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Modern Surgery - Chapter 29. Anesthesia and Anesthetics

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the two portions may be anastomosed after resection of a part of the tube. Kraske's operation may be done by an osteoplastic method, the bone not being removed. It is well to precede a Kraske operation two weeks by an inguinal colostomy, which permits of cleansing the lower bowel of feces and lessens the chance of severe wound-infection and delayed healing after the removal of the rectum. A preliminary colostomy may make the operation of extirpation more difficult by fixing the intestine, and thus interfering with the necessary drawing down of the gut (E. H. Taylor). If the growth is extensive and the mesocolon short, it may be best to perform a right inguinal colostomy; but in most cases left inguinal colostomy is preferred (Gerster). The colostomy remains open during the patient's life, except in those rare cases of Kraske's operation in which the continuity of the rectum can be re-established after excision of the growth. In such cases the artificial anus is closed some time after the resection of the rectum.

Robt. F. Weir ("Med. News," July 27, 1901) has been so much impressed with the difficulties and dangers of Kraske's operation in a case of high carcinoma that he now employs it solely in cases in which there is freedom from disease for two inches immediately above the anus and in which the cancer does not extend more than five inches above the anus. In other cases he does the following operation: Open the abdomen above the pubes, separate the peritoneum so that the bowel and "contents of the sacral curve" are liberated behind nearly "to the tip of the coccyx and in front of the edge of the prostate." The tumor is then tied off with tapes (Fig. 489). Theportion of the rectum bearing the tumor is removed, the lower end of the bowel is everted through the anus, and the upper end is drawn out of the abdominal incision (Fig. 490). The upper end is then caught with forceps and drawn through the everted lower end of the rectum (Fig. 491, a). The ends of the two everted portions (Fig. 491, b) are sewn together, the everted bowel is replaced, the divided peritoneum is sutured to shut off the peritoneal cavity, and posterior drainage is inserted (Fig. 492). The mortality of Kraske's operation is from 12 to 15 per cent. Twenty-eight per cent. of Kocher's cases of extirpation of cancer of rectum remain well from 3 to 16 years after operation (W. W. Cheyne, "Brit. Med. Jour.," June 13, 1903).

XXIX. ANESTHESIA AND ANESTHETICS.

Anesthesia is a condition of insensibility or loss of feeling artificially produced. An anesthetic is an agent which produces insensibility or loss of feeling. Anesthetics are divided into—(1) general anesthetics, as amylene, chloroform, ethylene chlorid, ether, bromid of ethyl, nitrous oxid, and bichlorid of methylene; (2) local anesthetics, as alcohol, bisulphid of carbon, chlorid of ethyl, carbolic acid, ether spray, cocain, eucain, ice and salt, rhigolene spray, and ethyl chlorid spray.

Anesthesia may be induced by a general anesthetic to abolish the usual pain of labor and of surgical procedures; to produce muscular relaxation in tetanus, herniae, dislocations, and fractures; and to aid in diagnosticating abdominal tumors, joint-diseases, fractures, and malingering.
Death-rate from Anesthetic Agents.—Hewitt combines the statistics of Julliard and Ormsby, with the following result ("Anesthetics and their Administration"):

<table>
<thead>
<tr>
<th>Anesthetic</th>
<th>Total Number of Administrations</th>
<th>Total Number of Deaths</th>
<th>Death-rate.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloroform</td>
<td>676,767</td>
<td>214</td>
<td>1 in 3162</td>
</tr>
<tr>
<td>Ether</td>
<td>407,553</td>
<td>25</td>
<td>1 in 16,302</td>
</tr>
</tbody>
</table>

Hewitt finds that during the last forty years only thirty fatalities are recorded as produced by nitrous oxid, and he thinks several of these should be excluded. It is practically certain, however, that many deaths, or at least some deaths, have not been recorded.

Ware ("Jour. Amer. Med. Assoc.," Nov. 8, 1902) collected 12,436 instances of anesthesia by chlorid of ethyl, with one death.

Preparation of the Patient.—Whenever possible, prepare a patient before administering a general anesthetic, and prepare him, if the case admits of it, during two or more days. Heart disease is not a positive contraindication to surgical anesthesia. It is quite true that anesthetics are dangerous to people with fatty hearts, but shock is also dangerous, and the surgeon stands between the Scylla of anesthesia and the Charybdis of shock. Gallant truly says that not enough attention is paid to the "character of the pulse and action of the heart before operation, by which to compare its work during anesthesia, and after the operation is over, and this neglect leads to unnecessary stimulation and overdriving a heart which is doing its average best."* Always examine the urine if the nature of the case allows time. If albumin is found, operation is not contraindicated; but the peril of anesthesia is greater, and certain dangers are to be watched for and guarded against. If much albumin is present, postpone operation except in emergency cases. If sugar is found, the danger is considerable, as diabetic coma occasionally develops. The percentage of sugar does not determine the amount of danger. Coma may arise when only a little sugar is present, and may not arise when there is a considerable amount. The presence of aceto-acetic acid is ominous. Empty the intestinal canal by purgation a number of hours before anesthetization. It is well to give the bowel six to twelve hours' rest before operation. The usual custom is to give a saline cathartic the evening before operation and an enema early on the morning of the operation. Of course, frequently the nature of the case or the necessity for haste does not permit of preliminary emptying of the intestine by the administration of cathartics. During the twenty-four hours preceding operation food should be taken in small amounts and in forms easily digestible. During the day or so before operation there is usually impaired digestion, and no undue strain should be put upon the stomach. In the morning allow no breakfast if the operation is to be performed at an early hour; but if the patient is very weak, order a little brandy and beef-tea. If the operation is to be about noon, give a breakfast of beef-tea and toast or a little consommé; never give any food within three hours of the operation, but brandy is admissible if it is required.

* Medical Record, February 2, 1899.
is not empty at the time of operation, vomiting is almost inevitable, and portions of food may enter the windpipe; if the stomach contains no food, vomiting is far less likely to happen; and even if it occurs and vomited matter should enter the windpipe, it may do little harm, as it consists chiefly of liquid mucus. In cases of intestinal obstruction in which there has been stercoraceous vomiting there is much danger that vomiting will occur during anesthetization. In some cases of intestinal obstruction, during the administration of the anesthetic, and during the anesthetic state, a stream of stinking brown fluid may flow without effort from the mouth. Vomiting or regurgitation of stercoraceous material is profuse, sudden, and dangerous. It may flood the bronchial tubes during inspiration and cause death by suffocation. In a case in which stercoraceous vomiting has occurred wash out the stomach before administering the anesthetic. If a patient with intestinal obstruction is too weak to permit lavage, a local anesthetic should be used instead of a general anesthetic. Vomiting while the patient is under the influence of an anesthetic is dangerous in any case, because of the great cardiac weakness which precedes and follows it. If a patient sleeps well the night before an operation, he will probably take the anesthetic better than if he sleeps poorly. Effort should be made to obtain a night's sleep. An excellent expedient is a hot ammonia bath, followed by a rub-down with weak alcohol.* It may be necessary to administer trional or bromid. Before giving the anesthetic see that artificial teeth are removed and that the patient does not have a piece of candy or a chew of tobacco in the mouth. Always have a third party present as a witness, because in an anesthetic sleep vivid dreams often occur, and erotic dreams in women may lead to damaging accusations against the surgeon. Place the patient recumbent. The effort should be to place him in as comfortable a position as possible if this position is consistent with operative necessities. See that the clothing is loose, particularly that there is no constriction about the neck and abdomen. Do not have the head high unless this position is demanded by the exigencies of the operation. The anesthetist must have a mouth-gag and a pair of tongue forceps. It is very wrong to say that a mouth-gag and tongue forceps are never necessary. It is quite true they are often used when not needed, but this does not justify us in being without them when they are needed, and they may be needed very badly. The anesthetist should also have a pair of artery forceps and some small gauze sponges to swab out the mouth and throat. A hypodermatic needle in *working order, and solutions of strychnin, atropin, digitalis, and brandy are to be in a readily accessible place, and it is well to have an electric battery and a can of oxygen at hand. Accidents, it is true, are rare, but they may happen at any time, and hence the surgeon should always be prepared for them. Any danger which arises must be met with promptness and decision, or action will be of no avail. Many surgeons give a hypodermatic injection of morphin a short time before operation, to steady the heart, prevent vomiting during anesthetization, to shorten the stage of excitement, and aid the bringing about of insensibility with very little of the anesthetic. There are, however, objections to morphin before anesthesia, and its use should be the exception and not the rule. It depresses the respiration, lowers temperature, and thus increases operative shock,

Ether and Chloroform

interferes with the pupillary phenomena of anesthesia, delays awakening from the anesthetic sleep, and actually favors post-anesthetic vomiting. In some cases we may anticipate trouble from the anesthetic. Cyanosis may occur in drunkards; in fat, thick-necked individuals of the Major Bagstock type, who are short of breath and congested in appearance; in individuals with some disease of the lungs, bronchi, pharynx, larynx, or trachea (empyema, emphysema, chronic bronchitis, croup, cancer of the larynx, etc.); in individuals suffering from fatty heart or valvular incompetence. Buxton points out that an individual without teeth and with stenosis of the nares is apt to become cyanotic under an anesthetic, because the lips and pillars of the fauces are drawn in like valves during inspiration.

Ether and Chloroform.—The two favorite anesthetics are ether and chloroform. Only the very best ether or chloroform should be used. It is a good plan, in order to lessen bronchitis, to mix with ether turpentine of Pinus pumilio in the proportion of 20 drops to 63 oz. (Becker, in "Centralbl. f. Chir.," June 1, 1901). Chloroform is more dangerous than ether in general cases, though it is more agreeable, less irritant to the lungs and kidneys, and quicker in its action. Chloroform is a safer anesthetic in warm than in cold countries. In fact, in the tropics it is difficult or impossible to use ether because of its great volatility. Chloroform is preferred in campaigns, because less is required and transportation is easier. Recovery from chloroform is quicker and quieter than that from ether, but chloroform-vomiting lasts longer than ether-vomiting. Chloroform may induce sudden and even fatal syncope. Hare's experiments on animals indicate that chloroform may kill by respiratory failure occurring secondarily to failure of the vaso-motor center; but certain it is that clinically the danger of chloroform is paralysis of the heart, and this condition may come on so rapidly that death may occur almost before an attempt can be made to save life. Leonard Hill has proved that most chloroform-deaths that take place after considerable of the anesthetic has been taken arise from paralytic distention of the heart. Sudden death, when inhalations of chloroform have just commenced, may be due to the irritant vapor acting on the nasal mucous membrane, exciting a nasal reflex and powerfully stimulating cardiac inhibition. If ether produces danger it does so usually through the respiration, and not the heart, and there is generally time to undertake means of resuscitation, which means are apt to be successful. Chloroform is to be preferred to ether in the following cases: for children under ten years of age, in whom ether causes a great outflow of bronchial mucus, which may asphyxiate; for people over sixty, free from advanced cardiac disease, at which age most persons have some bronchitis, and ether chokes them up with mucus. Ether also irritates the kidneys, which at the latter age are apt to be weak or diseased. Chloroform is given if the actual cautery is to be used about the face, neck, or mouth, because ether vapor may take fire and chloroform vapor will not. Chloroform is preferred for labor cases, when moderate anesthesia only is required, and for operations on the mouth and nose. In cleft-palate operations chloroform is usually preferred, because it causes but little cough and salivary flow. In ligation of a large artery which is overlaid by a vein, ether exercises the unfortunate influence of greatly enlarging the vein. Hence in such a case chloroform makes the operation easier. In goiter operations ether should
not be used, as it enlarges enormously the veins. In fact, a goiter should be removed with the aid of local anesthesia. Chloroform is particularly dangerous when there is myocardial disease, and is apt to produce cyanosis and embarrassed respiration. In valvular heart disease chloroform is more dangerous than ether, and even in functional heart trouble it is an undesirable anesthetic. Chloroform is preferred for patients with difficult respiration from any cause other than heart disease, for patients with kidney disease, and for patients with diabetes. Some surgeons do not use ether in abdominal operations, because they believe it may cause persistent oozing of blood, but this view is not in accord with the author's experience. Ether is the best and safest anesthetic for general use. It is much safer than chloroform in valvular disease and functional heart trouble. It is dangerous in myocardial disease, but not nearly so dangerous as chloroform. In valvular disease without heightened arterial tension it is reasonably safe, but in valvular disease with heightened arterial tension it is dangerous. Ether is dangerous when atheroma exists. Both ether and chloroform may induce changes in the blood.* In practically all cases they produce a diminution of hemoglobin and leukocytosis. In some cases they produce alteration in the shape of the corpuscles. These changes are especially marked in anemic blood. Ether produces distinct leukocytosis, probably toxic in origin. These blood changes indicate that prolonged anesthesia may militate against recovery from a severe operation. If a patient's hemoglobin is below 30 per cent., a general anesthetic should not be given. During the state of anesthesia the temperature drops from one to three degrees, hence the patient should be carefully covered during the operation. The question as to the effect of ether on the kidneys is much disputed. Most surgeons believe that it tends to cause albuminuria or increase existing albuminuria. Nitrous oxid is very dangerous when there is vascular degeneration, and it may induce apoplexy. In giving ether or chloroform the administrator must devote his undivided attention to the task. He must note every symptom, must order or carry out proper treatment for complications, and must keep the operator informed as to the necessity for haste. The anesthetist must be a man who has a wholesome respect for ether and chloroform, although not afraid of them.

Can an anesthetic be administered to a sleeping person without waking him? I know that chloroform can be so given, for I have succeeded in giving it to a child without breaking the slumber. Probably, in most cases, an attempt will fail, but in some it will succeed. Stone ("Cleveland Med. Jour.," Jan., 1902) reports successful administration to sleeping children and also the chloroforming of a resident physician while asleep. Paugh ("Jour. Amer. Med. Assoc.," May 18, 1901) reports three successes with children. Ether, because of the irrigant nature of its vapor, would be more apt to arouse a sleeper than would chloroform.

**Administration of Chloroform.**—Chloroform should be given only by a trained man. In fact, safety in giving chloroform is dependent upon skill and experience more than in giving ether. The most dangerous period is when the patient is incompletely anesthetized, but is going under. Most deaths happen at this time. In administering chloroform have at hand

*See the Author on the "Blood-alterations of Ether-anesthesia," Medical News, March 2, 1895, and also The Proceedings of the American Surgical Assoc. for 1901.
Administration of Chloroform

a mouth-gag, tongue forceps, artery forceps, small gauze sponges, a clean towel, a hypodermatic syringe, solutions of strychnin, atropin, and brandy, an electric battery, and a can of oxygen. Use only pure chloroform (Squibb’s). The patient must be recumbent. No special inhaler is required, but the drug may be given upon a thin towel, a napkin, or a piece of lint. The mask of Skinner is very useful (Fig. 493, B). Junker’s inhaler is used by many anesthetists (Fig. 493, A). In operations about the face Souchon’s instrument is serviceable. Souchon’s apparatus is so arranged that chloroform may be given through a tube which is introduced through the nose, the instrument being well out of the way of the operator. Some surgeons cocainize the nares before giving chloroform, so as to prevent supposedly dangerous nasal reflex (Rosenberg). It is a good plan to smear the lips with cosmolin to prevent blistering. The chloroform-vapor must be well mixed with air. The chloroform is sprinkled on the fabric with a drop-bottle. Raise the napkin well above the mouth, add five drops of chloroform, and tell the patient to take deep and regular breaths, but do not tell him to breathe forcibly. Forcible respiration may lead to cessation of respiration. Add a

![Fig. 493, A.—Junker’s inhaler.](image)

![Fig. 493, B.—Skinner’s mask.](image)

few more drops of chloroform, and when the patient grows so accustomed to it that it does not choke, turn the wet part of the fabric toward the face and place it near the mouth; do not touch the mouth with the wet lint, because it will blister. If the drug is given gradually, struggling is not usually violent or prolonged. Never pour on a large amount at one time. Keep the lower jaw pushed forward during the time the chloroform is being given. Cough and vomiting at this time mean that the vapor is too strong. During the stage of excitement do not suspend the administration of chloroform unless respiration becomes difficult, in which case suspend it until the patient takes one or two respirations. If the patient struggles, do not hold him and push the administration of the drug. He holds his breath while struggling, and as struggling ceases takes full, deep breaths. If the inhaler is saturated with chloroform, he may inhale a dangerous amount during the deep respiration after struggling. Chloroform given in considerable amount when the patient is breathing deeply from the effects of ether is unsafe. If chloroform is given subsequent to anesthetization by ether, it should be given gradually and well mixed with air. When the patient becomes anesthetized, give just enough of the drug to keep him so. After the patient has been anes-
Anesthesia and Anesthetics

... thetized, hiccough usually means that vomiting is going to occur. If vomiting occurs at this time, more chloroform must be given to abolish the reflexes. Deep and sighing respiration and repeated swallowing indicate that more of the anesthetic is required. Stop the administration or give very little when shock becomes evident or when there is profuse hemorrhage. Chloroform-vapor is not inflammable, hence it is safer than ether when a hot iron is to be used about the face and when there is a lighted lamp or a stove in a small room; but the presence of flame decomposes chloroform into irritant products of chlorin, which sometimes cause the patient and the surgeon to cough (C, HCl, and CCl4).

Chloroform and Oxygen.—The use of this mixture was suggested by Neudorfer. Some anesthetists advocate the use of chloroform and oxygen, asserting that it does not produce spasm of the glottis or muscles of respiration, that it does not produce cyanosis or weakness of circulation, that it does not irritate the kidneys, is safer to life than pure chloroform, and is less often productive of severe and prolonged vomiting. These alleged advantages are probably stated with rather undue emphasis, although I do believe the mixture has less tendency to produce cyanosis than has the pure drug, is not so often followed by vomiting, and is somewhat safer. Hewitt does not think that the method offers any "special advantages" ("Anesthetics and their Administration," by Fred. W. Hewitt). If this method is used, a bag containing oxygen is attached to the hand-bellows attachment of a Junker inhaler, and oxygen is forced through the chloroform and is taken to the face-piece.

Administration of Ether.—The administration should not be intrusted to a novice. The anesthetist should be one of your best men. Ether is best given by a partially open inhaler. The most satisfactory appliance is Allis’s inhaler (Fig. 494). This inhaler secures a plentiful supply of air. Before being used, the metal frame is scalded, dried, and threaded with a clean gauze bandage. The end of the frame which is to be toward the mouth is covered with one layer of gauze. The frame is then inserted in a clean metal case and the case is wrapped in a clean towel. Many surgeons prefer closed inhalers. The Clover inhaler is popular in England (Fig. 495). F is the face-piece; C, a reservoir of ether through which the air-current passes; B is an India-rubber bag. In this apparatus there is no provision for the entrance of fresh air. By turning the reservoir C on the tube t the amount of current passing over the ether can be regulated. When this apparatus is used, the ether-vapor breathed into the lungs is expired into the bag and is rebreathed. This inhaler, if used by a skilful man, is very useful; but any lack of watchfulness or skill will permit of cyanosis, and the very young, the senile, the anemic and feeble, are best anesthetized by the Allis inhaler.

An admirable detailed account of anesthetization by the closed method will be found in Mr. Frederic W. Hewitt’s treatise on "Anesthetics and their
Ether and Oxygen Administration (page 272) and in Mr. Dudley W. Buxton’s treatise on “Anesthetics, their Uses and Administration” (page 109). When giving ether, have at hand the same drugs and appliances as when chloroform is given, and keep the lower jaw pushed forward during the administration. When anesthetizing by Allis’s inhaler, place the dry inhaler over the mouth and nose, let the patient take several breaths to gain confidence, pour a few drops of ether into the cone, let the patient take several more breaths, and so on, gradually increasing the amount of ether. If he tends to struggle, diminish the amount of ether for a time, but do not hold him. Do not tell him to breathe forcibly. Forcible breathing is liable to cause cessation of respiration. Never suddenly add a large amount of the anesthetic: it causes coughing and often vomiting. When the patient becomes thoroughly anesthetized, diminish the amount of ether. When bleeding is profuse or shock is marked, suspend the administration of ether or give very little of it. If a hot iron is to be used about the face, remove the cone and fan away the ether before bringing the iron near. Have any light set high up, as ether-vapor is heavier than air, and no explosion is possible until it reaches the level of the flame. If the vapor takes fire, cover the patient’s mouth and nose with a towel. If he rolls his eyes from side to side, if the respirations are deep and sighing, if there are repeated movements of swallowing, more anesthetic should be given (Tarnowsky). Hiccough is often preliminary to vomiting, and always means that the reflexes are returning.

Ether and Oxygen.—This mixture is useful in certain cases in which respiratory difficulty exists, particularly in empyema. If during the administration of ether cyanosis tends to occur, it is often advantageous to give oxygen with the ether. The process of anesthetization by ether and oxygen is somewhat slower than by ether-vapor mixed with air. It can be given by inserting beneath the Allis inhaler or pushing deep down into it from

![Clover's portable regulating ether-inhaler.](image)
above, a tube attached to a reservoir of oxygen and from which a stream of oxygen emerges.

**Rectal Etherization.**—Roux suggested this method in 1847. A bottle of ether is set in water at a temperature of 122° and a rubber tube connected with the bottle is inserted in the rectum (Molliére, in "Lyon Médical," April 28, 1884). The method has never come into general use. It irritates the large intestine, and sometimes is said to lead to protracted stupor ("Anesthetics and their Administration," by Fred. T. Hewitt). Dudley W. Buxton, however, has employed it in many operations about the face, mouth, and larynx, and in some operations for empyema, and commends it.

**Anesthetic State from Ether or Chloroform.**—The inhalation of an anesthetic produces irritation of the fauces, often some cough, a profuse secretion of mucus, acts of swallowing, dilatation of the pupils, flushed face, and sometimes struggling (especially in children and in drunkards). If the vapor is given at once in concentrated form, cough will be violent and will cause cyanosis. If the anesthetic is given carefully, the cough soon ceases, the respirations become rapid and often convulsive, the pulse becomes frequent, and the patient passes into a condition of active intoxication with preservation of sight and touch, loss of hearing and smell, diminution of pain and sensibility, and often with illusions or hallucinations. In this stage the patient may struggle, and while efforts are being made to hold him cyanosis may occur. From the stage of excitement just alluded to, many subjects (strong men and drunkards) pass into a stage of rigidity in which the muscles become firmly fixed, the breathing impeded, the respirations stertorous, and the face bluish and congested. Too rapid forcing of the anesthetic tends to cause rigidity, and a skilled anesthetist endeavors to avoid its production, because it is dangerous. The next stage is one of insensibility; the pupils are contracted, but react to light. If anesthesia is deep, the contracted pupils will not react to light; if anesthesia is profound, the pupils dilate, but will not react to light. The conjunctival reflex is gone; the lids are closed; if the arm is lifted and allowed to fall, it drops as a dead weight; the skin is cool and moist, and often wet with sweat; the respirations are easy and shallow; the pulse is slow; and there is complete unconsciousness to pain. The conjunctival reflex is the usually accepted sign that the patient is unconscious. In a young child this reflex is soon exhausted by touching the eye, and the sign is unreliable. If a baby is to be anesthetized, the administrator places his finger in the infant's hand. The child grasps the finger, and relaxes its grasp when unconscious.

Always bear in mind that a dilated pupil reacting to light and associated with preserved conjunctival reflex means that anesthesia is not complete; that a contracted pupil reacting to light and without conjunctival reflex means moderate anesthesia; that a contracted pupil not reacting to light and without conjunctival reflex means deep anesthesia; that a dilated pupil not reacting to light and associated with lost conjunctival reflex means dangerously profound anesthesia; that weak pulse and pallor may be due to nausea, but always require instant attention; that vomiting may be due to forcing strong vapor upon the patient, but that it may also be due to his partially emerging from a state of insensibility.

Watch the pulse carefully to see if it becomes very weak, irregular, ab-
Treatment of Complications

normally slow, or abnormally fast. Syncope may be due to nausea, shock, hemorrhage, or the giving of too much of the drug. Watch the respiration, and do not forget that the chest-walls and belly may move when no air is entering the lungs; hence always listen to the breathing. Cyanosis is a dusky or bluish discoloration of the skin. This condition indicates want of oxygen in the blood. The individual may have been cyanotic or predisposed to cyanosis to start with; cyanosis may be due to posture; to cough early in the administration; to struggling during the stage of excitement; or to rigid fixation of the respiratory muscles. It may also be due to obstruction of the air-passages by some foreign matter, as blood or vomit, lodging in the bronchial tubes, windpipe, larynx, or pharynx; falling back of the tongue (swallowing of the tongue); closure of the epiglottis; or to the glottis being pushed against the pharyngeal wall by bending the head forward. Some patients with occluded nostrils may fail to get enough air because of closure of the lips. A patient may appear to "forget to breathe." Shock is manifested by deadly pallor, weak and irregular pulse, slow respiration, cold extremities, and a drenching sweat. In rare cases edema of the lungs occurs. 

Treatment of Complications.—Vomiting due to too much anesthetic is corrected by giving a few breaths of air; vomiting due to incomplete anesthesia is amended by giving more of the vapor. When the patient vomits, hang the head over the edge of the bed, separate the jaws with the gag, and wipe out the vomited matter, mucus, and saliva. Shock is treated by diminishing the amount of the anesthetic given, by the hypodermatic injection of adrenalin chlorid, from 10 to 20 minims of a 1:1000 solution, or atropin (the last-named drug is very useful when there is a profuse sweat), by the administration of hot saline fluid by the rectum, by surrounding the patient with hot-water bottles, or by wrapping him in hot blankets, and by lowering the head of the bed. A tendency to syncope requires lowering of the head of the bed, suspension of the anesthetic, and hypodermatic injection of strychnin. In extreme syncope, which is most apt to occur from chloroform, do not wait for breathing to cease, but suspend the anesthetic, lower the head of the bed, open the mouth with the gag, catch the tongue and make rhythmical traction while an assistant is making slow artificial respiration. If the patient does not at once improve, invert him completely, holding him by the legs and continuing artificial respiration by compressing the sternum (Nélaton). By continuing artificial respiration the blood is urged on through the heart. Leonard Hill holds that in the failure which arises soon after administration of chloroform is begun the trouble is due to vaso-motor paralysis with starvation of the nerve-centers. In such a case he applies abdominal compression and inverts the patient, making artificial respiration at the same time. In the failure which occurs after considerable chloroform has been taken there are paralytic distention of the heart, fulness of the venous system, and loss of the compensations for the hydrostatic effects of gravity. In such a condition empty the distended heart of venous blood by raising the patient into an erect position; and after a moment place him recumbent and make artificial respiration. Give hypodermatic injections of adrenalin chlorid, atropin, ether, or even of ammonia. Put mustard over the heart and spine. Employ faradism to the phrenic nerve (one pole to the epigastric region,
the other to the right side of the root of the neck). Let fresh air into the room, put hot-water bottles around the legs, apply friction to the extremities, wrap the patient in hot blankets, give an enema of brandy, and hold ammonia to the nose.

"Forgetting to breathe" is met by removing the inhaler and waiting a moment; a breath will usually be taken soon; but if it is not taken, open the mouth and pull forward the tongue; this causes a reflex inspiration. Cyanosis is practically not encountered when oxygen is given with ether or chloroform. Cyanosis, if slight, and due to cough or struggling, is met by removing the inhaler while the patient takes a breath or two of air. If position is responsible for cyanosis, correct it. In empyema, lying upon the sound side may produce it, and obstruction to breathing may be due to bending down the head. If due to stenosis of the nares in a person without teeth, hold the lips apart with a finger.

Dudley W. Buxton points out that duskiness will often pass away if ether is removed, one or two inhalations of chloroform given, and ether then continued. If in any case cyanosis is severe or grows worse, suspend the drug, dash cold water in the face, force open the jaws, pull forward the tongue, make artificial respiration until a breath is taken, and then give oxygen for a time. If these means fail, stretch the sphincter ani and bleed from the external jugular vein. If a breath is not now taken, do tracheotomy. In respiratory or heart failure forced artificial respiration by Fell's method is of great value. In Fell's method a tracheal tube is inserted, and by means of a foot-bellows air is forced into the lungs, after first passing through a warming chamber. Instead of a tracheal tube, we may use a face-mask and an intubation-tube. "Swallowing the tongue" is corrected by pulling the tongue forward. If it tends to recur, lay the head upon its side or keep the tongue anchored with forceps. Closure of the epiglottis is corrected by pulling the patient's head over the edge of the table and pushing strongly back upon his forehead. This maneuver lifts the hyoid bone, and with it the epiglottis. The epiglottis can be lifted by passing a spoon-handle or the index-finger over the dorsum to the base of the tongue and pressing forward. If, in obstruction to respiration, the above means fail, make artificial respiration at once; if obstruction continues, perform tracheotomy.

Edema of the lungs is treated by instant venesection, the inhalation of nitrite of amyl, and the administration of stimulants and nitroglycerin hypodermically. Sometimes, during the anesthetic state, the muscles of the belly become very rigid, a condition which greatly interferes with an abdominal operation. It may arise during cyanosis, and if so caused is amended, as cyanosis abates under proper treatment. In some cases it is due to the fact that sufficient anesthetic has not been given. If the air-passages are obstructed, abdominal rigidity is apt to arise. In some cases it seems impossible to overcome it with ether. In such a case, if the anesthetist is a trusted man, anesthetize the patient with gas and ether and then give chloroform (Blumfield, in "Lancet," May 31, 1902).

Artificial Respiration.—Laborde's Method.—Place the patient on his back with the head lower than the body, all the clothing loosened, and the jaws wedged apart, and wipe the mucus from the throat and mouth. Grasp the tongue with forceps, and once in every four seconds pull it quickly
and strongly forward and then permit it to go back. It may be necessary to keep up this proceeding for thirty minutes or even more.

Laborde’s method should be associated with “concentric thoracic and upward abdominal pressure applied in a rhythmic manner by two assistants at the time of relaxation of the tongue.” Laborde believes that tongue-traction causes contractions of the diaphragm.

Sylvester’s Method (Figs. 496, 497).—The patient is placed recumbent with the foot of the bed raised. The surgeon grasps the arms just above the elbows, and draws them outward and upward until they are nearly perpendicular; they are held perpendicular for two seconds while air is entering the lungs; the arms are then lowered and pressed against the sides of the chest for two seconds, during which time the chest is emptied as in expiration. These movements of elevation and depression are made twelve or fifteen times a minute.

The Reaction from Anesthesia.—After the administration of the anesthetic has been suspended and the operation has been completed the temperature is usually subnormal. The patient must be watched until consciousness returns. If he is left alone, a change of posture may lead to arrest of feeble respiration, the assumption of the erect position may cause fatal syncope, or mucus or vomited matter may block the air-passages and cause suffocation. The best position to place him in is the recumbent, the head being level with the body or somewhat lower, and the side of the face resting on the pillow. Shock is treated by ordinary methods. The inhalation of oxygen is of great value in rousing a patient from the state of anesthesia, and will often prevent vomiting. If vomiting occurs, the head should be upon its side or should be hung over the edge of the bed, and after the spell of vomiting the mouth must be wiped clear. The face should

*Joseph D. Bryant’s “Operative Surgery.”
be washed with cold water and be fanned rather actively. It is routine practice in the Jefferson Medical College Hospital to administer vinegar by inhalation during the reaction from an anesthetic. This proceeding often prevents vomiting. Some patients awake from anesthesia as from a quiet sleep; others are noisy, turbulent, and violent. The duration of the period of reaction varies with the anesthetic used, the amount given, and the personal tendencies of the patient. The patient must not be allowed to sit up for several hours at least. No food is to be allowed for at least four hours.

**After-effects of Anesthetics.** — **Vomiting.** — Vomiting may persist for hours, greatly exhausting the patient and doing infinite harm, it may be, if the operation were upon the brain or an intra-abdominal structure. If vomiting continues, forbid food. Very hot water in doses of a teaspoonful should be given at frequent intervals. A draught of hot water may relieve the condition by washing out the mucus from the stomach. Other remedies which may succeed are: hot black coffee, a mustard plaster over the stomach, fresh air in the room, small pieces of ice placed in the mouth and sucked, small doses of iced champagne, and drop doses of a 3 per cent. solution of cocain or 3-drop doses of a 5 per cent. solution of eucain. The best remedies for persistent vomiting are inhalation of vinegar and lavage of the stomach. Some persons, as Dudley W. Buxton points out, suffer greatly from nausea although there is little or no vomiting. In such cases Buxton uses ½ of tincture of nux vomica in a teaspoonful of hot water every ten minutes until six doses are taken. If this plan fails, he gives drop doses of wine of ipecac or minim doses of dilute hydrocyanic acid.*

Vomiting from chloroform is usually more difficult to check than vomiting from ether.

**Respiratory disorders** are more often noted after ether than after chloroform. Bronchitis may follow or bronchopneumonia (ether-pneumonia). Respiratory difficulties may be due to chilling the patient by bringing him from a warm operating-room through a cold hall and into a cool bedroom. Bronchopneumonia is especially common in septic patients, and may be due in some cases to aspiration of septic material into the bronchi (cases of cancer of tongue and pharynx, and cases with stercoraceous vomiting). Bronchitis and bronchopneumonia are much more common after ether than after chloroform. They are treated by ordinary methods. If chloroform is given when a gas-light is in the room, the vapor is decomposed and certain highly irritant products are inhaled, which produce laryngeal spasm and possibly bronchitis. The treatment is to freely admit fresh air into the room, and to have the patient inhale oxygen or vinegar. Ether-pneumonia must not be confounded with post-operative pneumonia, described by Wm. H. Bennett.† This latter condition may arise from seven to fourteen days after operation in robust, gouty people, and is usually unilateral.

**Renal Complications.** — After the administration of an anesthetic, blood, albumin, or sugar may appear in the urine, and the secretion may become scanty or even be suppressed. It is usually maintained that chloroform is less apt to irritate the kidneys than is ether, but there has been much dispute on this point. If albumin is present before anesthetization, the condition may be rendered worse when ether or chloroform is given. The

* *“Anesthetics,” by Dudley W. Buxton.
† Practitioner, Dec., 1896.
truth of the matter probably is that if the kidneys are healthy a small or moderate amount of either drug is not particularly irritant; but if the kidneys are diseased, a small amount, and even if they are healthy, a large amount, of either drug produces decided renal irritation. Chloroform is less irritant because less chloroform than ether is given to secure and maintain anesthesia. Scantiness or suppression of urine may be due to operative shock rather than to ether or chloroform. If the urine becomes somewhat scanty or if albumin appears in it, give non-irritant diuretics, diaphoretics, and cathartics, and employ enteroclysis. If the urine becomes very scanty, use hypodermoclysis. If post-operative suppression arises, give intravenous infusion of hot saline fluid.

**Post-anesthetic Paralysis.**—Paralysis may arise during anesthesia as a result of cerebral hemorrhage or embolism.

It sometimes happens that when a person has come out of anesthesia a palsy of some part is found to exist, the condition being peripheral and not central in origin. Such palsies may be due to pressure of an extremity upon a table-edge or to pressure upon nerves by placing the patient in certain positions.* Garrigues points out that when the arm is elevated to the side of the head or when it is drawn out strongly from the body the brachial plexus may be compressed by the head of the humerus (Braun). When the arm is in external rotation and is drawn backward and outward the median nerve is stretched, and when the forearm is flexed and supinated the ulnar nerve is stretched (Braun, quoted by Garrigues). Garrigues insists that in most cases the brachial plexus is squeezed between the collar-bone and the first rib, and it is particularly apt to be squeezed when it is stretched by the head being drawn to the opposite side or being allowed to fall back.†

Post-anesthetic paralysis is most common in the arm, but may occur in the leg or face. The prognosis is good as a rule. The treatment is that of any pressure-palsy.

**Primary Anesthesia.**—Instruct the patient to count aloud and hold one arm above his head. Give the ether rapidly. In a short time he becomes mixed in his count and his arm sways or drops to the side. There is now a period of insensibility to pain lasting only about half a minute, and during this period a minor operation can be performed. The patient quickly reacts from primary anesthesia without vomiting (Packard).

**Mixtures.**—**Mixture of Ether and Chloroform.**—This may be used in varying proportions. Hewitt employs 2 parts of chloroform to 3 parts of ether.

**Mixture of Alcohol and Chloroform.**—All the chloroform mixtures produce the effects of chloroform, but we are giving the drug in an unknown amount. It was believed by Sansom, who devised this mixture, that the alcohol prevents concentration of chloroform-vapor by retarding evaporation. When used, 1 part of alcohol is added to 4 parts of chloroform.

**Nitrous Oxid and Oxygen.**—(See page 883.)

**A. C. E. Mixture.**—This mixture is often valuable in cases in which ether cannot be given. It is composed of 1 part of alcohol, 2 parts of chloroform, and 3 parts of ether. Its action is supposed to be between that of

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chloroform and ether. The objection to the A. C. E. mixture, as to any mixture, is that the materials do not evaporate in the ratio in which they are mixed, hence an uncertain amount of chloroform-vapor is being inhaled (Buxton). This mixture can be given in a Junker or an open inhaler. Plenty of air must be given with it. The anesthetic acts similarly to chloroform.

**Schleich's Mixture for General Anesthesia.**—Schleich has recently introduced a new anesthetic agent which he claims is safer than chloroform. This surgeon maintains that a material is safe as an anesthetic only when almost all of the amount taken in at an inspiration is expelled on expiration. The anesthetic is unsafe in direct proportion to the amount absorbed; and the lower the boiling-point of an anesthetic, the less is absorbed; hence an anesthetic agent, to be safe, should have a low boiling-point. Schleich makes three solutions. The first contains (by volume) 1 1/2 oz. of chloroform, 3/4 oz. of petroleum ether, and 6 oz. of sulphuric ether. The second contains 1 1/3 oz. of chloroform, 3/4 oz. of petroleum ether, and 5 oz. of sulphuric ether. The third contains 1 oz. of chloroform, 3/4 oz. of petroleum ether, and 2 1/2 oz. of sulphuric ether. The anesthetic can be given on an open inhaler or a towel. The anesthetic state is quiet, reaction is rapid, and vomiting occurs in but half the cases. The superiority of this new anesthetic has not been proved. It sometimes causes dangerous symptoms, and has produced death. Garrigues, who formerly approved of it, has abandoned it. It will certainly not displace ether or chloroform.

**Ethyl bromid** is sometimes used for short operations. It is thought to be safer than ethyl chlorid. It is given while the patient is recumbent. The unconsciousness is obtained in from one to three minutes and is rapidly recovered from, and there is no after-sickness. The unconsciousness lasts about three minutes. Three drams are given to a child, and six drams to an adult. A towel is put over the face, and the entire amount to be given is poured on at once, and as soon as the patient is unconscious the towel is taken away and no more of the drug is given (Cumston). Cases have been reported in which sudden death has followed the administration of this drug, and it should not be given if there is disease of the heart, lungs, or kidneys.* If it kills, it acts like chloroform. It may be given before ether to prevent unpleasant effects, but it is usually not considered proper to give it before chloroform. Zematski, however, has used it before chloroform in 2000 cases ("Vratch," August 25, 1901).

**Chlorid of ethyl** is a rapid anesthetic and appears to be a safe one. It should be given upon a mask so that it does not evaporate into the air. The odor of the drug is agreeable. The anesthetic state is induced in from thirty seconds to three minutes, and the anesthetic condition lasts from one to three minutes, and it is recovered from rapidly, usually without vomiting or unpleasant after-effects. It is to be noted that complete muscular relaxation does not occur, in many cases the conjunctival reflex is not completely abolished, and often the pupils do not contract. Its superiority over nitrous oxid is doubtful, and sometimes it fails to produce complete unconsciousness. Lotheisser, in a study of 2500 cases of anesthesia by this agent, reports 1 death. Ware, as previously noted, collected 12,436 cases with

Nitrous Oxid Gas

r death. From 8 to 10 gm. of ethyl chlorid are given for a short operation. The patient must always be recumbent when taking it. The drug is only used for a brief operation or examination. When it kills, it acts in a similar manner to chloroform. It may be given before ether to prevent unpleasant symptoms, but not before chloroform.

Nitrous oxid gas may be used to obtain anesthesia for brief operations. It is contraindicated when vascular degeneration exists, because apoplexy may follow its administration. This gas is stored in steel cylinders, in which it is liquefied. The gas is passed into a rubber bag (Fig. 498), and is given to the patient by means of a tube and a mouth-mask, a wedge being placed between the patient's molar teeth, and the nostrils being closed by the anesthetist's fingers. The wedge must be held by a string, so that it cannot be swallowed. The patient becomes unconscious in about one minute, and we know the patient is anesthetized by the stertor and cyanosis and the insensitiveness of the conjunctivae. Watch the pulse, and if it flags at once suspend the administration. The phenomena are asphyxial, stertorous respiration, cyanosis, and even convulsions, dilatation of the pupils, rapidity of the heart, and swelling of the tongue.* It is sometimes useful to give nitrous oxid first and follow this with ether (page 885). By this method the patient is anesthetized rapidly and pleasantly with the nitrous oxid, and the anesthesia is maintained by the ether.

It used to be thought that nitrous oxid necessarily produces cyanosis, because the gas can only cause anesthesia by partially asphyxiating the patient. We know this is untrue, because if nitrous oxid is mixed with oxygen or atmospheric air anesthesia is obtained without cyanosis. Nitrous oxid is a genuine anesthetic agent. If a prolonged administration of nitrous oxid is desired, pure nitrous oxid can be given, a breath of fresh air being allowed from time to time. By this method Preston has anesthetized many patients, the duration of the anesthesia being from ten to fifty minutes. A better plan is to give nitrous oxid and oxygen. Hewitt formulates the following views as to the use of oxygen and nitrous oxid:*†

“In order to obtain the best form of anesthesia oxygen should be administered with nitrous oxid by means of a regulating apparatus (Fig. 499), the percentage of the former gas being progressively increased from 2 or 3 per cent. at the commencement of the administration to 7, 8, 9, or 10 per cent., according to the circumstances of the case. The longer the administration lasts, the greater may be the percentage of oxygen admitted.

“The next best results to those obtainable by means of a regulating apparatus for nitrous oxid and oxygen are to be secured by administering certain constant mixtures of these two gases. Mixtures containing 5, 6, or 7 per cent. of oxygen are best for adult males; and mixtures containing 7, 8, or 9 per cent. are best for females and children. The next best results to those last mentioned are to be obtained by means of mixtures of nitrous oxid and air, from 14 to 18 per cent. of the latter being advisable in anesthetizing men, and from 18 to 22 per cent. in anesthetizing women and children.”
Nitrous Oxid Gas Followed by Ether

Bichlorid of Methylene.—The composition of the so-called bichlorid of methylene is a matter of dispute. Some high authorities believe it to be a mixture of methyl alcohol and chloroform. It rapidly produces unconsciousness, and the patient returns quickly to consciousness when the administration is suspended. Some surgeons have thought highly of it, and claim that it is pleasant, safe, and is not followed by vomiting as often as is chloroform. The weight of opinion is that it is dangerous, death being similar to death from chloroform. It is given with a Junker apparatus.

Anesthetic Successions.—Bromid of Ethyl Followed by Chloroform or Ether.—(See page 882.)

Chlorid of Ethyl Followed by Chloroform or Ether.—(See page 882.)

Chloroform Followed by Ether.—Chloroform is sometimes given until the sensation becomes more or less obtunded, when ether is substituted. This is done to save the patient from the unpleasant sensations of etherization. It is a practice not to be commended, because it is precisely in the beginning that chloroformization is most dangerous.

Ether Followed by Chloroform.—When the patient cannot be relaxed or rendered unconscious by ether, or when some other complication develops, it is common practice to suspend ether and substitute chloroform. If the change is made, chloroform should be given cautiously. A large quantity should never be poured upon the inhaler at one time. The change should never be made when the patient is struggling, because the deep respirations which attend or follow struggling may lead to the rapid inhalation of a dangerous dose of chloroform-vapor. Further, as Hewitt points out, the change should not be made unless it is imperatively necessary, when the patient is deeply under the influence of ether.

Nitrous Oxid Gas Followed by Ether (Gas and Ether).—This very valuable method was suggested by Clover. The patient is made unconscious by nitrous oxid and is kept unconscious by ether. Thus are avoided excitement, struggling, and the very unpleasant sensations induced by ether. More important even than this, the method is safe. It is more satisfactory in women and children than in men. In very muscular men and in very stout elderly men it should not be used. Many operators first anesthetize with nitrous oxid, using an ordinary dental apparatus, and then give ether on an ordinary inhaler. The anesthetist must bear in mind that ether must be given gradually, not suddenly poured on in large amount. Others prefer to use a combined gas-and-ether inhaler. Hewitt thus describes the administration by means of Clover’s portable ether-inhaler fitted with a stop-cock and a detachable gas-bag (“Anesthetics and their Administration”):

“If the patient be lying upon his back, his head should be turned to one side. The face-piece with the charged ether chamber is then applied during an expiration. Air will be breathed backwards and forwards. When the respiration is seen to be proceeding freely, and the face-piece fits well, the charged gas-bag is attached to the ether chamber. Air will still be breathed, but not through the valves of the special stop-cock. When the valves are heard to be working properly, ‘gas’ is turned on, and is likewise breathed through the valves. Three or four respirations (or about one-half of the contents of the bag) are allowed to escape. The valve action is now stopped by turning the tap at the upper part of the stop-cock. At the same
moment at which the patient begins to breathe ‘gas’ backwards and forwards, the rotation of the ether chamber, for the addition of ether-vapor, should be commenced. The administrator will, in fact, find that he can, in a few seconds from the commencement of the administration, rotate the ether chamber as far as ‘1’ or ‘1 ½’. Should swallowing or coughing arise, he must rotate more slowly. Respiration soon becomes deep and regular, and more and more ether may be admitted. At about this juncture, if the apparatus has been fitting the face well, signs of nitrous oxid narcosis may appear, especially in those who are quickly affected by this gas. Should jerky breathing or ‘jactitation’ arise, one full inspiration of air may be admitted at the air-tap. It should be remembered, however, that in giving ‘gas and ether’ by this method, the object is to just steer clear of the clonus and ‘stertor’ of nitrous oxid narcosis, and to gradually but increasingly mix ether with the gas.

“In muscular and vigorous subjects, the quantity of gas above mentioned will be found to be, as a general rule, insufficient to lead to the usual signs of deep nitrous oxid anesthesia. The rotation of the ether chamber should be continued till the indicator points to ‘2’, ‘3’, or ‘F’.

“The mistake that is most commonly made is that of admitting air too soon. Should air be given during the first half or three-quarters of a minute, the patient will partially come round, hold his breath, set his teeth, and give a good deal of trouble. Duskeness of the features must be expected. Speaking generally, air should not be allowed until the patient is stertorous, when one breath may be given. In this manner the patient will continue breathing a mixture of nitrous oxid, ether, and air, till the usual signs of deep ether anesthesia appear, when the gas-bag may be detached, and the little bag ordinarily used with Clover’s inhaler substituted.”

Hewitt prefers to use a modified Clover’s inhaler, which permits of the introduction of ether after the inhalation of nitrous oxid has begun.

Local Anesthesia.—Freezing.—*Ice and salt* may be used. Take one-quarter of a pound of ice, wrap it in a towel, and break it into fine bits; add one-eighth of a pound of salt; then place the mixture in a gauze bag and lay it upon the part. The surface becomes pallid and numb, and in about fifteen minutes decidedly analgesic. A spray of rhigolene freezes a part in about ten seconds. It is highly inflammable. Ether-spray anesthesia was suggested by Benjamin Ward Richardson. Chlorid of ethyl comes in glass tubes (Fig. 500). Remove the cap from the tip of the tube and hold the bulb in the palm: the warmth of the hand causes the fluid to spray out. Hold the tube some little distance from the part and let the fine spray strike the surface. The skin blanches and whitens, and is ready for the operation in about thirty seconds.

Cocain Hydrochlorate.—Always bear in mind that cocaine is sometimes
Cocainization of a Nerve-trunk

a decidedly dangerous agent. There are on record fourteen deaths from cocaine (Reclus). The urethra is a particularly dangerous region, and so is the face. Never use over two-thirds of a grain upon a mucous surface, and never inject hypodermatically more than one-third of a grain, and be sure never to inject the drug into a vein. Mild cases of cocaine-poisoning are characterized by great tremor, restlessness, pallor, dry mouth, talkativeness, and weak pulse. In severe cases there is syncope or delirium. Death may arise from paralysis or from fixation of the respiratory muscles (Mosso). Cases with a tendency to respiratory failure require the hypodermatic injection of strychnine. In cases with tetanic rigidity of muscles give enemata of chloral, hypodermatic injections of nitroglycerin, or inhalations of the nitrite of amyl. In cases marked by delirium, if the circulation is good, give chloral or hyoscine. In any case give stimulants, employ a catheter, and favor diuresis. Cocaine-poisoning is always followed by a wakeful night. Cocain should not be used if the kidneys are inefficient. In using cocaine try to prevent poisoning. Because of the dangers inherent in cocaine, have the patient recumbent. One minute before giving the cocaine administer one drop of a 1 per cent. alcoholic solution of trinitrin, repeating the dose once or twice during the operation. In operating on a finger, after making the part anemic, tie a tube around the root of the digit before injecting cocaine, and after the operation gradually loosen the tube. A hot solution of cocaine is more efficient than a cold solution (T. Costa); hence hot solutions can be used in much less strength and are safer. The method of injection is as follows: A sharp needle is held at an angle of forty-five degrees to the surface, and is pushed into the Malpighian layer. One or two minims of a 2 per cent. solution are forced into the Malpighian layer, and a whitened elevation forms. The needle is withdrawn, at the margin of the wheal is reinset, and more fluid is introduced, and so on until the region to be operated upon has been injected. After waiting five minutes the operation is begun. If, after cutting the skin, it is necessary to cut the subcutaneous tissue, pour a few drops of a 1 per cent. solution into the wound from time to time. After the completion of the operation, if a rubber band were used, it is loosened for a few seconds, tightened for a few minutes, again loosened and readjusted, and so on several times (Wyeth). In this way only a small quantity of cocaine is admitted into the circulation at one time, and toxic symptoms are prevented. For operations upon the eye a 1 to 4 per cent. solution is employed; a drop of fluid is instilled every ten minutes until three drops have been given. Over two-thirds of a grain should not be painted upon a mucous membrane. Rarely use over a 10 per cent. solution on mucous membranes, although in laryngeal operations a 20 per cent. solution may be required. For the nasal mucous membrane a bit of wool soaked in a 5 per cent. solution is inserted or a spray of 4 per cent. solution is thrown from an atomizer into the nostrils. In the rectum, vulva, vagina, and uterus use a 5 per cent. solution; in the urethra a 4 per cent. solution, and in the bladder a 2 per cent. solution.

Cocainization of a Nerve-trunk.—Krogius has pointed out that if cocaine is injected into the tissue about a nerve-trunk anesthesia will follow in the area supplied by the nerve. The anesthesia will be produced in five minutes, and will last fifteen minutes. If cocaine is injected about the root
of the finger, all of the tissues of the digit will become insensitive. Injection over both supra-orbital notches renders the middle of the forehead insensitive. Injection over the ulnar nerve causes complete anesthesia of its trajectory. This plan is extensively used in Helsingfors.

It has been demonstrated by Crile ("Jour. Amer. Med. Assoc.," Feb. 22, 1902) that the injection of cocain into a nerve-trunk interposes an absolute block to the transmission of afferent and efferent impulses and greatly lessens operative shock. In 5 cases he employed this method to secure anesthesia for amputation of the leg, and 4 of the patients did not know that any operation was being performed.

**Eucain hydrochlorate** is far safer than cocain, and in most cases is to be preferred to it. It is injected in the strength of from 2 to 5 per cent. It can be boiled without destroying its properties, and hence can be readily rendered sterile. It occasionally, though rarely, happens that the injection of eucain causes sloughing, especially at the extremities, in fatty tissue, in tendon-sheaths, and in bursae. It can be used on mucous membranes.

**Infiltration-anesthesia** was devised by Schleich, of Leipsic, who was dissatisfied with cocain, because it is not safe and sometimes fails to produce complete local anesthesia, owing to want of thorough diffusion. He found that salt solution (0.2 per cent.), if injected into uninflamed parts, produced anesthesia. To obtain this anesthesia the part must be distended by wide infiltration. If minute quantities of cocain, morphin, and carbolic acid are added to the solution, the anesthesia becomes more thorough and more prolonged, and can be obtained even in inflamed areas.

Schleich uses three solutions:

No. 1, a strong solution, which is used in inflamed areas: cocain hydrochlorate, gr. iij; morphin hydrochlorate, gr. $\frac{2}{3}$; sodium chlorid, gr. iiij; distilled sterile water, $\frac{5}{3}$iiij; phenol (5 per cent.), 2 drops.

No. 2, a medium solution, which is employed in most cases: cocain hydrochlorate, gr. iss; morphin hydrochlorate, gr. $\frac{2}{3}$; sodium chlorid, gr. iiij; distilled sterile water, $\frac{5}{3}$iiij; phenol (5 per cent.), 2 drops.

No. 3 is the weak solution used to infiltrate extensive areas: cocain hydrochlorate, gr. $\frac{1}{3}$; morphin hydrochlorate, gr. $\frac{2}{3}$; sodium chlorid, gr. iiij; distilled sterile water, $\frac{5}{3}$iiij; phenol (5 per cent.), 2 drops.

The injections are begun in the skin, not under it (Fig. 501), and are made one after another until the area to be operated upon is surrounded above, below, and on all sides with Schleich's solution. At each infiltrated area a wheal forms in the skin. This infiltration can be made painlessly by touching with pure carbolic acid the point where the needle is to be inserted, or by freezing this spot with ethyl chlorid. After infiltration of the skin an incision is made, and when deeper tissues are reached they are infiltrated before incising them. If a nerve comes in sight, touch it with a drop of pure carbolic acid. Van Hook says that the anesthesia obtained by this method is due to artificial ischemia, pressure upon the tissues, the direct action of the drugs, and the lowered temperature.* The method is very efficient, and can be used for operations of considerable magnitude. Matas uses a special apparatus to infiltrate the tissues. The fluid is driven by compressed air, and widespread or "massive" infiltration is produced.

Cocainization of the Spinal Cord.—Bier has produced complete anesthesia of the entire body except the head by the injection of a small amount of cocain into the subarachnoid space of the spinal cord. A solution of cocain of a strength of from 0.5 per cent. to 1 per cent. is used by some, but cocain cannot be boiled without impairment of its anesthetic power, and carabolic acid must be added to it in small amount. Hence cocain so prepared is not certainly sterile, and the carabolic acid added may induce harmful symptoms. (See Neugebauer, in "Wien. klin. Woch.," 1901, Nos. 50, 51, 52.) Some surgeons use a solution of eucain, which can be boiled, but it is not so rapid and certain as cocain. Some use tropacocain (Illwicz). A solution of this drug can be boiled, is less poisonous than cocain, and somewhat slower in action. Experimenters tell us that gr. ss to gr. iss may be given, but it is not wise to give over 0.5 of a grain.

The best plan is that of A. W. Morton. He takes chemically pure crystalline hydrochlorate of cocain, places it for fifteen minutes in a dry temperature of 300° F., and puts it in sterile tubes until wanted. The dose depends upon the locality in which we wish to induce analgesia and varies between 0.3 gr. and 0.5 gr. The required dose is placed in the barrel of the sterile syringe and is dissolved in cerebrospinal fluid drawn into the syringe for that purpose. The syringe should be of glass, so that it can be boiled. The concave portion of the needle should be dull, so that a plug of skin will not be cut out and obstruct the needle (A. W. Morton, in "Jour. Amer. Med. Assoc.," Nov. 8, 1902). The patient lies upon his side with the back curved. The back has been previously sterilized. The dressings are removed and the region to be punctured is resterilized. The spines of the third and fourth lumbar vertebrae are located and the needle is entered in the mid-line beneath the spine of the third or fourth lumbar vertebra and is pointed upward and forward. The surgeon determines that he has punctured the subarachnoid space by lessened resistance and the appearance of fluid at the needle-opening. The syringe, with a closed piston, contains 0.3 gr. of sterile cocain. It is attached to the needle; the piston is withdrawn until the syringe is half full of cerebrospinal fluid. When the cocain is dissolved, the solution is slowly injected, the needle is withdrawn, and the puncture is sealed with collodion.

The anal region becomes anesthetic in from one to two minutes; the lower extremities in from three to six minutes, and the upper extremities in from fifteen to thirty minutes. The anesthetic condition lasts from one
to three hours, or even longer, and is due to the contact of cocain with the nerve-roots (A. W. Morton, "Jour. Amer. Med. Assoc.," Nov. 8, 1902).

In performing the operation care must be taken to prevent the escape of cerebrospinal fluid.

After cocainization of the spinal cord surgical operations can be performed on many regions, without causing pain. Among the operations which have been performed are resection of the knee, resection of the ankle, osteotomy (Bier), amputation of the leg (Lower), and hysterectomy (Tuffier).

Cocainization of the spinal cord is not growing in popularity. It is regarded by most surgeons as rather a surgical curiosity. It should never be used as a routine procedure, and it will not displace ether or chloroform. By it analgesia can usually be secured. A. W. Morton ("Jour. Amer. Med. Assoc.," Nov. 8, 1902) has used it 673 times without a failure, and 60 of these operations were above the diaphragm. Most operators have had failures above the diaphragm. No one should attempt it who is not well trained in aseptic methods, because infection of the cord or its membranes will prove fatal. Whether or not ultimate harm ever comes to the cord is not certain. Bristow ("Brooklyn Med. Jour.," 1902, xvi, page 410) reports the case of a man, fifty-five years of age, on whom he operated for hemorrhoids after spinal cocainization. An examination one month later indicated degeneration of the posterior and lateral columns of the cord (spastic lower extremities, ataxic gait, increased knee-jerks, ankle clonus, and inability to retain urine). Marx ("New York Med. Record," Dec. 22, 1900) states that one case in his experience, after cocainization of the spinal cord, developed a typical locomotor ataxia. Dandois ("Jour. de Chir. Brux.," April-May, 1901) reports a case upon which he had operated for traumatic rupture of the urethra. Spinal cocainization was employed. Paraplegia developed and lasted two months. Dr. Francis D. Patterson, who furnished me with the above references, writes me that there are several cases of hemorrhage into the sub-arachnoid space on record.

Is there any danger of death from cocainization of the cord? If the operation is not performed with scrupulous aseptic care, it is very dangerous. Even when performed by the best surgeons death may occur. Dr. Francis D. Patterson, who has investigated this subject, writes me that Tuffier places the mortality at 3 in 2000, but excludes from consideration 3 deaths ("La Presse Médicale," vol. lv, 1901, page 190). Reclus finds 6 deaths in less than 2000 cases (Address before the Paris Academie de Médecine, March 19, 1901). Hahn, in 1708 cases collected from literature, found 8 deaths ("Mitt. f. d. Grenzgeb. d. Med. u. Chir.," 1900, iii, 337). Patterson's investigations persuade him that the mortality is about 3 in every 1000 cases.

Cocain seems to act like a toxin on the pia and arachnoid. Examination of fluid withdrawn after the performance of cocainization shows that it contains polymorphic leukocytes (Ravant and Aubourg, in "Gaz. Hebd. de Méd. et de Chir.," June 27, 1901).

Unpleasant after-effects are common. Among these are nausea, vomiting, sweating, overaction of the heart, involuntary evacuation of feces, cramps in the limbs, headache, chills, and shock. Many of these symptoms are probably due to absorption of cocain, but the headache must be due to tension, because it is relieved by the withdrawal of some cerebrospinal fluid by lumbar
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puncture (Ravant and Aubourg, in "Gaz. Hebd. de Méd. et de Chir.," June 27, 1901).

In a case in which, because of heart disease, pulmonary disease, kidney disease, or some other condition in which a general anesthetic is inadmissible, spinal cocainization is justifiable. I agree with Francis D. Patterson that spinal cocainization should be reserved for cases in which other forms of anesthesia are positively contraindicated.