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GENERAL AND LOCAL ANESTHESIA
IN
OBSTETRICS

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HISTORICAL CONSIDERATION

The use of some means of anesthetic to give relief from the pain of childbirth was comparatively unknown before the middle of the nineteenth century. Although literature indicates that man has long sought to assuage grief and pain by some means of dulling consciousness, there are few incidents relating to attempts to relieve the pain of childbirth. Simpson (1) quotes Plautus in his Ophelion in which a woman in childbirth received narcotic draughts and was rendered insensible to pain, at which time a lively boy was born. In the sixteenth century there are many cases in which witches were persecuted for attempting to abolish the pains of labor by charms or other means. One method practiced was to hold a sword before the patient, who was directed to look at it steadily in the same way that Latina is said to have held a palm branch and brought forth Apollo without suffering; an attempt at mesmerism in reality. Another way employed was to hang the husband up by his feet in the next room until the labor was accomplished. Such a plan would not meet with much approbation and encouragement now. The celebrated case of the Countess de St. Geran is another instance of narcotic draughts being administered to alleviate the pains of labor. After she had been nine hours in
labor, the midwife gave her a mixture which kept her in an anesthetic state until the following morning, at which time she was safely delivered of a son.

Perhaps one of the reasons that soporifications were not used to relieve the pain of childbirth was due to the fact that the nature of the substances available—opium, for instance—precluded their employment in effective doses. They arrest the progress of the birth and likewise are injurious to the child. Moreover, religious doctrines were opposed to the use of any means to alleviate pain of childbirth. This was the formidable barrier that faced the pioneers of modern anesthetics in the field of obstetrics.

Meanwhile, narcotic drugs had long been used, not producing true anesthesia, but to give relief in part from wounds or painful diseases and thus to allow the sufferer to rest. During the era of Grecian literature (2), Homer in his Odyssey caused Helen of Troy to put some drug in his wine to lull all pain and anger, and bring forgetfulness of every sorrow. Helen's "nepenthe" was believed to have been mandragora, while others maintain that it was opium.

Five hundred years later Herodotes inhaled the fumes from a variety of hemp which produced an exalted mental state, followed by sleep.
By the beginning of the Christian Era mandragora was well known to the writers of that period, among them Dioscorides and Galen. At the same time the Jews and Chinese were using Indian hemp (hashish) as a means of producing intoxication, mental exaltation, and sleep. A Chinese practitioner of the third century, Hoa-tho, gave a patient a preparation of hemp rendering him insensible as if he had been deprived of life. After a certain number of days, the patient found himself reestablished without having experienced the slightest pain during the operation. Later in the middle ages, an oil was used on occasion of painful operations. Consisting of opium, the juice of the unripe mulberry, hyoscyamus, the juice of hemlock, the juice of the leaves of mandragora, the juice of the leaves of wood ivy, of lettuce seeds, of dock seeds and water hemlock; the oil was boiled with a sponge. The solution was then applied to the nostrils. To awaken the patient, another sponge, soaked in vinegar, was applied to the nose.

The events leading up to the discovery and use of modern inhalation anesthesia were the discovery of hydrogen in 1766, nitrogen in 1772, and oxygen and nitrous oxide in 1774. Thus was opened the field of pneumatic chemistry. By 1800, Sir Humphry Davy (3)
in England had used nitrous oxide for the alleviation of headache and also for the extraction of one of his own wisdom teeth. This latter event led him to make the historic prediction, "Since nitrous oxide seems capable of destroying pain, it may be used in surgical operations." The value of this suggestion was not recognized for nearly a half a century. The first experiments on lower animals were made by Henry Hill Hickman between the years of 1820 and 1828. Having successfully operated upon anesthetized dogs, Hickman tried in vain to interest his colleagues in England and France, but was ridiculed and rebuffed at every turn. Disappointed and hopeless, Hickman died at the age of twenty-nine.

In 1844, Horace Wells of Hartford, Connecticut, began to use nitrous oxide in dentistry and thus was the first man to make a practical application of anesthesia. Wells was led to use the gas as the result of an observation made while attending a lecture given on nitrous oxide in New Haven, Connecticut. The lecturer allowed members of his audience to inhale the gas, and Wells noticed that those under the influence of the gas did not appear to be sensible to slight injuries caused by falling or by staggering against the furniture of the stage. Some years later
a death resulted from an anesthesia which he gave, and this caused Wells to withdraw from practice. He eventually became depressed over what he regarded as his failure and put an end to his life.

Wells reported the progress of his work to William Morton of Charlton, Massachusetts, a friend and former partner. After the failure of nitrous oxide, Morton was on the lookout for some substance which would be safe and reliable. Morton practiced dentistry in Boston and undertook at the same time the study of medicine at the Harvard Medical School. His work there brought him into contact with Dr. Charles Jackson and from him Morton learned of the anesthetic properties of ether. Jackson had obtained this knowledge through an observation similar to that made by Wells at the lecture on nitrous oxide. Ether was sometimes inhaled by medical students at so-called "ether frolics", indulged in for amusement and for the mild intoxication or "ether jag" which the vapor produced. Jackson had noticed that when the students were thus under the influence of ether they appeared to be insensible to pain caused by falling over furniture. Jackson had never taken advantage of his knowledge to use ether for the purpose of obtaining relief from pain; but Morton, searching for an anesthetic to be used in his
dental practice, at once saw the possibilities presented by ether. He accordingly experimented with the ether at his home, first using the family dog as a subject, and finally anesthetizing himself. His next step was to use it in his dental practice and an opportunity to do so was soon presented in the person of one Eben Frost. To the joy of the operator and the astonishment of the patient the attempt was perfectly successful.

This event occurred in the last part of September, 1846.

Morton, as stated above, was a medical student as well as a dentist, and, after his success with his patient, Eben Frost, his mind quite naturally turned to the possibility of using ether to lessen the frightful suffering from surgical operations which were then performed with nothing to relieve the pain. After two weeks of preparation he called on Dr. Warren, who was senior surgeon of the Massachusetts General Hospital at Boston. Morton told him of his use of ether and of his success in relieving pain, and asked for an opportunity to give a demonstration of his method on a patient undergoing a surgical operation. Dr. Warren consented and the date of the demonstration was set for October 16, 1846. The operation was highly satisfactory and thus ether was introduced to Surgery. However, four years prior to Morton's demonstration at
the Massachusetts General Hospital, ether was used for an operation in a small town in Georgia by a Dr. Long who did not, however, make public its use until after Morton's declaration.

To Dr. James Y. Simpson of Edinburgh, professor of obstetrics at the University of Glasgow, belongs the honor of having first induced unconsciousness by ether for the purpose of facilitating delivery.

On the tenth of February, 1847, Professor Simpson laid the subject before the Obstetrical Society of Edinburgh at some length, and presented the lessons derived from his experience in the following terms.

1. That the inhalation of ether procured for the patient a more or less perfect immunity from the conscious pain and suffering attendant upon labor.

2. That it did not, however, diminish the strength or regularity of the contraction of the uterus.

3. That, on the other hand, it apparently (more especially when combined with ergot), sometimes increased them in severity and number.

4. That the contraction of the uterus after delivery seemed perfect and healthy when the fetus had been delivered.

5. That the reflex assistant contractions of the
abdominal muscles, etc., were apparently more easily called into action by artificial irritation and pressure on the vagina etc., when the patient was in an etherized state.

6. That its employment might not only save the mother more pain in the last stage of labor, but might probably save her also, in some degree, from the occurrence and consequences of the nervous shock attendant upon delivery and thereby reduce the danger and fatality of childbed; and

7. Its use did not seem to be injurious to the child.

In a short time Dr. Murphy of London, Dr. Lloyd, Dr. Frotheroe Smith, and Mr. Landsowne of Bristol had used it successfully. Also it was very early tried in France. Fourrier Dechamps and Paul Dubois being of the first to introduce it in that country, closely followed by Villeneuve of Marseilles and Staltg of Strasburg. In Germany, Martin of Jena and later Siebold published papers on the subject.

In our country ether was not resorted to as early as might have been expected considering that it was the birthplace of artificial anesthesia. The first administration took place April 7, 1847, by Dr. N. C. Keep
of Boston, and a little later ether was used by Dr. Walter Channing, who wrote a book on the subject, "A Treatise on Etherization in Childbirth", 1848.

Soon came the introduction of a new anesthesia, with Simpson again the pathmaker, as chloroform was tried in November, 1847, and a few months later, following the reports of Simpson, it was tried in this country by Dr. A. K. Gardner of New York.

However, in spite of the almost miraculous properties of anesthesia to alleviate pain, its use in childbirth was very strongly antagonized by not only the clergy of that period, but also by the members of the medical profession. "In sorrow thou shalt bring forth thy children" was quoted from the Bible and interpreted to mean that the woman was to suffer thus for her sins.

In no better person than Simpson could obstetrical anesthesia have found a champion. He alone was more than equal to the forces of opposition. Scotland has a legend regarding anesthesia: Thenu, the mother of St. Kentigern, or St. Mungo, of Glasgow was impregnated without her knowledge under the influence of some soporific potion. In consequence, as a punishment, she was cast down from the top of a high hill, but, wonderful to say, she was unhurt. Not satisfied with
this evidence of divine intervention, her judges then sentenced her to be set adrift in a small boat on the Firth of Forth, whereupon she floated across to Fife, and was received by St. Servanus. In due time, she was safely delivered of a son, who became afterward the famous St. Kentigern. Having a saint whose history recorded an anesthesia so closely connected with childbirth may have given the clergy some sensitiveness on the subject. At any rate, it is a historical fact that in 1591 a lady of rank, Eufane Macalyane, sought the assistance of Agnes Sampson for the relief of pain at the time of the birth of her two sons. Agnes Sampson was tried before King James, for her heresy, was condemned as a witch, and was burned alive on the Castle Hill of Edinburgh. Again in the nineteenth century the Scottish clergy rose, if not to burn Simpson with fire, at least to consume his practices with their fiery condemnations. Simpson, less submissive than the lady of the sixteenth century, turned, and with their own weapon of religious interpretations silenced the clergy and cleared the way for the more serious controversy with the men of his own profession with the following biblical quotation: "And the Lord God caused a deep sleep to fall upon Adam, and he slept; and he took one of his ribs, and closed up the
flesh instead thereof." (Gen. II-21).

At the same time that Simpson was fighting for the use of chloroform to alleviate pains of childbirth, Dr. Channing of Boston was waging a less picturesque but none the less effective struggle to introduce ether for a similar purpose. An objection brought in America against Dr. Channing's work was one that would seem ridiculous today if it were not for the fact that as late as 1921, in the revival of "twilight sleep", the same objection was raised. It can be phrased best in the words of one of Channing's correspondents, who claimed that "the very suffering which a woman undergoes in labor is one of the strongest elements in the love she bears for her offspring."

In the middle of April, 1853, an event occurred which exerted a greater influence on popular acceptance of anesthesia at childbirth, not only in Great Britain, but in America as well, than all the efforts of Simpson. Queen Victoria accepted chloroform for the delivery of her seventh child, Prince Leopold. Nothing could exceed the astonishment with which the announcement was received. The tone of the leading medical journals showed only too plainly what would have been the sentence passed on Her Majesty's medical attendants had anything untoward occurred. There was
not one word of approval for the medical men, for
the royal patient, or for humanity. The Lancet, May,
1853, said: "In no case could it be justifiable to
administer chloroform in a perfectly ordinary labor."

Again in 1857, the Queen accepted chloroform for
her confinement. Formal opposition ceased in Great
Britain thereafter, and chloroform was after referred
to as 'anesthesia a la reine.'

Although ether and chloroform are still the
anesthetics most extensively used in childbearing,
nitrous oxide and the other gaseous anesthetics have
replaced them to some extent. Nitrous oxide in
particular has the advantage that it can be given for
a long time with less danger to the mother and the
child than is the case of chloroform or even ether.
Nitrous oxide, which was suggested as an anesthetic
by Sir Humphry Davy in 1800, and used in dentistry
by Wells in 1844, was recommended for childbirth by
Klikowitch of St. Petersburgh in 1880. The increasing
use of nitrous oxide, either alone or combined
with ether, for surgical purposes has led to the more
general use of this anesthetic in childbirth. (5)
While it is unquestionably safer than chloroform and
much more rapid in action and less irritating than
ether, it has the practical disadvantage of requiring
special and cumbersome apparatus for its administration. It is used to some extent in lying-in hospitals and to a much less extent for deliveries at homes, and there only among the comparatively few patients who can afford such service.

The anesthetics which are inhaled have been an inestimable boon to the child-bearing woman; they have been also a step in the search for the means to make childbirth painless.

In 1899 the use of morphine combined with scopolamine, a drug closely related to belladonna, was advocated to relieve the pain of surgical operations. The patient was drugged into a semiconscious dreamy state called "twilight sleep," in which pain was felt but not appreciated, and was soon forgotten. In 1902, the method was used in childbirth, and from the first reports it seemed, indeed, as if the painless childbirth so eagerly sought for had at last been attained. The medical profession naturally grasped this opportunity to relieve the pain of the child-bearing woman, and the drugs were soon extensively employed, and soon abandoned in most places. Labor was in many instances prolonged and it was necessary to use forceps in a greater number of cases. The method was not adapted for home use, but only in such hospitals as had an
unusually large staff, for it was necessary to guard against danger to the child, since the drugs used were harmful to the child. The woman accepting "twilight sleep" as a relief from some of her suffering, did so at the risk of possible injury or even, occasionally, the loss of the child. In 1921 there was a revival of interest in "twilight sleep", but at that time it was shown that the increased mortality for the child from drugs used had not been eliminated.

A mixture of chloroform and ether or a combination of the two with alcohol was tried by Drs. Ellis, Serson, Edis, Isaac Brown, Playfair, and others with presumably great success. An article of this nature appeared in the American Journal of Obstetrics in April, 1885.

Chloral was introduced to therapeutics in 1869. In the same year it was first used in obstetrics by Simpson, who found that while the patient was so deeply hypnotized by it as to be only partially aware that labor was going on, the uterus still continued to contract strongly and regularly. In 1874, Dr. Playfair urged its especial use in women of a "highly organized nervous type, primipares, and in those whom dilatation of the os took place slowly and painfully."

Bromide of ethyl was first used in obstetrics by Dr. Turnbull and Dr. H. Augustus Wilson in
Philadelphia in 1880.

Local anesthesia, meanwhile, had its historic beginning in the use of "ligatura fortis" by the Arabian physicians, which served to prevent loss of blood and at the same time reduced pain by compression of the nerve trunks. In 1676, Schnurer described the use of such methods in which the surgeon had removed a woman's foot before she realized the operation was completed.

There followed methods of local anesthesia by freezing tissue before surgery. This was first noticed on the battlefields in 1807 and was first described in literature by Annott in 1848. Then in 1853, Wood, of Edinburgh, discovered hypodermic injections by means of a hollow needle, which coupled with the advent of cocaine in 1855, gave local anesthesia a new impetus. However, it was thirty years later, in 1885, that Daleris, of Paris, first used cocaine in obstetrics. This was a solution of ointment applied to the cervix and vulva. From this time to the present, local anesthesia has enjoyed a very slow rise in use and popularity in obstetrics, the present status of which will be discussed later.
OBSTETRICAL ANESTHESIA

General anesthesia is administered in labor in two distinct classes of cases: (8)

1. In operative obstetrics and painful maneuvers.
2. In normal labor to relieve pain.

In the first class of cases the use of anesthesia is similar to that in surgery. Deep anesthesia is the same in one as in the other and usually calls for considerable muscular relaxation. More important is the fact that two lives are at stake.

The second class calls for a special type of anesthesia, however, which for lack of a better term is called obstetrical anesthesia. The immediate goal of obstetrical anesthesia is to alleviate or annul suffering in labor without complete loss of consciousness, permitting the physician to remain in command of the patient's will, while the relations with the external world remain but little disturbed.

The urgency for relief of pain is in direct proportion to the severity of pain in the average individual. From the standpoint of the anesthetist, the duration of the period of labor, as well as the severity of the pain is an important factor in the choice of anesthetic agent or methods to be employed.
The physical condition of the patient is a most important factor in determining how the pain should be relieved, as certain conditions or diseases may contraindicate the use of the agent or method that might otherwise be used; for example, in operative obstetrics the problem is easier than in normal labor because there is a wider choice of agents and methods, mainly for the reason that the duration of pain is shortened in the operative case whereas in normal labor the period of duration is uncertain.

The physiological basis of obstetrical anesthesia is the fact that the action of anesthetics is regularly progressive, affecting first the lower portions of the nervous system and ascending gradually to the high. Experimental proof of this was furnished by Flourens and Longet as early as 1847 and repeated in 1875 by Bernard. First, the lower part of the spinal cord is affected, then the dorsal and cervical portions, finally the medulla oblongata. The intellectual processes are early disturbed, then comes loss of perception of external impressions, as of touch and the special senses, then entire loss of consciousness, while sensibility to internal impressions remains, and reflex actions arising from them are only abolished later. In labor the contractions of the uterus continue
after consciousness is lost; they will be excited to increased energy upon passing the hand into the organ even in a condition of deep narcosis. At a more advanced period this internal or unconscious sensibility, if the term may be used, is also abolished, the reflex actions dependent upon the medulla oblongata (respiration and circulation) cease and life is extinguished.

The pharmacological properties of the several available anesthetics agents determine to a large extent their usefulness in obstetrical procedures, during which analgesia as well as anesthesia must be accomplished in controlling a variety of pains. The character of respiration during anesthesia or analgesia in obstetrical procedure does not interfere with the progress of labor, as it may with operative procedures in the upper part of the abdomen, so that the characteristic quiet breathing, associated with the administration of the agent, does not have the same significance in the former as it does in the latter procedure. On the other hand, relaxation comes in for considerable consideration. In the first part of the labor, steady relaxation, except of the cervix, produced by any agent or method, is undesirable. Relaxation of the uterus and patient between pains is desirable. However, when the head is being delivered, it may be very
desirable to produce muscular relaxation and to inhibit labor for a few minutes to permit control of the presenting part on the perineum. The question of producing immediate or remote untoward results is twice as important as in general surgical practice because there are two types of patients to be considered. Each of them is quite different from the other in many respects as to ability to withstand the respiratory depression caused by anesthetic agents.

The obstetrician has divided labor into three main stages and the anesthetist can divide the pain of labor into three main phases. \(^{(9)}\) However, just as the first stage of labor involves two mechanisms; namely, dilatation of the cervix and descent of the head, so is the first phase of pain of two distinct types, one of which is associated with dilatation of the cervix and the other with the descent of the head. The second stage of labor, consisting of the passage of the head through the perineum, is accompanied by the second phase of pain, and the third stage of labor, consisting of birth of the placenta, by the third phase of pain.

The peoples of the world today, more than at any time, are concerned over their birth rate and maternal mortality, and it is our duty, in so far as lies in our
power, to contribute to the safety of mother and child.(10)

It is probable that every known type of anesthesia, analgesic, and amnesic has been used to mitigate or eliminate the pain of natural and operative childbirth. Opinion is by no means unanimous regarding the use of various anesthesia and analgesia, so much so that, not only are new kinds appearing almost daily in the literature, but combinations of old types and also of new and old methods are being constantly tried.

From the foregoing it can be seen that the perfect obstetrical anesthesia and analgesia have as yet not (and probably never will) been found. However, the requirements of obstetrical anesthesia and analgesia have recently been more fully recognized and there is a great increase in scientific interest in the subject of obstetrical analgesia on the part of the profession.(11) Numerous drugs in various combinations are being used in an attempt to meet requirements under various conditions. No routine method can be used in all cases and no method is without danger to mother and child unless they are handled with great care and intelligence. The best results are obtained by being familiar with more than one method and individualizing the patient, using the best method applicable to the particular case. Only large experience with various drugs will
prepare the obstetrician to administer them skillfully.

The ideal obstetrical anesthesia should meet the following demands:(12)

1. It must induce surgical anesthesia swiftly and without excitement.
2. It must permit the birth of an unaffected infant.
3. It must not relax uterine musculature to the point of causing hemorrhage.
4. It must not induce vomiting.
5. It must permit of rapid clear awakening.
6. It must not depress circulatory or respiratory function.

It must be remembered that the cardinal aim of an anesthetist is first, the preservation of life of his charges, and secondly, the relief of pain.
GENERAL ANESTHESIA

ETHER

Ether remains today the most commonly used anesthetic in both obstetrics and general surgery. The open drop method of administration is still used in hospitals for brief intervals of light anesthesia and is most popular out of the hospital in the hands of the general practitioner. In hospitals when surgical depth anesthesia is required, we find that the technique of administering ether is changing, the modern tendency being to avoid using ether alone. Rather, ether is used as an adjunct to nitrous oxide-oxygen, or ethylene-oxygen administered by means of rather complicated anesthesia machines.

Ether has considerable support because of its comparative safety in the average case and because ether can be administered in normal obstetrics by either trained or untrained assistants. Moreover, ether produces a considerable degree of muscular relaxation which is a great aid in passage of the fetus through the birth canals, minimizing lacerations of the mother.

There are numerous factors which weigh against the use of ether, however, that should be carefully considered in each case, namely:

1. Ether has an unpleasant odor and taste and is
thus disagreeable to the patient.

2. Ether irritates the mother's respiratory passages, as well as her kidneys, and may lead to later complications. Two per cent of all patients (14) have some form of pulmonary complication after ether anesthesia, as infections of the upper respiratory passages find easy access to the lung in etherization. 

3. Ether produces little analgesia, as the dose to control pain produces an unconscious patient. At the same time ether produces anesthesia slowly as compared with gas anesthesia. 

4. Ether is second in toxicity only to chloroform. This anesthesia depresses the child's respiratory apparatus for one to two hours after administration to the mother, leading to difficult resuscitation. (15) 

5. If used in any quantity, as in a long labor, ether tends to produce nausea and vomiting. (16) This in turn leads to dehydration and intoxication of the patient. Thus it can be readily seen that ether is not a desirable anesthesia when used at length in obstetric procedures. 

6. Ether is contraindicated in diabetes, renal disorders, respiratory disorders, and pulmonary
conditions. (17) Here the anesthesia causes cumulative effects on the already pathological conditions.

Ether then, has its its disadvantages, but still may be widely used in obstetrics in the normal case which requires short anesthesia. Rayston (13) advocates the use of ether only in the second and third stages of labor. The anesthesia should be given only after the cervix is fully dilated, with the period of anesthesia falling in the last forty-five minutes of the delivery of the fetus and placenta. Here it seems the disadvantages of ether are minimized and a safe usage of this anesthetic is probable.

CHLOROFORM

Chloroform is still used throughout the world and entirely so in the tropics (18) in spite of the fact that it is our most toxic anesthetic. (19) America has slowly but surely condemned the use of chloroform in obstetrics, but this feeling is not universal. Danforth and Davis (20) came forth with the sincere statement that chloroform today has no place in obstetrical practice. Yet chloroform has its good points, in that the anesthetic produces swift anesthesia. That would be a boon to the obstetrician who is working alone and must himself administer the
anesthetic. Chloroform does not produce pharyngeal or bronchial irritation (19), thus affording safety to the patients with upper respiratory infections. Again, chloroform has no unpleasant odor and is agreeable to the patient. Usually, chloroform produces no nausea and vomiting unless used over a long period of anesthesia. Finally, chloroform produces a degree of muscular relaxation that is favorable to all obstetrical procedures and is certainly of some protection to the mother in reducing the difficulties of delivery, as well as possible lacerations. The use of chloroform has been continued only due to the fact that the actively practicing medical men have been content to enjoy the advantages of chloroform and have evaded a consideration of the points which stand against the use of chloroform. Hewer (19), in a resume of critical observations on chloroform, finds that the anesthetic is six to eight times more potent than ether. Chloroform depresses the brain three times as much as ether and likewise depresses the respiration three times as much as ether. Furthermore, it acts as a depressant twenty-five to thirty times as much as does ether. Certainly these important factors indicate that chloroform is by far too dangerous an anesthetic to be used in obstetrics where a trained anesthetist cannot always
be present. Even the accoucheur is, for the most part, too busy to give more than fleeting attention to his anesthetist, often leaving this duty to untrained hands. Parsons (21) feels that even the modern preparation of chloroform in capsules is not safe in the hands of an untrained anesthetist.

Chloroform is contraindicated (22) in diabetic patients, patients with liver or kidney damage, and patients suffering from toremias of pregnancy. Autopsy has shown post-operative necrosis of the central portion of the liver lobule, plus parenchymatous changes in other organs. Such findings follow cases of chloroform poisoning (13), with symptoms of persistent vomiting, profound jaundice, and marked urinary findings. Death comes two or three days following the chloroform anesthesia. Striving first for the preservation of life, the physician should always remember the above paragraph and hesitate to use chloroform. There are other anesthetic agents to fill every demand for chloroform, and with two lives at stake no obstetrician should be willing to gamble these lives against a shorter, more pleasant, more relaxing anesthesia.
NITROUS OXIDE

Nitrous oxide anesthesia was introduced to obstetrical usage in 1915 (23) and as used in combination with oxygen has long ranked as the anesthetic of choice in obstetrics. Webster, Lynch, and Davis, who first used nitrous oxide-oxygen anesthesia felt that there were no contraindications to the use of this anesthetic as concerns toxemias, diabetes, or nephritis in the mother. In addition, these men found that the lowest fatal concentration of nitrous oxide was three times the concentration required for anesthesia, which was, to them, a greater margin of safety than any other anesthetic.

Certainly nitrous oxide-oxygen anesthesia has only slightly suffered through the findings of Brown, Lucas, and Henderson (24) that the anesthetic effect of nitrous oxide depends upon a depressing effect on medullary centers and thus the necessary presence of a certain degree of anoxemia in the patient. Macklin feels that this anoxemia is detrimental only in such conditions as toxic goitre, uncompensated heart lesions, pulmonary tuberculosis and pneumonia.(25)

Although nitrous oxide probably has some retarding effect on the pains of the first stage,(16) still this anesthesia can be used throughout the second stage
without causing any cessation of uterine contractions. In fact, nitrous oxide has an oxytoxic action in the second stage. (26) Keeping in mind the tendency to produce anoximia in the patient which in turn would by reflected in the child, nitrous oxide is usually given first in the concentration of 90% nitrous oxide and 10% oxygen. Given at the very beginning of the pains, and then only for two or three breaths, the concentration is rapidly cut down to a mixture of 50% nitrous oxide and 50% oxygen, and then to pure oxygen for three breaths, after which the inhaler is removed. This provides analgesia and at the same time provides for sufficient oxygen for mother and baby. Such anesthesia may be used over periods as long as four to six hours at a time, without danger to the mother or the fetus, danger signals being cyanosis, loss of consciousness, and headache in the patient. Naturally, as the second stage nears an end, the anesthesia must be deepened for a few minutes.

Such anesthesia is highly praised as its use through the second stage arrests the pain of the mother, lessens chances for later complications, prevents shock and exhaustion, and at the same time does not slow down labor. (26) Doyle (27) feels that the arrest of pain may even hasten the second stage as the
inhibition of voluntary effort caused by pain is removed. His estimation is that labor in expulsion is shortened 25%.

Nitrous oxide-oxygen anesthesia has added safety in that this gas exerts no known deleterious effect on the liver or kidneys. (16) Moreover, the elimination of the gas is very rapid via the lungs and recovery is swift and usually uncomplicated by nausea.

Unfortunately, nitrous oxide-oxygen anesthesia at once intimates that perhaps some special apparatus is needed for administration, and such is true. Today, small portable machines are in use and tend to spread the feasibility of use even wider than the previous use only in hospitals. In the same trend, this anesthesia in untrained hands becomes more dangerous than either chloroform or ether. (16) (26)

Obstetricians also find fault with nitrous oxide-oxygen anesthesia in that there is little muscular relaxation obtained and thus its use is precluded in many operations and manipulations. (28) The chance for lacerations and tearing of the soft tissues of the birth canal is enhanced and presents a serious problem in numerous normal deliveries.

Advantage has been taken, however, of the good qualities of this anesthesia in using it as an intro-
duction to ether anesthesia. Likewise, nitrous oxide-oxygen anesthesia used sparingly is valuable when combined with local or regional anesthesia. Certainly this anesthesia used transiently during labor in the hands of the skilled anesthetist is comparatively safe and pleasant to the patient.

**ETHYLENE**

Ethylene is used as an anesthetic similarly to nitrous oxide, and although used extensively only since 1923, (29) there are many who feel that this anesthesia is superior to all others for routine obstetrical demands.

The induction time with this anesthesia is slightly shorter than that of nitrous oxide-oxygen anesthesia, with the early production of a state of analgesia in which there is a satisfactory degree of suppression of consciousness and of reflexes with scarcely any effects on the other functions. This condition is produced with a higher concentration of oxygen being used, (about 20%), so there is no anoxemia. In addition, the patient may be carried through the second stage of labor with a concentration of 50% ethylene-50% oxygen which definitely prevents anoxemia of mother or child.

As in nitrous oxide-oxygen, there is no irritation of lungs or kidneys, the induction is pleasant, and the
recovery swift and only occasionally accompanied by nausea. In addition, ethylene produces much more muscular relaxation than is afforded by nitrous oxide-oxygen and approaches that of ether anesthesia.

The chief disadvantage of ethylene comes in that the gas is highly explosive when mixed with gas or air, and is inflammable in the pure state. The upper and lower limits of explosive mixtures are 3.5% to 28.5% in air and with oxygen, 3.1% to 79.9%. In America there have been ten explosions in 332,721 administrations of ethylene. Thus it is unsafe to use this gas with any form of cautery and each case should have the anesthesia machine, table, and patient wired to prevent the production of a spark. Moreover, by keeping the humidity of the room above 56 degrees by means of a humidifier, inflammability is done away with. Nevertheless, Griffiths (15) feels that this anesthetic remains too dangerous for routine use in obstetrics, despite the evident advantages over ether and nitrous oxide. DeLee (32) uses ethylene in preference to nitrous oxide-oxygen and starts the inhalations towards the end of the first stage of labor, when the cervix is at least 7 cm. dilated and the pains are severe. At the very beginning of the pain, diagnosed by the hand feeling the uterus harden,
or from the parturient squirming a little, a few deep breaths of 50% ethylene and 50% oxygen are given, and the mask is removed as the height of the pain passes. The patient does not go to sleep, does not change color or show cyanosis, respirations are but slightly depressed, and secretions are not increased. (33) As the second stage pains grow stronger, the percentages of the two gases are changed--60 and 40, 30 and 20, 90 and 10, but never pure ethylene. As soon as the head is born, the administration is stopped, to be resumed only if repairs are to be made. The mother shows no ill effects and the baby shows no asphyxia unless the analgesia has been continued for several hours. Moreover, the uterus contracts well after labor, and there is only slightly more bleeding than in nitrous oxide-oxygen anesthesia. (13)

Again a very good but dangerous anesthesia for obstetrics has been presented with only a limited following in this country. Perhaps use of this anesthetic routinely with a staff carefully trained towards safety, such as DeLee has advocated, would see greater use of this anesthetic. Unfortunately, the average practitioner could not hope to maintain proper conditions for the use of this anesthetic.
CYCLOPROPANE

Cyclopropane is the latest inhalation anesthetic to be introduced to the practice of obstetrics, although its use has not been general.

Cyclopropane is capable of producing narcosis in concentrations as low as 4% administered along with oxygen.(19) The average concentration of cyclopropane for first plane, third stage anesthesia (roving eyeball) was 7.4%; second plane (fixed eyeball) 13.0%; and third plane (with intercostal paralysis) 23.3%. Respiratory arrest was produced with an average concentration of 42.9%. Induction was by the closed carbon-dioxide absorption technique.

The physical signs are the same as for ether anesthesia except that induction and recovery are very rapid.(34) Surgical anesthesia may be produced in three to five minutes and recovery takes place in less than five minutes, and the after-effects of this anesthetic are very slight.

Clinical laboratory studies show that cyclopropane has a minimum deleterious effect upon the metabolic processes of the body. The electrocardiographic changes are no more evident than with other commonly used agents.(35) Post-operative complications compare very favorably with ethylene and ether. The blood
pressure, pulse, and respiratory rates are lowered somewhat, (36) and there is no liver damage demonstrable after the use of cyclopropane.

After a years study Walters and his collaborators of the University of Wisconsin have found that cyclopropane in much lower concentrations is equal in (34) efficiency to other gaseous anesthetics and that an excess of oxygen may be administered with this potent anesthetic; that it causes relaxation comparable with ether; and that laryngeal reflexes are abolished more quickly than with ether; that it replaces ethylene to the satisfaction of all concerned; that it is to be chosen in preference to ether in well over 75% of the work formerly done under that agent. It is also to be preferred to nitrous oxide as a means of inducing ether anesthesia.

Because of the high percentage of oxygen used with cyclopropane, no cyanosis occurs, and the patient retains a pink, healthy color. Used with oxygen within ordinary anesthetic limits it is not explosive or just mildly so.

Bournes (37) used cyclopropane in his obstetrical cases as an intermittent analgesia as indicated for the more severe labor pains, and as anesthesia for delivery. He states that satisfactory analgesia was easily produced
with very small quantities of cyclopropane inhaled in oxygen. Although none of the times of analgesia were continued long in his cases he believes it would be quite safe to relieve the pains with cyclopropane much earlier in labor than has been done, for the reason that the uterine contractions have not been inhibited, and that so much oxygen is used with it.

We all know that it is good to administer oxygen intermittently, -good for the mother and good for the baby, especially should the heart of the latter be weak. The use of oxygen in obstetrics is very important. With cyclopropane anesthesia any required degree of muscular relaxation can be obtained without evident harm and recovery is devoid of any untoward effect to mother and child.

Bournes concludes by saying that cyclopropane seems to be very suitable for the relief of pain in obstetrics for the following reasons:

1. An abundance of oxygen is given with cyclopropane.
2. Circulation and respiration are not depressed.
3. Anesthesia is produced without appreciable metabolic disturbance.
4. Liver and kidney function are not impaired.
5. Anesthesia is quickly and agreeably induced, satisfactorily maintained at any desired depth,
with ready flexibility and with minimum
danger to the mother and child, and recovered
from easily and uneventfully.

Thus the only objection to the use of cyclopropane
in obstetrics would be its explosive tendencies, and
the required presence of a machine for administration.
Undoubtedly this means of analgesia and anesthesia
will find more extensive use in our country and abroad
as time goes by. Certainly, according to all indications,
here is a very favorable anesthesia for obstetrics.

VINYL ETHER

Vinyl ether is another anesthetic that has been
recently brought into use, although it is comparatively
in its experimental stage.

Rough and Major (38) feel that vinyl ether pro-
duces anesthesia much more easily than ether; that there
is a lessened excitement stage with less mucous secre-
tions; (39) that recovery takes place more quickly
than with ether; that nausea and vomiting are at a
minimum, and that there are no significant pathological
effects on the various organs.

The success in the obstetrical field is due to the
rapidity with which an anesthetic state can be reached
when vinyl ether is inhaled, (37) the promptness of
recovery, the negative effect on uterine contractions,
and the comparative safety. Due to its volatility, a closed apparatus is preferred to avoid waste, yet this anesthetic may be very readily used via the open drop method, thus lending itself to the use of the physician who must practice obstetrics outside of the hospital.

Unfortunately, vinyl ether produces anesthesia in only a few inhalations,(40) and thus provides no analgesia which might be used during the second stage before actual delivery. Experiments have shown this anesthetic to be four times as strong as ether which accounts for this swift induction, and a discouraging note arises from England where Shipway (41) reports two deaths from liver necrosis following use of this agent, suggested by the fact that tests have shown a very slight impairment of the liver function (bromsulphalein dye test) following the administration of this anesthetic.(42)

With this warning of impending liver damage, vinyl ether should be reserved for reinforcing nitrous oxide-oxygen anesthesia when chloroform and ether are not suitable. Its continued use in obstetrics would undoubtedly show evidence of maternal mortality which violates our rule of preservation of life.

In addition to the six means of inhalation
Anesthesia just discussed, ethyl chloride, acetylene, and propylene have been used as general anesthetics, but their use in obstetrics is so limited that a worthwhile discussion regarding them should not be attempted.

EVIPAL

The anesthesia by means of intravenous evipal or evipan sodium has recently come into considerable use with its advocates being highly enthusiastic, holding as the goal of perfect anesthesia the following qualifications:

1. Safe.
3. Terminates quickly and pleasantly in thirty-five to fifty-five minutes.
4. Produces complete amnesia.
5. Allows adequate relaxation immediately.
7. No dangerous sequelae.

Findlay and Findlay (43) feel that evipal meets these requirements in every respect and is the perfect anesthetic thus far known. Careful investigation has shown the above support of evipal to be largely true; but, as usual, this anesthetic is not fool proof and not without its dangers.

Although the ratio of the minimum lethal dose to
the anesthetic dose has been found to be between three and four to one, (44) there have been reported four deaths in a large series of cases. (45) Study has thus shown that this anesthetic is dangerous in cases of debilitated patients, patients with liver or kidney damage, and patients with marked sepsis, such as empyema, cellulitis, peritonitis, or septicemia. In such cases, the drug must be administered very slowly, taking care to keep the dosage low.

The study of the use of this anesthetic in obstetrics is made difficult by the scarcity of literature regarding this subject. Although foreign operators have reported its use in several instances, the American profession has been slow to use evipal in obstetrics.

Kasseboom and Schreiber (46) did report a series of cases in which the anesthesia was used in operative deliveries and also in spontaneous deliveries. In each instance the anesthetic was satisfactory, with forceps deliveries, packing of uterus and vagina, and manual removal of placenta carried out successfully. The anesthetic was not satisfactory in cases of attempted version, for continued uterine contractions and unaltered irritability of the uterine musculature made version impossible. In spontaneous deliveries
this was of value only at the end of the second stage and produced no effects on the fetus. The intravenous anesthetic was most satisfactory if combined with gas-oxygen analgesia during the second stage. Needless to say, episiotomy and repair are very successfully done under this anesthetic.

With the use of the drug limited to shorter procedures, due to its inability to produce a long safe period of analgesia, there is no reason for a general use of this anesthetic in obstetrics. Certainly, the cases should be carefully picked, and continued use of the anesthetic may develop further contraindications to its use. With two lives at stake, the obstetrician does not dare to experiment with relatively unknown and uncertain types of anesthesia.
LOCAL ANESTHESIA

When the subject of infiltration or nerve block local anesthesia is considered, there seems to be both apathy on the part of obstetricians in their daily practice and a paucity of articles in the literature. J. W. Williams (47) in his text in the sixth edition states that he has had no experience with the use of such anesthesia in obstetrics. J. L. Baer (48) says in speaking of the conduct of normal labor, "Infiltration anesthesia of the cervix and perineal body has not won general approbation and is not to be recommended." R. M. Tovell (49) says, "Sacral block is to be generally preferred over less precise and less satisfactory methods such as infiltration of the perineum or nerve block of the inferior pudendal and inferior hemorrhoidal nerve." J. B. DeLee (32) is more enthusiastic about the use of local anesthesia. In the sixth edition of his textbook he says, "Whenever in obstetrics, as in surgery, it is possible to operate under local novocaine infiltration or nerve blocking, this should be done, since unquestionably the dangers are more than halved by the avoidance of general anesthesia." In the Chicago Lying-In Hospital, in the home service of the Chicago Maternity Center, central episiotomy and repairs are usually done under 'local.'
In 1916, R. W. King (50) in an excellent paper, to which little attention seems to have been paid, said, "While marked advancement has been made in the realm of anesthesia, as applied to the local and general blocking of the sensory nerves of the various parts of the body, it is strange that so little attention has been paid to applying these methods in the sensory innervation of the female perineum. The literature of this subject is remarkable because of its scarcity; the subject apparently has not engaged the attention of American investigators, and practically the only work of importance that has come to my notice has been carried on in Germany."

Such statements accurately reflect the present attitude of the American medical profession as a whole. The past twenty years have found only a few men who had used this form of obstetrical anesthesia and had entered their findings in the literature. The results have been uniformly successful, yet no impression has been made upon the obstetricians and there has been little tendency for them to attempt this mode of anesthesia. Why this restraint? The American profession has long followed the innovations of the foreign authorities, and the new procedures which have been tried and successfully tested in Europe are brought to America
and put into use more or less generally in a short time. American operators pride themselves on their technical ability and yet here is a procedure simple enough, which has not been practiced to any extent. All in all, there can be found no plausible and concrete evidences why the American obstetricians have not more generally used local anesthesia in obstetrics. This section is dedicated to a simple consideration of the problem from every standpoint, with a final attempt to determine the practicality and plausibility of such anesthesia.

A brief consideration of the drugs employed in local anesthesia is of importance here. While much energy has been expended in the search for a drug that is both efficient and safe for the production of local anesthesia, none yet discovered meets all requirements. Novocaine has thus far most nearly suited the demands of the general surgeon, and is safe and efficient within the limits required for local anesthesia. Cocaine, pontocaine, nupercaine, and metycaine are the other leading drugs in use in local anesthesia which will be considered representative in this discussion.

Cocaine,(51) although the first local anesthetic of any import, is now limited to surface anesthesia,
and is never injected into the body by modern surgeons. Recognized because of its powerful action, cocaine is now used as a standard on which is based the comparative classification of the strength of other local anesthetics.

Novocaine (procaine) is as efficient as cocaine when injected and much safer. It has a toxicity seven times less than cocaine and few persons possess a susceptibility to this drug. Injected locally this drug produces immediate local anesthesia with practically no irritation and produces a comparatively bloodless operative field. Injected into a nerve, the anesthesia is instantaneous, while injections in the region of a nerve require fifteen to twenty minutes for anesthesia. If novocaine is used alone, the effects begin to disappear in about fifteen minutes. If used with a vaso-constrictor drug, the anesthesia is prolonged for one to three hours. The strength of the solution to be used may be either \( \frac{1}{2} \) or \( 1\% \), with a total dosage of 1 to 1.25 gms. considered the maximum safe dosage.

Nupercaine (percaine) differs from the cocaine-novocaine group in that it is a quinoline derivative. First used in 1929, \( (19) \) it was found that nupercaine was twenty-five times as toxic as novocaine, but this
was more than counterbalanced by the fact that its minimal effective concentration is about one-fortieth that of novocaine. The minimal reported lethal dose is about 90 mg. (52), although individuals have survived the administration of 750 mg. and 1500 mg. The resultant anesthesia always lasts ninety minutes and lasts as long as six to eight hours if used with a vaso-constrictor, thus definitely reducing the after-pain of surgery. The usual dosage of nupercaine is 60 cc. of 1:1000 solution.

Pontocaine is similar in effect to novocaine and nupercaine, and it is just about midway between the two as regards toxicity and length of anesthesia. (53) The dosage is 150 mg. to 200 mg.

Metycaine, or neotheasin compares closely with novocaine, being about the same in toxicity when injected subcutaneously, but from two to four times as toxic when injected intravenously. (54) The anesthesia lasts about one-fourth to one-half longer than novocaine. The maximum safe dosage is 200 mg. or slightly above.

It has already been noted that all the local anesthetics except cocaine cause vaso-dilatation. (55) It is customary, therefore, to incorporate a vaso-con-
strictor in all solutions used for infiltration and field blocking. The advantages then secured are:(56)

1. A relatively ischaemic field.
2. A more prolonged effect of the analgesic drug due to its delayed escape from the injected area.
3. Diminished toxic effects from the drug owing to its slower absorption.

The vaso-constrictor drugs used commonly are adrenaline, epinephrine, and cobrafin.(19) Adrenaline is most commonly used in a final dilution of 1:200,000 for infiltration. This solution is unstable and cannot be resterilized by boiling. Moreover, the drug may cause severe tachycardia in patients suffering from toxic goitre, and also causes sudden collapse with fall of blood pressure in patients who are adrenaline sensitive.

Epinine is a synthetic product with an action similar to that of adrenaline. It is rather more stable than the latter substance and is used in about ten times the strength.

Cobrafin is also chemically related to adrenaline, is used in about ten times its strength, and does not produce collapse in adrenaline sensitive patients.

The extended use of local anesthetics has forced
the question of toxicity to the front and it is now realized that these drugs and methods have their dangers just as in general anesthesia. It must be remembered that local anesthetics are protoplasmic poisons possessing special affinity for nerve tissue (55), the sensory fibers being affected before the motor fibers, with the unmyelinated nerve fibers and then the smallest to larger myelinated nerve fibers being anesthetized. Thus the anesthetized area loses first vaso-constriction, then temperature, pain, touch, and lastly, joint and pressure sense.

In the usual process where a vaso-constrictor is used, the drug remains in the tissues locally long enough to be partially destroyed, with the liver and kidneys completing this breakdown (56) thus preventing the drug from acting generally on the nerve fibers of the central nervous system.

Cases of toxic reaction to local anesthetics can be divided into three main groups. First is overdose. This is rare as the universal adoption of novocaine and nupercaine has provided a fairly wide margin of safety, and overdosage in adults is rare although by no means unknown. The toxic symptoms produced by overdosage of local anesthetics are excitement, restlessness, rapid and feeble pulse, and later followed by uncon-
sciousness, convulsions, and death.(57)

Secondly, normal dosage in a susceptible patient as an allergic factor is a real problem, although cases are rare. One must guard against such a possibility by a careful investigation of the patient's history of reaction to drugs, and further safety is provided by locally testing the first injection.(58) A small wheal in these cases will almost immediately turn bright red. People sensitive to local anesthetics may have: 1. General ill health; 2. Low blood pressure; 3. Anemia; 4. Defective liver and kidney function; and 5. Allergy.(59)

Thirdly, inadvertent intravenous injection is the most reasonable explanation of the tragic cases of sudden collapse and death.(60) It has been estimated that the intravenous lethal dose of a local anesthetic is about one-tenth of its subcutaneous lethal dose.(56) The direct injection of the drug into the bloodstream does not allow for local changes and there are immediate depressing effects on the respiratory and circulatory systems, with the action on the cerebrospinal centers producing convulsions. The adrenaline present undoubtedly increases the liability to cardiac failure and it has been suggested in such cases that the actual cause of death is ventricular fibrillation.(61)
Local toxic reaction may result from the use of an excessive amount of adrenaline with resulting vaso-motor or trophic disturbances. Extensive sloughing may follow local anesthesia in debilitated patients (62) and may even produce fatal results. (63)

The toxic effects as affecting the fetus have not received attention, for the simple reason that no cases have been reported in which the fetus has been harmed through use of local anesthesia during labor.

The treatment of any toxic reaction to local anesthetics is initiated by the use of barbiturates in the preliminary medication during the first stage of labor. Barbiturates are specific drugs to prevent such reactions, and their use raises the minimum lethal dose of local anesthetics considerably. (55) Sodium amytal is especially effective in this role. In the active treatment of such toxic reactions it is also well to remember that the more toxic barbiturates have swifter actions in treatment of the condition brought on by the local anesthetics. Thus dial and nembutal are advised in heavy dosage in toxic reactions. (64)

Novocaine, nupercaine, pontocaine, and metycaaine are easily prepared, as their respective crystals are readily soluble in water and, if sterilized by boiling, remain stable. Clark has found that if the anesthetic
solutions are alkaline, the induction period of the anesthetic is reduced 600%, while the toxicity is reduced 50%. Resolution is also more rapid in the field of operation. Novocaine as ordinarily prepared has a pH value of 5.5, while that of novocaine borate is 8.4. Experiments show that values of 7.4 to 8.4 have the above advantages, with the only possible disadvantage being a twenty-five per cent reduction of duration of surgical anesthesia. Tennent stresses the fact that solutions of local anesthetics should always be freshly prepared, thus guarding against deterioration, and at the same time providing a good check on the contents and strength of the anesthetic. (66)

With the use of local anesthesia during the late second stage, it is advisable to use analgesic preparations to lessen the pain of the first stage. The natural question of resulting depression affecting the fetus is quite in order, but it is felt that the small doses of analgesic required here are never sufficient to affect either the child or the mother. The purpose here is to quiet the mother somewhat and allay her fears. The pains of the first stage are in most cases not severe enough to cause any great distress.

Analgesics are used according to each author's fancy, with nembutal, morphine and scopolamine, and pentobarbital
being the most popular. Greenhill (67) feels that morphine, gr. 1/4, and scopolamine, gr. 1/200, have no effect on the child whatsoever if the delivery is made within two hours after the injection of these drugs. In his experience, deliveries three and four hours after use of these drugs are apt to find fetal respiratory depression. Rose (68) uses intradermal infiltration during the first stage to relieve pain. With the abdomen cleansed with soap and water and then painted with 2 to 4% mercuriochrome, he infiltrated three areas. The first is a longitudinal area, or more truly, a line which extends almost from the height of the fundus down to just above the umbilicus. The second, on the right side, starts about an inch medial to the anterior superior spine and, conforming to the contour of the uterine corpus and overlying the inguinal ligament, curves medially and downward, terminating in the midline over the symphysis. The third area is a similar line on the other side meeting the end of the second line. These latter lines as they approach the symphysis should run along its superior margin. His success in this procedure has been remarkable, analgesia lasting over three hours.

The time to begin the infiltration during the second stage is naturally variable, with different
authors using different methods of choosing the moment when injection should begin. Rose begins infiltration in the primipara when the os is fully dilated and the cervix is completely taken up; in the multipara, the same or when there is still a slight rim of cervix left. Ditter (69) waits until the head or buttock advancing on the perineum begins to open the anal orifice. Torland (70) feels that the obstetrician can differentiate between first stage pains and real bearing-down pains when the head begins forcing its way through the pelvic floor. Thus he begins his local infiltration when the patient begins having her more severe second stage pains.

Local anesthesia may be used to relieve the pain of labor according to several techniques, with the most popular being perineal infiltration. This technique, as advocated by Torland and King and described by Walker (71) is a combination of nerve block and infiltration. The instruments necessary consist of a Luer Lok syringe of 10 cc. capacity, two local anesthetic needles of about 19 guage, and novocaine, 1% solution, 40 cc. With the patient in the lithotomy position, the skin of the perineum and vulva is prepared by scrubbing with neutral soap and water, and douched off with either a weak iodine solution or merthiolate solutions. No
other antiseptic solution or application is used as reliance is placed in thorough use of soap and water. Before the patient is draped, the surgeon puts on a pair of sterile gloves which are used for the administration of the local anesthetic, and then changes to a fresh pair for the delivery. At a point 2 cm. above the posterior border of the vaginal outlet and 2 cm. medial the pubic ramus, the needle, attached to a syringe containing 1% novocaine solution is inserted until it pierces the fascia at a depth of about 3 or 4 cm. The piercing of Colles fascia transmits about the same sensation to the operator as does the piercing of the arachnoid in performing spinal block. In this situation 5 cc. of anesthetic solution are injected. The same procedure is carried out on the opposite side. This injection serves to block the fibers of the pubic nerve which supply the skin over that area and also the labia and clitoris. There is also some blocking of the fibers of the genito-crural which supplies this same area and are to be found at the same level under Colles fascia. At a point midway between the ischial tuberosities and the anus, the needle is again inserted at an angle so that the point of the needle impinges on the tuberosity. It is then withdrawn a short distance and reintroduced about 1 cm. medial and about 2 cm. deep
to the tuberosity. At this point 10 cc. of 1% novocaine are introduced, the last 3 or 4 cc. being introduced after the needle has been withdrawn 1 or 2 cm. A like injection is carried out on the opposite side, this injection serving to block the larger branches of the inferior pudic nerve as it emerges from behind the gluteus muscle. These nerve branches are superior perineal, inferior hemorrhoidal, and dorsal nerve to the clitoris, all of which branch from the inferior pudic in this region and lie in a plane just deep to the ischial tuberosity and between it and the anus. Inasmuch as the operative activity is concentrated in the perineum and due to the fact that, unless contraindicated, there is done routinely a medial episiotomy, about 10 cc. of novocaine are infiltrated into the perineum in the median line and well into the vaginal mucosa. In a short time, usually about five minutes, anesthesia is effective so that the patients usually state that they feel numb and have lost the severe pain which accompanies the attempts at expulsion with fetal head on or near the pelvic floor. In the great majority of cases, good anesthesia is evidenced by relaxation of the pelvic floor and loss of pain, although tactile sensation is not altogether abolished. With the onset of good anesthesia any necessary procedure
for the delivery of the baby may be carried out. Episiotomy and repair, manual rotation of the persistent occipito-posterior head, Scanloni maneuver, and all of the low and midforceps deliveries have been satisfactorily performed under this anesthesia.

Ditter enlarges upon this technique for the second set of injections by inserting his index finger into the vagina and directing it to the ischial tuberosity which will act as his landmark. Keep the tip of the finger at this point as it marks the approximate position of the pudendal nerve.

Ditter also warns of the precaution to retract the plunger of the syringe before injecting to make sure that none of the solution is injected directly into the blood stream. Due to the abundance of the blood vessels in this region it will be an easy mistake to make. While an effort should be made to block the pudendal nerve, one cannot always be certain of success, so it is suggested that an effort be made to block off all the branches by fanning out the novocaine solution in a horizontal direction. Usually 30 to 40 cc. of solution is sufficient on each side in this procedure.

Greenhill (72) also advocated the injection of anesthetic solution along the edges of the labii majora and across the fourchette, as well as in the layer
between the vaginal wall and the rectum, not only in the midline, but also well out to the sides in the shape of a fan. This author tends to use more of a general infiltration with no attempt at specific nerve block to accomplish his purpose, using from 60 to 70 cc. of anesthetic solution on each side.

Indications (73) for the use of local anesthesia in obstetrics, as in major surgery, have long been thought to include cases in which there is some contraindication to general anesthetics. Therefore, individuals with cardiac or renal disease, pulmonary complications, severe diabetes, toxic goitre, marked anemia, and toxemia of pregnancy are those especially chosen for this type of anesthesia. Greenhill (74), however, assails this view in that he feels this practice is limiting the use of local anesthesia to too great an extent. His belief is that it is not a wild prophecy to believe that the time will come when, instead of saying, "Local anesthesia should be used when general anesthesia is contraindicated", one will say,"Inhalation or spinal anesthesia should be employed only when infiltration anesthesia cannot be used." The increased use of local anesthesia in normal obstetrics indicates there is the growing realization in obstetricians that here is perhaps the ideal obstetrical anesthesia for the
routine practice.

Results in the use of this means of obstetrical anesthesia have been almost uniformly successful. O'Connor (75) bests describes the results obtained when he says that after the method has been used twenty-five or thirty times by an individual, the nerve block is perfect in nearly every case in thin or normal women. In stout patients, it has been his observation that occasional partial failures result. Even in these, the amount of general anesthesia required is less than ordinarily used and this is advantageous.

The length of anesthesia obtained naturally varies with the drug used. (75) Novocaine will dependably give anesthesia for a period of forty-five minutes to an hour, with a longer duration very often the case. Abdurel and Reist state that they obtain an anesthesia lasting four or five hours with 1:1000 or 1:2000 nupercaine solution. Realizing the extreme vascularity of the tissues involved, a vaso-constrictor drug is used as previously described.

Infection is always a possibility in such cases where injections are made. Episiotomy further makes possible the chance of infection. However, the greater vascularity of the tissues reduces this factor it a minimum and in cases reported there is no record of
an infection due to the infiltration. King, in 1916, one of the pioneers of this method, did get slight superficial necrosis at the sites of injection due to the use of too strong an adrenaline solution. Since his first efforts, this point has been corrected and he no longer has this trouble.

One may briefly record the advantages of local infiltration anesthesia as being: (76)

1. There is no mortality due to this method as has been reported in obstetrical cases.

2. There are no pulmonary complications directly attributable to this procedure. One of the chief reasons for the absence of these complications is the fact that the lungs are well aerated not only during delivery but afterward. Frey reports a series of 281 cesarian sections performed under direct infiltration anesthesia without the occurrence of pneumonia in a single instance, whereas in the 72 cases in his series in which general anesthesia was used, five patients developed pneumonia. Greenhill has performed 21 cervical cesarian sections under direct infiltration anesthesia without the occurrence of post-operative pneumonia or a fatality.
Two women in his series did develop pneumonia after ether anesthesia, both recovering.

3. There are no local or general complications. An old needle might break, the injection might be made into a vein, or the patient might have an idiosyncrasy to the drug used, but each of these factors is guarded against by the preliminary investigation and preparation for delivery.

4. The technique is simple and may be employed in the home as well as in the hospital.

5. There is no harmful effect on such vital organs as the liver, lungs, heart, circulatory apparatus, and central nervous system.

6. No special knowledge is required and the physician is not dependent upon a second individual as anesthetist.

7. No special after care is required, as is necessary after general or spinal anesthesia.

8. There is a striking reduction of bleeding in episiotomy so that the amount of blood lost is negligible.

9. There is no interference with the action of the uterus, of the abdominal walls, or of respiration.

10. Gastro-intestinal symptoms after operation are
11. Patients may take liquids and carbohydrates before, during, and after the procedure.

12. There is no need to hurry through a procedure; hence more time can be paid to proper suturing of episiotomy wounds.

13. The tissues must be handled gently; this is advantageous to the patient in recovery.

14. There is less wound infection, owing to diminished local trauma and to the fact that the patient's general resistance has not been lowered.

15. The fear of having general anesthesia is eliminated.

16. Routinely perfect relaxation is obtained at the outlet.

The disadvantages of infiltration anesthesia in obstetrics are: (77)

1. Infiltration anesthesia cannot be used if the site at which the solution must be injected is infected or inflamed; a condition rarely seen in obstetrics.

2. This form of anesthesia should not be attempted in a woman who is exceedingly high strung and has an almost morbid fear when she is told
that her delivery will be performed under local anesthesia. Fortunately, there are only few women of this type.

The number of women, as just described, can still further be reduced by properly preparing patients for this form of anesthesia. After all, local anesthesia is a relatively new procedure and patients believe that they will see their delivery performed; that they will hear all that goes on in the operating room, and that they will experience much pain. A proper preparatory talk on the part of the operator is essential. The patient should be promised that her eyes will be covered so that she will not see anything around her; that the conversation she will hear will not be gruesome and disagreeable; that the rattle of instruments and pans will be reduced to a minimum; and, above all, that, if she feels too much pain and desires it, a general anesthetic will be administered to her. The operator should live up to his promises all the way through the delivery or the patient may lose confidence, become excited, and demand a general anesthetic.

Local anesthesia has been used in abdominal cesarian sections for years. Webster's (78) first operation of this kind took place as early as 1909 and Traugott published a series of twelve cases in 1914. The
abdominal incision is rendered painless either by infiltrating the abdominal walls in successive layers along the line of the proposed incision, or by injecting into the tissues around the incision in the form of an ellipse. (79) The uterus itself possesses no sensibility and may be incised and emptied of its contents without causing discomfort; but any pull or pressure on the parietal peritoneum produces more or less pain. It follows then, that any method in which the uterus is left in situ is better suited for local anesthesia than the classical cesarian section with evacuation of the organ. Since cervical cesarian section is constantly gaining in favor among progressive obstetricians, this field is very promising for local anesthesia. Irving (80), Trout (81), Roes (82), and DeLee (83) have obtained very satisfactory results with this method and leave no doubt as to its feasibility.

SPINAL ANESTHESIA

Spinal anesthesia, or lumbar anesthesia, produced by injecting a local anesthetic into the sub-arachnoid space of the spinal canal, has been used more or less constantly since the discovery of Novocaine in 1904 gave this method of anesthesia a new impetus. When a local anesthetic agent is injected into the cavity of the spinal arachnoid, it affects the
nerve roots with which it comes in contact by narcotizing them. The most marked effect is upon the sensory roots in the immediate region of the injection. (34) However, the anterior motor roots and sympathetic fibers are also affected. The posterior roots are affected by the loss of pain, tactile, temperature, and muscle sense in the involved segments, while the anterior roots are affected by the loss of voluntary movement, paralysis, muscular relaxation, and absence of superficial and deep reflexes. The sympathetic fibers are affected by causing a vaso-motor palsy, varying with the number of rami affected. When all the white rami from the second dorsal to the second lumbar are blocked there is complete vasomotor relaxation of the entire body. If the head and shoulders are raised with complete vaso-motor palsy, the patient becomes pulseless and unconscious from cerebral anemia. (35)

Under spinal anesthesia the contractions of the heart become slower and weaker from the interruption of cardio-augmentor nerves, diminished vis a tergo, and unopposed action of the inhibiting vagus. The corresponding drop in blood pressure may vary from 0 to 70 mm. of mercury, depending on the height of the anesthesia. (36) Transient nausea and vomiting are produced in from five to fifteen minutes following the injection of the
anesthetic, and corresponds to the maximal drop in blood pressure. (85)

Respiration under spinal anesthesia is quiet, slow, of small amplitude, and largely diaphragmatic, from paralysis of the abdominal and thoracic muscles. (87) Respiratory failure occurs if the level of anesthesia rises too high and affects the phrenic nerves or if the respiratory center is directly affected by the drug in the blood stream.

There is an increase in peristalsis with strong gastric and intestinal contractions occurring, accompanied by incontinence of the anal sphincters. At the same time, the uterus in labor continues active, forcible contractions, thus reducing hemorrhage during labor and acting for swifter delivery. (88)

The intensity and duration of anesthesia varies directly with the dose and concentration in the spinal fluid. (89) The nerve roots first reached by the anesthetic are affected most intensely and for the longest time. Therefore, the injection is made in the lower lumbar segments for normal or operative deliveries. The drug used will also vary the length of anesthesia, as novocaine has been surpassed by the three hour anesthesia produced by pontocaine and nupercaine. (87) Although more toxic, these drugs may still be used in
smaller doses which offset their toxicity.

The height of anesthesia from a given dose of local anesthetic varies according to the position in which the patient is injected and the specific gravity of the solution used, the anesthetic having been injected in a given interspace. (90) The level also varies with the force of the injection, the amount of fluid withdrawn, and the decompression of the dura. (91) The lateral recumbent position is preferred to the sitting position because in the former the dural sac has no obstruction which may arise from the varying lumbosacral curves seen in the latter position. (92) Moreover, the spread of the fluid injected is diminished by the lateral recumbent position. By regulation of the specific gravity of the anesthetic, spread to upper or lower levels of the cord may be gained at will. The patient should lie still for ten to fifteen minutes following injection with the body level so as to permit the fixation of the anesthetic at the level desired. Naturally, forcible injection produces a wider spread of the anesthesia, as does the injection of large amounts of anesthetic.

There has been much discussion and disagreement concerning the diffusibility of spinal anesthetic agents upward in the spinal canal and causing death through affecting the vital centers. Labat (93) says, "The
assumption that the anesthetic agent diffuses to the brain and is the cause of respiratory failure is based neither on chemical or laboratory findings but is due to vasomotor paralysis causing cerebral anemia."

Circulation of the spinal fluid from cranial cavity to the spine and out to the venous system at nearly all levels is also a factor against upward diffusion. Pitkin (90) has proven that solutions remain at the site of injection by tapping the spinal canal with needles at various intervals afterwards. Pitkin has also found that unless an excessive dose has been used, the drug becomes fixed in the first ten minutes following injection and thus prevents further diffusion.

The evident advantages of spinal anesthesia in obstetrics are: (94)

1. This anesthesia may be used in patients with pulmonary tuberculosis and upper respiratory infections.
2. It removes the dread so many patients have of going to sleep during delivery.
3. There is comparative freedom from post-operative vomiting.
4. Relaxation of the perineum is quite adequate.
5. There is a minimal general reaction to the anesthesia with absence of any effect on the
kidneys, liver, or respiratory passages.

6. The fall in blood pressure aids in reducing hemorrhage post-partum.

7. There is no excitement stage of anesthesia.

8. The anesthesia is economical.

A careful consideration of the disadvantages of spinal anesthesia in obstetrics is warranted with the above advantages. The disadvantages are:

1. There is a definite mortality. Generally, the death occurs shortly after the injection and is attributed to respiratory paralysis or fall in blood pressure. Cooke (95) says that spinal anesthesia "is apparently, as judged by mortality rates, more dangerous than general anesthesia." Bower, Clarke, and Burns say: (96) "Spinal anesthesia is responsible for more deaths than any other anesthetic in proportion to the number administered—Undoubtedly many deaths have occurred from spinal anesthesia which have been attributed to other causes."

Pregnant women are especially susceptible to complications after spinal anesthesia. DeLee (97) knows of seventeen deaths in obstetrics from spinal anesthesia, while other authors (98) likewise report deaths during delivery under
under spinal anesthesia, with the anesthesia the contributing factor in the death.

2. The incidence of pulmonary complications is at least just as high as after inhalation anesthesia. In fact, Brown and Debenham (99) found that pulmonary complications, especially atelectasis, occurred 4.29 times more commonly after spinal than after inhalation anesthesia. This is attributed to inhibition of respiratory movements over a long period of time; secretions of the tracheo-bronchial tree are more viscous, and the patient remains quiet longer after a spinal anesthesia.

3. There is a definite toxic effect on the spinal cord and spinal nerve roots which is manifested both clinically and pathologically. (100) Observations show varying degrees of inflammation in the leptomeninges; changes in the ganglion cells of the gray matter of the cord; swelling and fragmentation of the axis cylinders, and signs of degeneration in the fiber tracts of the cord. Koster and Kosman (101) disagree with this statement and maintain the spinal cord is normal in twenty-four hours after spinal anesthesia is used. Certainly
there is a definite possibility of the introduction of infection into the spinal canal that must be considered.

4. There is frequently a pronounced fall in blood pressure, which may be accompanied by vomiting, restlessness, pallor, cold sweat, weak pulse, shallow respiration, and sometimes unconsciousness. In 5% of all cases the blood pressure does not return to its normal level for at least twenty hours after the patient has had her delivery completed. (102)

5. Headaches, both temporary and persistent, frequently occur after delivery. Kosman, Kosman, and Shapiro (103) investigated the possible causes of such headaches after the use of spinal anesthesia and concluded the possible causes were: seepage of cerebrospinal fluid after puncture; an irritative meningitis; contamination of material injected, causing irritation of nerve tissue.

6. After the drug has been injected into the spinal canal it is beyond control, and, if alarming symptoms appear, the cause cannot be removed.

7. This method of anesthesia fails in at least
5 to 10% of all cases. In Arnheim and Mage's series (104), supplementary inhalation anesthesia had to be employed in 32.7% of the cases. Deaver and Eckels (105) report that in their series of 2,302 cases, additional anesthesia was required in as high as 32.3%. In nearly all cases in which supplementary anesthesia is necessary, a general anesthetic is chosen. As McKittrick, McClure, and Sweet (102) emphasize, serious harm may result to both mother and child if proper care is not exercised in the administration of a general anesthetic when the field of operation is already partially anesthetized.

3. Spinal anesthesia cannot be used in cases of intra-abdominal hemorrhage, or abruptio placentae, and is hazardous in women with anemia or cardiac decompensation.

CAUDAL ANESTHESIA

The procedure known as caudal (intrasacral, sacral, epidural, and extradural) anesthesia is made possible by the anatomy of the central nervous system and the coverings in the region of the sacral nerves. (106) The lower termination of the dural sac containing spinal fluid is found quite constantly at the level of
the second sacral vertebra, while the bony spinal canal continues to the sacral hiatus, a gap left by the failure of the fifth spinous process of the sacrum to form. This hiatus is bounded laterally by the sacral cornu, and above by the fourth sacral spine, being thus a triangular area covered by a fairly resistant tissue, the sacro-coccygeal membrane, and giving direct access to the spinal canal. Introduction of local anesthetic into this space makes possible blocking of the sacral nerves without introducing the drug into the cerebro-spinal fluid.

Such a procedure produces an anesthesia lasting from one to three hours, and extends from the sacral region and perineum down to the medial surface of the thighs. Some patients complain of numbness, paresis, and paralysis of the lower extremities (107), while in a few cases the numbness continued up over the abdomen as high as the costal margins. Anesthesia with relief from labor pains is usually produced in five minutes with marked relaxation of the perineum, thus allowing an easy delivery. (108) Further advantages are:

1. Episiotomy and repair are easily and painlessly accomplished.

2. There are none of the after effects of inhalation anesthesia.
The disadvantages of such a procedure are: (109)

1. The technique is difficult and the results are not uniform. The procedure should not be used in the average home delivery.

2. There is difficulty in timing the administration of the drug, since it is often too early in the primiparae and too late in the multiparae.

3. Caudal anesthesia produces a certain amount of uterine inertia in practically every case, from a very slight reduction to a complete abolishment of the uterine contractions, necessitating operative deliveries for the completion of labor. (110)

4. It produces definite toxic manifestations in the mother and, without doubt, is the cause of fetal distress.

5. It does not relieve the pain of uterine contractions when an inertia does not develop. Since these pains are apparently almost as distressing as the pain from delivery of the head over the perineum, adequate relief is not obtained for the patient. (111)

First used as early as 1903, varying reports of success have been obtained. Oldham, in 1923, reported a series of 200 deliveries with marked effectiveness in
85 to 90% of these cases. (112) Meeker and Bonar (113)
reported on 90 cases with like success, while Rucker (114),
and recently, Oldham (115), have reported considerable
success with this method of obstetrical anesthesia.

On the other hand, Perrill (116) found that caudal
anesthesia lessened uterine contractions and was not
sufficient for repairs. Schlimpert (117) reported the
method as being worse than worthless. Kelso (109)
reported 50% failure of anesthesia in a series of 34
cases. It is apparent that the above mentioned disad-
vantages of this anesthesia are truly formidable in this
procedure and excellent results difficult to obtain.

CONCLUSIONS

1. The ideal obstetrical anesthesia is not
possible with the present anesthetics.

2. Ether, despite its apparent disadvantages,
is yet the most popular anesthetic used in obstetrics
and is probably the safest anesthetic considering the
use of general anesthetic agents today.

3. Chloroform has no place in obstetrics.

4. Nitrous oxide-oxygen anesthesia as administered
by competent anesthetists is the best and safest
obstetrical anesthesia obtainable, but is not practical
for use outside the hospital.

5. Ethylene-oxygen anesthesia surpasses nitrous
oxide-oxygen anesthesia as an obstetrical anesthetic, yet the inflammability of this gas makes its use hazardous.

6. Cyclopropane gives very satisfactory obstetrical analgesia and anesthesia, but is too swift in action to be used by anyone other than a trained anesthetist. This anesthetic is not practical for routine use in the home in that a machine is required for administration.

7. Divinyl ether is not a suitable anesthetic for obstetrics because it provides no period of analgesia and is harmful to the liver of the patient.

8. Evipan sodium is not suitable for routine use in obstetrics.

9. Novocaine is the least toxic of all local anesthetic agents, while nupercaine produces a longer anesthesia with a relatively less toxic dosage.

10. Local infiltration anesthesia in obstetrics offers a comparatively new means of alleviating the pains of childbirth that has not been generally regarded as practical by the American medical profession.

11. Local infiltration anesthesia compares very favorably with ether, cyclopropane, and nitrous oxide-oxygen anesthesia in obstetrics, with novocaine, nupercaine, and pontocaine the drugs of choice.
12. The use of local infiltration anesthesia in skilled hands offers the best obstetrical anesthesia for routine use outside the hospital.

13. Spinal anesthesia is not satisfactory as an obstetrical anesthesia.

14. Caudal anesthesia in skilled hands produces a satisfactory obstetrical anesthesia in operative deliveries.

15. Obstetrical anesthesia does not receive sufficient attention in the medical education of young physicians.
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