- No pattern exists.

The domains are quite distinct and exhibit no overlapping; this makes it appear that the majority of investigators have limited their attempts to the already tried (but not proven) domains of their predecessors.

Sinusoidal parameters, frequency and current magnitude are shown in Figure 5. There seems to be a relationship between increasing frequency and decreasing current, but no real proof.

Table II-IV are divided into sleep, narcosis, and anesthesia. These

FIGURE 5. Electrical Anesthesia Domains Utilizing Sinusoidal Current Waveforms

tables give information on the type and number of test subjects, electrical data, success or failure data, and electrode placement which primarily illustrate the reliability of the experiments. Investigations run with just a few test subjects (regardless of success can hardly be considered criteria for future work.

Recent investigators have found and recorded some isolated significant results which should definitely benefit future efforts in electrical anesthesia. The most important of these are:

- Potassium-free electrode pastes and saline solution reduce skin burns.
- Direct current tolerances in man are $0 \leq 30$ mA.
- Direct current tolerances in dogs are at least 50 mA.
- Small incremental application of current reduces spasmodic responses.
- Application of direct current in addition to unipolar square pulses does little to enhance the anesthetized state, and does not reduce side effects.
- Narrow waves of 0.2 to 2 msec cause less discomfort than broad waves of 5 to 10 msec.
- Certain deleterious physiological responses appear regularly and must be controlled with drugs.

Many side effects with electrical anesthesia tend to complicate and detract from the ideal situation. Several of these complications are:

- Increased salivation
- Spasms
- Convulsions
- Hypertension
- Hypertonus
- Apnea
- Skin burns
- Anxiety
- Bradycardia
- Valsalva maneuver

Some or all of the above side effects occasionally accompany electrical depression of the nervous system on a single animal, and necessitates the use of drugs to counteract these side effects.

Electrical anesthesia experiments to date have shown no harmful aftereffects. Morphologic, hematologic, and histologic studies^(5,10,16,17,18) have shown no permanent changes, and test subjects have not lost any of their learned traits because of electrical anesthesia. It should be noted, however, that these were short-term analyses, and more time is actually required to determine any long range effects.

The drugs used on test subjects to reduce salivation, relax muscles, deaden peripheral nerves, and generally quiet patients for intubation and electrode placement are shown in the appendix.

Investigations into the experiments where drugs were used to supplement the electrical current have resulted in some startling mistakes and disappointing techniques.

One investigator, using 700 Hz sine waves, 45 mA current, premedicated his dogs with atropine sulfate and morphine sulfate to reduce salivation and bradycardia. A side effect of these drugs is reduced respiration. This promoted anoxia which he counteracted with hexylcaine. To achieve muscle relaxation, he injected curare which depresses respiration even further. It appears that the investigator spent most of this time counteracting the side effects of each drug with a new drug.⁽¹⁰⁾

In another case, a human patient with a cardiac disease was anesthetized

with a 700 Hz, 40 mA current and pre-medicated with promethazine hydrochloride (Breviril). This patient died twenty minutes after the current was shut off. The contra-indications of Breviril include cardiac patients. (11)

Severe pressure from holding electrodes in place often causes discomfort and burning, so one investigator administered procaine to reduce the localized pain associated with the scalp electrode. Side effects of procaine, excitement, restlessness, and anxiety, were reduced by a tranquilizer. Here is another case of continual drug administering to achieve the desired relaxed state.

Thus, the present state of the art demands the use of drugs in addition to electrical current to produce the desired depressed state, previous examples illustrate the necessity of careful consideration of side effects and contra-indications. It is also evident (from the above examples and from the appendix) that the number of drugs used is lengthy and that any reduction in the number of drugs necessary to reduce side effects will be difficult to achieve.

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APPENDIX

DRUG, CHEMICAL AND PHARMACOLOGICAL INDEX1. ATROPINE SULFATE (DELKADON)

EFFECTS: Mild sedation, antispasmodic and antisecretory

SIDE EFFECTS: Dry mouth, blurred vision, difficult urination

CONTRA INDICATIONS: Glaucoma, prostatic hypertrophy, hypertension

2. CURARE (INTOCOSTRIN)

EFFECTS: Relaxes skeletal muscles and softens convulsions

SIDE EFFECTS: Skin rash, depressed respiration

CONTRA INDICATIONS: Myasthenia gravis

3. GUANETHIDINE SULFATE (ISMELIN)

EFFECTS: Reduces moderate to severe hypertension

SIDE EFFECTS: Hypotension, dizziness, diarrhea

CONTRA INDICATIONS: Use cautiously with peptic ulcer patients

4. LIDOCAINE (XLOCAINE HYDROCHLORIDE)

EFFECTS: Rapid acting local anesthetic

SIDE EFFECTS: None

CONTRA INDICATIONS: None

5. MORPHINE SULFATE (VITARINE)

EFFECTS: Sedation

SIDE EFFECTS: Nausea, vomiting, respiratory depression

CONTRA INDICATIONS: Asthma, convulsive states, diabetes

6. PENTOBARBITAL SODIUM (NEMBUTAL)

EFFECTS: Sedation, analgesic

SIDE EFFECTS: Habit forming, allergic reactions

CONTRA INDICATIONS: Barbituate sensitized patients

7. PHENTOLAMINE METHANESULFONATE (REGITINE)

EFFECTS: Reduces blood pressure, prevents paroxysmal hypertension due to anesthesia

SIDE EFFECTS: Tachycardia

CONTRA INDICATIONS: Give cautiously to patients with coronary occlusive disease

8. PROCAINE HYDROCHLORIDE

EFFECTS: Systemic analgesia, eases edema and traumatic pain

SIDE EFFECTS: Excitement, restlessness, anxiety, rapid pulse, irregular respiration, hyperactive reflexes.

OR

Fall in blood pressure, pallor, sweating, loss of consciousness

CONTRA INDICATIONS: Do not administer to procaine sensitized patients

9. PROMETHAZINE HYDROCHLORIDE (BREVEDIL)

EFFECTS: Sedation, topical anesthetic, central nervous system depressant

SIDE EFFECTS: Dryness of mouth, dizziness, blurred vision

CONTRA INDICATIONS: Administer with caution to patients with hypertension, cardiac or peripheral vascular disease. hyperthyroidism or diabetes

10. SCOPOLAMINE

EFFECTS: Relieves spasms and reduces hypersecretions

SIDE EFFECTS: None

CONTRA INDICATIONS: Glaucoma and prostatic hypertrophy

11. SODIUM METHOHEXITAL (BREVITAL-SODIUM)

EFFECTS: Short term anesthesia

SIDE EFFECTS: Hiccups, sneezing, muscular twitch when administered too slowly. Apnea when administered too quickly

CONTRA INDICATIONS: None when administered by a competent anesthesiologist

12. THIOPENTONE

EFFECTS: Ultra-short acting barbiturate for induction of anesthesia

SIDE EFFECTS: Respiration problems

CONTRA INDICATIONS: None, if administered by a competent anesthesiologist with capabilities to control or assist respiration

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