instructions, advising him to watch for certain enumerated manifestations of ill effects. These instructions had been carefully prepared by competent authorities, and listed the unfavorable reactions that were known at that time. He was instructed to report to the doctor immediately upon the discovery of any of these symptoms, and he was an intelligent young man. Once a week he was examined, and tests which were generally used by the profession at that time were made. No evidence of unfavorable reaction occurred until the end of the fifth week, at which time the treatment was stopped. It appears from the evidence that the treatment was administered scientifically and carefully, and that the results which followed could not have been anticipated. The treatment was proper under all of the circumstances. The unfortunate consequence was not the result of negligence.

Judgment will be for the defendants.

State Building.

MALCOLM H. MERRILL,
San Francisco.

Knowledge of disease has now advanced so far that it is very often desirable to treat the patient before he knows that he is sick. People stricken with acute disease hasten to their doctor for aid. Those suffering from a chronic disease of insidious onset tend to put off their visit to a doctor and to seek relief by self-treatment. Yet we know that, in many diseases, the best hope for cure depends on early treatment, treatment even before the symptoms appear. This is not only true of tuberculosis, but of several other diseases, including the two at the top of the list of causes of death, cancer and heart disease. It is true of diabetes, of many cases of syphilis, and of certain kidney diseases which though so slight as to be overlooked may cause high blood pressure later on. An attempt has been made by the American Medical Association to adjust the private practice of medicine to this situation, but periodic medical examinations have not been widely accepted.—J. Rosslyn Earp, M. D., *Health News,* May, 1940.

Two American Physicians Are Honored by Special Postage Stamp Issue.—The benevolent character of the service which physicians give to suffering humanity is typified by the general practitioner of medicine and the army medical officer thus memorialized, *The Journal of the American Medical Association* says, in commenting on an announcement by the Post Office Department that the late Major Walter Reed, M. D., of the Army Medical Corps, and Crawford W. Long, M. D., of Georgia, will be among those honored in a famous American series of postage stamps to be issued soon.

"Although other names might well have been added to this brief list, no one will deny that the two selected fully merit this honor," *The Journal* says. "Our Eastern shores and many of our cities were invaded some ninety-five times by yellow fever before Doctors Reed, Carroll, Agramonte, and Lazear conducted experiments in Cuba which demonstrated that yellow fever is transmitted by the bites of certain species of mosquitoes. Yellow fever had been present in the Western Hemisphere for at least three hundred years and had caused tens of thousands of deaths. Following this discovery by Walter Reed and his associates in 1900, yellow fever soon disappeared from North America and has never returned. Dr. Crawford W. Long, a general practitioner of medicine, on March 30, 1842, first used sulfuric ether as an anesthetic during the performance of a surgical operation. Doctor Long performed this operation on James M. Venable in Jefferson, Jackson County, Georgia, a small town then many miles from a railroad."

The Journal called attention last year to the disparity between the number of physicians in other countries who had been honored by special issues of postage stamps and the number so honored in the United States.

ORIGINAL ARTICLES

GAS CHANGES IN MATERNAL AND FETAL BLOOD DURING CYCLOPROPANE OBSTETRIC ANESTHESIA*

By E. A. ROVENSTINE, M. D.
JOHN ADRIANI, M. D.
AND
W. E. STUDDIFORD, M. D.
New York, N. Y.

MORE than ninety-three years have passed since the first obstetric anesthesia. During all of this time there has been a constant search for the ideal anesthetic, or analgesic drug, to relieve pain associated with childbirth. The lack of agreement in the voluminous literature that has been accumulated on the subject is evidence that the search must go on.

In nearly a century of experimenting, many drugs have been recommended enthusiastically and many unwarranted claims have been made, but no drug is definitely established today as being superior to all others. In fact, it is not unreasonable to cast considerable doubt on any claim that there is a safer drug available than ether, which Simpson gave during the first obstetric delivery with anesthesia.

Other surgical procedures have been more fortunate in so far as efforts to improve anesthesia for their more satisfactory and convenient completion are concerned. But it is not strange that obstetric anesthesia has not kept pace with other advances in the specialty. The obstetrical patient presents certain problems that are apart from those of surgery in general. Firstly, there are the lives of two individuals to be considered when anesthetic drugs are administered during childbirth. This, in itself, would not be greatly significant were it not true that in one of them the physiological relationships are not only decidedly different, but are poorly defined. Secondly, the physiology of the pregnant uterus is readily influenced by drugs administered to relieve the pains associated with its contractions. Thirdly, physiological variations from the normal female are always encountered to complicate the whole procedure.

When maternal welfare is placed above that of a nonviable fetus, no more perplexing problems are presented than are regularly encountered with surgical anesthesia. Fortunately, these cases are rare. Most often the efforts at maternal pain relief must be made with the more important consideration of delivering an uninjured fetus.

All drugs producing analgesia or anesthesia must, in some way, alter or interrupt the processes of cell metabolism. This alteration, if carried out to a certain degree, results in irreversible cell activity. Therefore, no drug for this purpose falls without the classification of a protoplasmic poison.

---

* Read before the joint meeting of the sections on Anesthesiology and Obstetrics and Gynecology of the California Medical Association at the sixty-ninth annual session, Coronado, May 6-9, 1940.

From the Division of Surgery, Departments of Anesthesia, and Obstetrics and Gynecology, New York University College of Medicine, New York, N. Y.

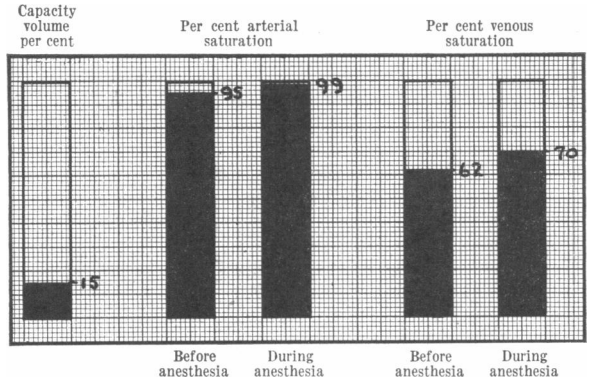

Fig. 1.—Maternal blood oxygen.

Drug poisoning is, of course, both quantitative and qualitative, depending upon the drug and the cell. Drugs given to pregnant women are being exposed to two types of cells: the maternal, which may react in one way, and the fetal, which may react differently. At the present time there is considerable speculation in explaining drug action on the maternal cell. There is scarcely enough evidence even to speculate on the action of drugs on the cells of the fetus.

New drugs and new methods, as they are introduced for obstetric anesthesia, gain popularity with certain individuals. Others may use them for want of something better or because of their convenience. No new drugs are employed because their pharmacological action is established as being safer or more desirable for both mother and fetus. The laboratory studies that might establish these criteria are not easily completed. The clinical observations, to which the final appeal must be made for any drug, lend themselves more readily to forming impressions than to accurate interpretations.

CYCLOPROPANE

Cyclopropane is one of the more recent drugs recommended for obstetric anesthesia. It was to be expected that this gas would be received enthusiastically, since it has many properties which suggest it might overcome certain objections to other agents in use. The potency of this gas was among the most important of these properties. Its administration may be carried out with very high oxygen dilution. Since no cause of neonatal death has been stressed more than asphyxia, the high oxygen in cyclopropane mixtures seemed very desirable. It has been determined that the fetus *in utero* is in a state of asphyxia. Whereas the arterial blood of the normal adult is saturated to about 95 per cent of its capacity, that of the fetus is often not more than half as well saturated. The fetus is also in a state of acidosis, with a high carbon dioxid tension in its blood.[1] Moreover, these biochemical differences from the adult are exaggerated in infants with asphyxia neonatorum. They are also augmented by anesthesia associated with low oxygen tensions, as is had with nitrous oxid-oxygen mixtures. These facts have made oxygen an urgent necessity in the prevention and treatment of fetal asphyxia. It was the logical inference that a small amount of cyclopropane, mixed with much oxygen, would eliminate the danger of reducing the fetal blood oxygen during anesthesia.

The first clinical report of the use of cyclopropane in obstetrics was conservative in its claims, since it was realized that many experiments, long clinical trial, and much statistical data must accumulate to establish the merits of any drug.[2] A more generous endorsement followed the widespread use of cyclopropane throughout the country. However, cyclopropane has about passed through the early wave of enthusiasm, and it may be said to be now in the stage of critical evaluation and experimental investigation. Its proper place, however, in obstetrical anesthesia is yet to be determined. Years of accumulated information may be needed to establish that place.

There is considerable clinical and laboratory evidence accumulated to guide in the proper use of cyclopropane for the mother. It may be expected, in competent hands, to produce anesthesia even in the unpremedicated patient, rapidly and pleasantly when concentrations as low as 15 per cent are administered. The presence of respiratory infections need not give alarming concern, since their severity probably will not be increased with cyclopropane. The gas undergoes no change in the body and is eliminated almost entirely by the lungs. After a few minutes of anesthesia, the venous blood concentration of cyclopropane approaches the arterial. This average figure is 15 milligrams per 100 cubic centimeters during second-plane anesthesia. Complete body saturation does not occur at this time, but requires two or more hours. Desaturation requires a similar time, and most of the agent is eliminated in less than ten minutes with but traces in the blood for two hours. The rapid elimination permits rapid recovery and the return of normal reflex activity. The incidence of vomiting during cyclopropane anesthesia induction is less than with volatile agents. The gas does not stimulate respirations and respiratory arrest precedes circulatory paralysis. The effects of the drug upon the circulatory system are the subject of an important controversy. Cardiac arrhythmias are not uncommon and their etiologic mechanism is not established.

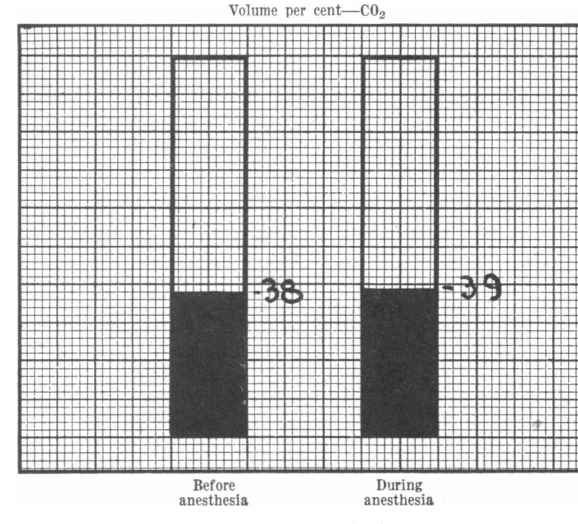

Fig. 2.—Maternal blood.

However, patients without serious pre-anesthetic arrhythmias need not be expected to develop them during cyclopropane anesthesia.

The effects of cyclopropane upon the liver of the pregnant woman are interesting, since even in the presence of toxemia the excretion of dyes used for liver function tests is unchanged by cyclopropane. Cyclopropane, in contradistinction to other inhalation anesthetic agents, does not alter the acid-base balance or decrease the p^H of the blood. The total base, the nonprotein nitrogen, the sugar and combining power of the blood are not changed by cyclopropane in the normal pregnant woman.

The effects of the drug upon the uterus have been carefully studied.[3] The frequency and duration of uterine contractions are not affected by cyclopropane. The strength of contractions which are markedly reduced with ether and chloroform are unaffected by cyclopropane. The contribution of the abdominal muscles to the intra-uterine pressure is reduced with the gas or any other narcotic drug. The effective arterial pressure which irrigates the placenta is increased with cyclopropane, and other anesthetics. Clinical observations have suggested that light cyclopropane increases uterine tone, and that even though tone is decreased with deep anesthesia the uterus contracts rapidly and strongly during recovery.

The effects of cyclopropane upon the fetus cannot be set down with confidence. Laboratory studies are scarce, incomplete and difficult of interpretation. It is established that cyclopropane, like other narcotics and hypnotics, passes from the maternal to the fetal circulation. The changes from normal blood gas tensions that occur have been reported by Smith[4] and studied here.

EXPERIMENTAL METHOD

The initial problem that required solution in this study was the selection of a convenient method for collecting blood samples containing cyclopropane. Because of the marked solubility of the gas in oil, the familiar methods could not be used. A simple syringe method of collecting blood anaerobically and storing it over mercury was devised by one of us (J. A.).[5] This method was later adopted and used by Smith[4] to carry out his work with cyclopropane.

All available types of obstetrical cases were studied. No pre-anesthetic medication was given.

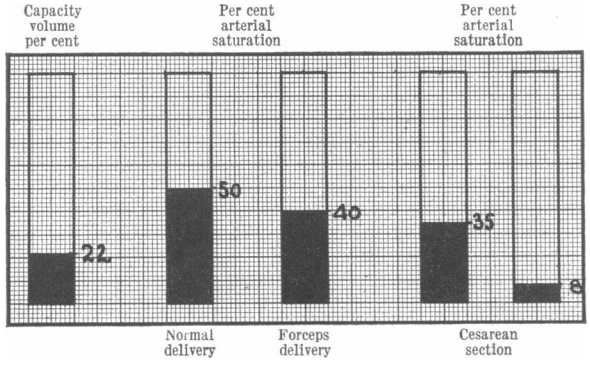

Fig. 3.—Fetal blood oxygen.

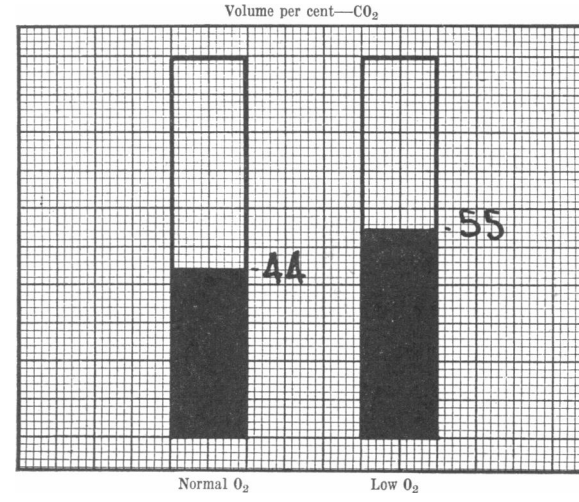

Fig. 4.—Fetal blood.

Anesthesia was administered by physicians specializing in anesthesia. The closed or carbon dioxid absorption technique was utilized. Induction was accomplished with the carbon dioxid absorber in use. A mixture of 25 per cent cyclopropane and 75 per cent oxygen was first administered. After anesthesia was established it was maintained in the second plane of the third stage. A pharyngeal airway was inserted when required. Before anesthesia was induced, a specimen of maternal blood was collected from the radial or brachial artery, or in some cases from an arm vein. Immediately after delivery two Kocher clamps were placed about two inches apart close to the baby. Simultaneously another pair were placed close to the vulva. By cutting between them, a segment of cord was obtained. Blood from the infant was always taken before the onset of respirations. Enough arterial blood was removed from the umbilical vein to permit analysis for total carbon dioxid, oxygen, and cyclopropane. At approximately the moment the cord was clamped another material arm specimen was obtained. At cesarean section a segment of cord was obtained as soon as the uterus was incised in the same manner as during normal deliveries. The blood was analyzed as soon as possible after collection. The total carbon dioxid and oxygen contents were determined by the standard technique on the constant volume manometric apparatus of Van Slyke and Niell. Cyclopropane was determined on the manometer by the method described by Orcutt and Waters.[6] The oxygen capacity was determined by aerating 3 to 4 cubic centimeters of blood for fifteen minutes in a separatory funnel rotated at a high speed, and determining the total oxygen by the manometric method.

RESULTS

The cases studied include normal deliveries (6), forceps deliveries (12), and cesarean sections (18). The oxygen capacity of the maternal blood was found to be approximately the same in all patients, averaging 15 volumes per cent. The total carbon dioxid of the maternal arterial blood averaged 38 volumes per cent. There was an increase of 1 to 2 volumes per cent carbon dioxid in some patients,

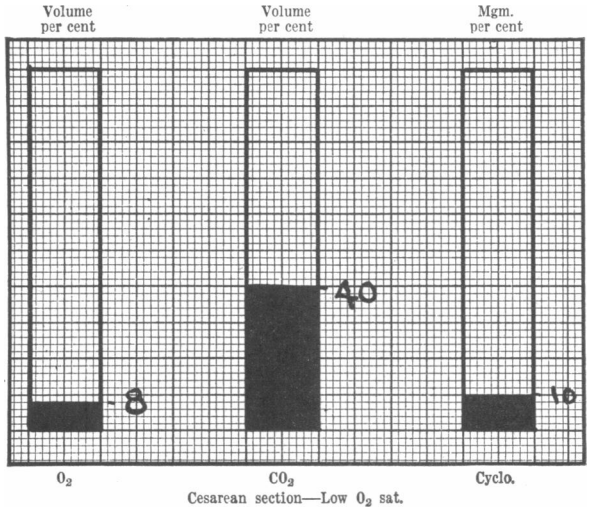

Fig. 5.—Fetal blood.

and a decrease of about one volume per cent in others during anesthesia.

The oxygen content of the venous blood varied widely (20 to 80 per cent saturation) before anesthesia. During anesthesia the venous blood oxygen saturation was always raised. The average for the series was 65 per cent saturation before and 70 per cent during anesthesia. The venous blood oxygen approached nearer the figure for arterial saturation in the cases with more prolonged anesthesia. It has been noted before that the difference in oxygen saturation of arterial and venous blood was less during cyclopropane than with other anesthetic mixtures. Although this phenomena has been explained on the basis of the high oxygen concentration given, it is quite likely that the action of cyclopropane is largely responsible. The gas may have an effect upon the contractile mechanism of capillaries. This same effect may account for the increased bleeding or oozing from cut surfaces that is often associated with cyclopropane anesthesia.

The oxygen content of the arterial blood of the mothers averaged 95 per cent saturation before anesthesia. There was a constant increase to 99 or 100 per cent saturation in all patients during anesthesia.

The oxygen capacity of the fetal blood was higher than the maternal. For all the cases it averaged 22 volumes per cent. This difference may be explained, partially at least, on the basis of the difference between maternal and fetal hemoglobin. The oxygen content of the fetal arterial blood varied with the type of delivery. In normal deliveries, the average was 11 volumes per cent or approximately 50 per cent saturation. This is slightly lower than the values given by Eastman for arterial blood of babies delivered from unanesthetized mothers. When delivery was accomplished with forceps and the anesthesia more prolonged (average 15 minutes), the oxygen content of the arterial fetal blood was lower, having as an average 40 per cent saturation. The studies made during cesarean sections had to be classified into two groups. In ten of these cases oxygenation approximated the values found in other deliveries averaging 35 per cent saturation. In the others the oxygen content was very low, amounting to only one volume per cent in the lowest recorded. The average figure in this latter series of eight cases was approximately 8 per cent arterial blood oxygen saturation. The reason for this wide variation in oxygenation of the two groups of cesarean sections could not be determined. There was some correlation with the elapsed time from incision of the uterus and delivery of the baby. When delivery was promptly completed after opening the uterus, the oxygenation of the fetal arterial blood was low. When there was a delay of five or more minutes after incision of the uterus before the baby was delivered, the oxygenation was higher. It would not be unreasonable to assume that mechanical stimulation of the uterus during cyclopropane anesthesia may cause a reflex contraction of this muscle and interfere with oxygenation of the fetus. If delivery is delayed, the reflex stimulation may be lost and better oxygenation ensue. During studies on experimental animals, Barcroft found that the oxygen content of the umbilical vein varied with

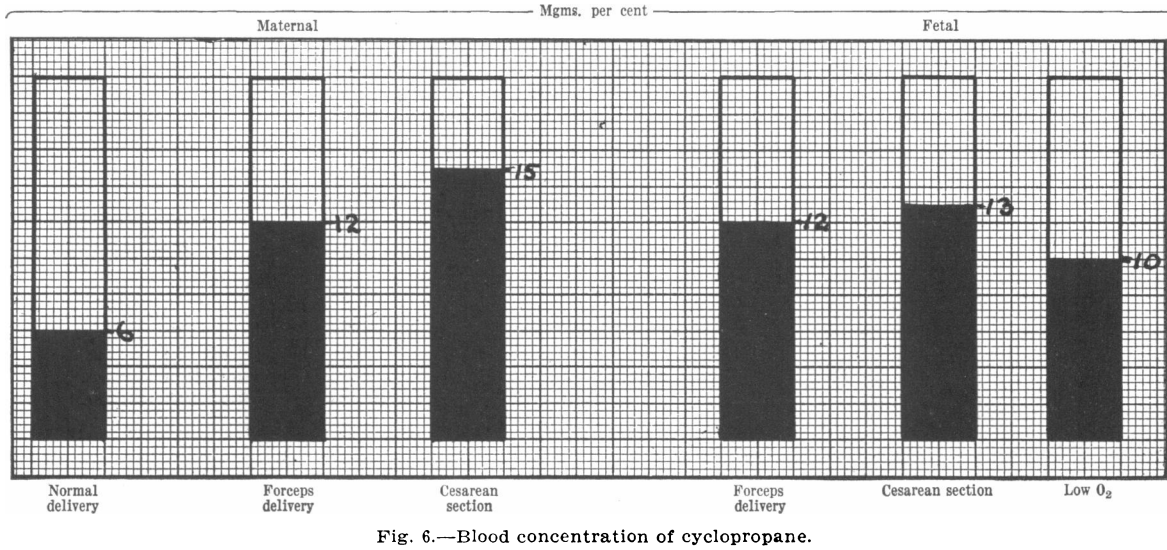

Fig. 6.—Blood concentration of cyclopropane.

the technique employed and the elapsed time in which the cesarean section was performed.

In these studies there was no correlation between the oxygen content of fetal arterial blood and the period of gestation. Whether or not the mothers were in labor at the time of operation seemingly had no influence upon fetal blood oxygenation. The average carbon dioxid content of arterial fetal blood of those cases with adequate oxygenation was 44 volumes per cent. In babies with low oxygen content the carbon dioxid was considerably higher, reaching values up to 60 and averaging 55 volumes per cent. The values found by Eastman in unanesthetized babies were approximately 44 volumes per cent.[1]

The cyclopropane content of the maternal blood varied with the duration of anesthesia. In normal deliveries the range was from 5 to 12 milligrams per 100 cubic centimeters of blood. When forceps were used and anesthesia prolonged, the arterial cyclopropane averaged approximately 14 milligrams per 100 cubic centimeters. This value was slightly higher in cesarean sections, averaging 15 milligrams per 100 cubic centimeters. The cyclopropane content of the fetal arterial blood varied, likewise, with the depth and duration of anesthesia. In normal deliveries the range was from 2 to 8 milligrams per 100 cubic centimeters, while in those done with forceps the average was approximately 12 milligrams per 100 cubic centimeters. The highest values for cyclopropane in fetal blood were in cesarean sections which averaged 13 milligrams per 100 cubic centimeters. The cyclopropane content of the arterial blood of the fetus was found to be considerably lower in babies with low oxygen saturation than in those that were oxygenated. It was interesting to find a high carbon dioxid content with a low oxygen and low cyclopropane content. It suggests an interference in the transfer of gases from the mother to the fetus. Asphyxia may alter placental permeability so that cyclopropane and oxygen are not so readily transported to the fetus, and similarly carbon dioxid is less easily transferred to the maternal circulation.

This study was undertaken primarily to learn the effects of cyclopropane anesthesia upon the saturation of fetal blood with oxygen and carbon dioxid. It was presumed that changes in the concentrations of blood gases would have an effect upon the initiation of respiratory efforts of the newborn. In this small group of cases no such correlation could be made.

In some cases with a very low oxygen saturation the initiation of respiration was prompt, while in others with similar oxygen content beginning respirations were delayed as much as eight to ten minutes. In normal deliveries the initiation of respiration was immediate in all six cases. In these the cyclopropane concentrations in the fetal blood were lower than in the other group.

One would hesitate to argue from these results that anoxemia at birth was unrelated to asphyxia neonatorum. The evidence already accumulated by Eastman,[1] Wilson,[7] and others cannot be refuted. It would not be logical to conclude that cyclopropane in the fetal blood delays the initial respiratory effort. Babies with 15 milligrams of cyclopropane per 100 cubic centimeters of blood breathed promptly. It can be stated, however, that this study adds to the accumulated indications that several factors influence the onset of respiration. It is almost certain that low oxygen saturation of fetal blood at birth is one of the more prominent of these factors, and it is not unlikely that high concentrations of cyclopropane in the blood may be another.

The data collected in this study are of little value in determining the effects of cyclopropane upon the fetus. The gas is promptly eliminated from the maternal blood and tissues, and it is not unreasonable to assume it is the same from fetal tissues, since elimination of inert gases follow physicochemical principles. The effect of cyclopropane upon fetal nervous tissue and reflexes is still unknown. The effect of cyclopropane on the fetal respiratory mechanism and the mechanism which initiates respiration is certainly not known.

Any procedure or drug which interferes with placental circulation during or before birth should be used cautiously and judiciously. In all analyses completed there was a lowering of the oxygen content of the arterial blood of the fetus at the moment of birth during cyclopropane anesthesia. This does not contraindicate the use of the drug, but it would seem to suggest that when cyclopropane anesthesia is employed for obstetrical patients the degree of narcosis should be carefully adjusted. In this clinic such anesthesia is never deliberately carried beyond second plane third stage.

SUMMARY

The oxygen, carbon dioxid, and cyclopropane content of arterial and venous blood from the mother and infant has been determined during administration of cyclopropane anesthesia for delivery. Deliveries completed spontaneously, with forceps and by cesarean section, were included.

The maternal blood oxygen content was found to be increased, and the carbon dioxid content little altered with cyclopropane anesthesia. Cyclopropane was present in the fetal blood in concentrations approaching those of the mother. The fetal blood oxygen content at birth varied widely in the different cases studied. It was not found to be more than the oxygen content reported from studies of fetal blood completed without maternal anesthesia. The variations in oxygen content of fetal blood could not be correlated definitely with other factors involved in delivery. There was no direct correlation between the oxygen or cyclopropane saturation of fetal blood and the initiation of respiratory activity.

The data collected could not be interpreted in favor or against the use of cyclopropane for obstetric anesthesia. It did suggest that when it is used the degree of narcosis should not exceed the upper planes of the surgical stage.

477 First Avenue.

REFERENCES

1. Eastman, N. J.: Asphyxia Neonatorum, Internat. Clin., 2: 274-300 (June), 1936.

2. Waters, R. M., and Schmidt, E. R.: Cyclopropane Anesthesia, J. A. M. A., 103:975-983 (Sept. 29), 1934.

3. Woodbury, R. A., Hamilton, W. F., and Torpin, R.: Relationship Between Abdominal, Uterine, and Arterial Pressures During Labor, Am. J. Physiol., 121: 640-649 (March), 1938.

4. Smith, C.: Cyclopropane in Obstetrics, Surg. Gynec., and Obst., 69:584, 1939.
5. Adriani, J.: Method for Collecting Blood for Gas Analysis, J. Lab. and Clin. Med., 23: 1094-1096 (July), 1938.
6. Orcutt, F. S., Waters, R. M.: Method for Determination Cyclopropane, Ethylene and Nitrous Oxid in Blood with Van Slyke-Neill Manometric Apparatus, J. Biol. Chem., 117: 509-515 (Feb.), 1937.
7. Wilson, R. A., Torrey, M. A., Johnson, K. S.: Initiation of Respiration in Asphyxia Neonatorum, Clinical and Experimental Study Incorporating Fetal Blood Analyses, Surg., Gynec., and Obst., 65: 601-622 (Nov.), 1937.

AMPUTATION THROUGH THE LOWER THIRD OF THE FEMUR: A MODIFIED TECHNIQUE*

By CLARENCE E. REES, M. D.
San Diego

PATIENTS upon whom it is necessary to perform amputations above the knee are often poor surgical risks. The vascular disease resulting in gangrene of the lower extremity, is only one part of a generalized process which may also have caused degenerative changes in the heart, brain, and kidneys. If diabetes is present, the susceptibility to infection is increased—a danger which, in any case, is great because of the bacteria in the lymphatic drainage of the necrotic area. In these patients, therefore, the plan of the operation and the manner in which it is performed, may determine whether the amputation is a life-saving or a life-taking measure.

SURGICAL PRINCIPLES

Certain surgical principles, which in the good-risk patient may be considered more lightly, must be strictly observed. The operation must provide for (1) the maintenance of maximum blood supply to all parts of the stump; (2) accurate hemostasis; (3) a minimum amount of devitalized tissue in the wound; (4) reduction to a minimum of the amount of foreign material allowed to remain in the wound; (5) avoidance of muscle tissue; and (6) elimination of tension in the closure of all soft tissues.

Any present-day amputation can be but a modification of procedures that have previously been described, and any such modification has for its goal improved technique and end-results. I wish to present a procedure for amputation above the knee which, I believe, (1) simplifies the performance; (2) assures more strict observance of the surgical principles just listed; and (3) produces a most satisfactory stump.

AUTHOR'S MODIFICATION

The operation is performed with the patient in the prone position. By this means the important vascular structures of the posterior thigh are brought into easy surgical accessibility. Sandbags are placed under the upper part of the thigh to elevate the knee three or four inches from the table. The lower one-half of the thigh and the upper one-third of the leg are surgically prepared, and the lower part of the leg and foot are wrapped in sterile dressings to avoid contamination of the wound when the knee is flexed. The entire area is then brought through the opening of a laparotomy sheet so that free motion of the knee is permitted throughout the operation.

With the knee flexed at a right angle, an incision which extends to the deep fascia is made around the leg at a level corresponding to the lower end of the tibial tubercle. The ligamentum patella is incised transversely. The joint capsule is incised on each side of the patella to a level above the upper margin of the patella into the suprapatellar bursa, and the anterior superficial structures are separated from the capsule of the knee joint. The tendon of the biceps femoris is detached from the head of the fibula, by a crosswise incision close to the bone. The tendinous attachments of the semitendinosus, semimembranosus gracilis, and sartorius muscles are detached from the medial tuberosity of the tibia. The knee is extended and the popliteal space is opened in the line of incision. The popliteal space is exposed by retraction en masse of

* Chairman's address. Read before the Section on General Surgery of the California Medical Association at the sixty-ninth annual session, Coronado, May 6-9, 1940.
From the Rees-Stealy Clinic.

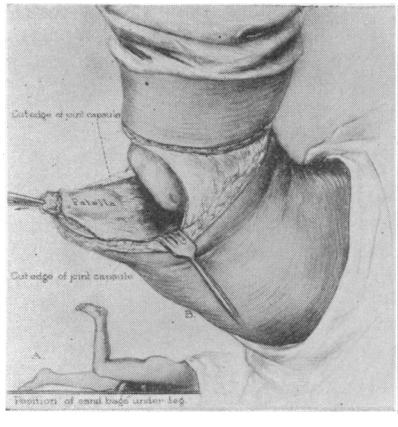

Fig. 1

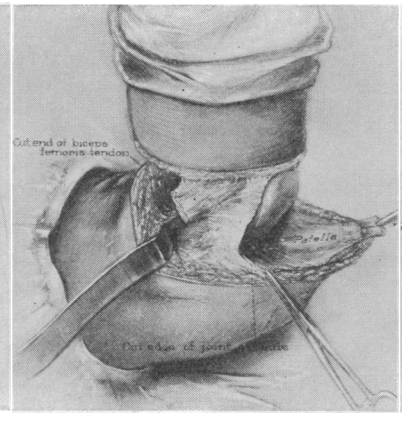

Fig. 2

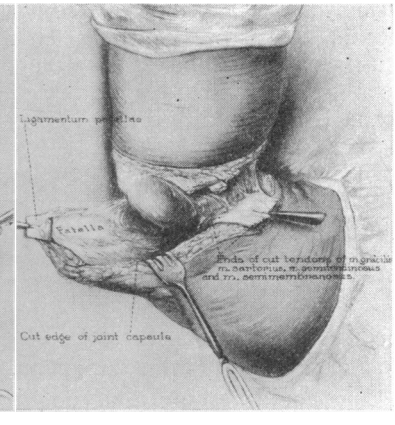

Fig. 3

Fig. 1—(*a*) Patient in prone position with sandbags under thigh. (*b*) Circular incision to the deep fascia at level of lower border of tibial tubercle. Patellar ligament detached. Incision of joint capsule over suprapatellar bursa.
Fig. 2.—Lateral view. Detachment of biceps tendon from head of fibula.
Fig. 3.—Medial view. Detachment of semitendinosus, semimembranosus, gracilis, and sartorius muscles from head of tibia.