A case of total laryngectomy (unsuccessful) and a case of abdominal hysterectomy (successful) : in both of which massage of the heart for chloroform collapse was employed, with notes of 25 other cases of cardiac massage / by W.W. Keen.

A Case of Total Laryngectomy (Unsuccessful) and a Case of Abdominal Hysterectomy (Successful), in Both of which Massage of the Heart for Chloroform Collapse was Employed, with Notes of 25 Other Cases of Cardiac Massage

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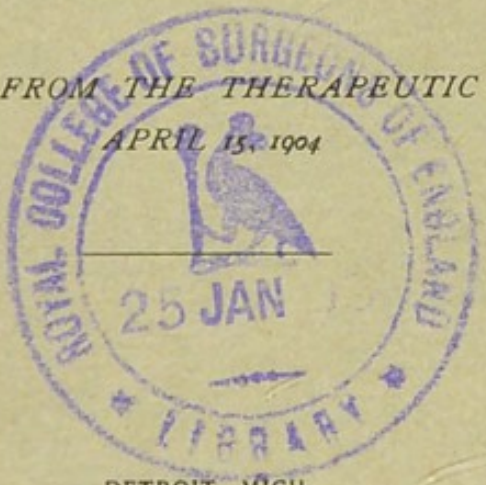

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A CASE OF TOTAL LARYNGECTOMY (UNSUCCESSFUL) AND A CASE OF ABDOMINAL HYSTERECTOMY (SUCCESSFUL), IN BOTH OF WHICH MASSAGE OF THE HEART FOR CHLOROFORM COLLAPSE WAS EMPLOYED, WITH NOTES OF 25 OTHER CASES OF CARDIAC MASSAGE.

By W. W. Keen, M.D., LL.D., F.R.C.S. (Hon.).

A fatal result during an operation is so rare that such cases should be reported, together with the means employed for resuscitation of the patient, especially when the means are novel. On only three occasions in my entire professional life have I been so unfortunate as to have a patient die on the table. The first two were respectively cases of operation on the brain and goitre. In both of these cases hemorrhage was the cause of death, and all the usual means were unavailing.

The third case of death on the table and the first case of massage of the heart here reported is of more than usual interest not only on account of the method employed for resuscitation, though, unfortunately, it was unavailing, but because of the prior fracture of the skull with entire recovery from mental as well as physical symptoms.

The notes of the second case have been kindly sent me by Dr. Kristian Igelsrud,

of Tromsö, Norway. He was present when I operated upon the first case, and as I was greatly interested in the account of his own case, I requested him to let me have the notes for publication, which he has kindly done.

CASE I (KEEN).—*Fracture of the skull followed by aphasia and partial loss of word memory; trephining; restoration of speech; recurrent hoarseness; development of squamous epithelioma of both vocal chords; unilateral laryngectomy; recovery; total laryngectomy; death from chloroform collapse; ineffectual attempt to restore life by massage of the heart.*

The patient, John H., was first seen December 13, 1902, at the instance of Dr. Charles E. McGirk of Phillipsburg, Pa., and Drs. B. Alex. Randall and Walter J. Freeman of this city. These gentlemen furnished me with the following facts: Prior to the accident about to be described he had always enjoyed good health, and had never suffered from hoarseness or any other trouble with his speech. In 1900, about two years before I saw him, he was struck on the left side of the head by a piece of paving brick thrown by accident, causing a fracture of the skull. Dr. McGirk writes me that his father, Dr. J. D. McGirk, saw him about twenty minutes after the accident, found him partially conscious, but unable to speak, and made the remark that he was drunk. The patient, however, by signs conveyed to Dr. McGirk that he wanted paper and pencil,

and upon this being furnished, he wrote that he was not drunk, but had been hit with a brick on the head. Dr. Charles E. McGirk saw him the next day, "when he could articulate words with great difficulty, and was suffering from motor aphasia and partial loss of word memory. He was unable to say many words, especially those beginning with 'b,' even after repeated trials. He would be talking and stop in the middle of a sentence, unable to proceed for some seconds on account of his inability to speak the remaining words, but knowing perfectly what he wished to say. Finally memory returned to him and he would complete the sentence. Along with this disturbance of speech slight hoarseness appeared, but about two months after the accident the hoarseness disappeared while the aphasia still remained." Dr. McGirk believes that the temporary hoarseness immediately after the accident was due to partial paralysis of the vocal chord, and that this may have had some influence in the later carcinomatous development.

"Some time prior to September, 1902, probably in June or July, hoarseness reappeared, and from this time the hoarseness became gradually worse, though it never caused him any dyspnea."

In September, 1902, the patient again consulted Dr. Chas. E. McGirk, who found a marked depression at the site of the old injury, and on October 3, 1902, trephined and removed the depressed bone

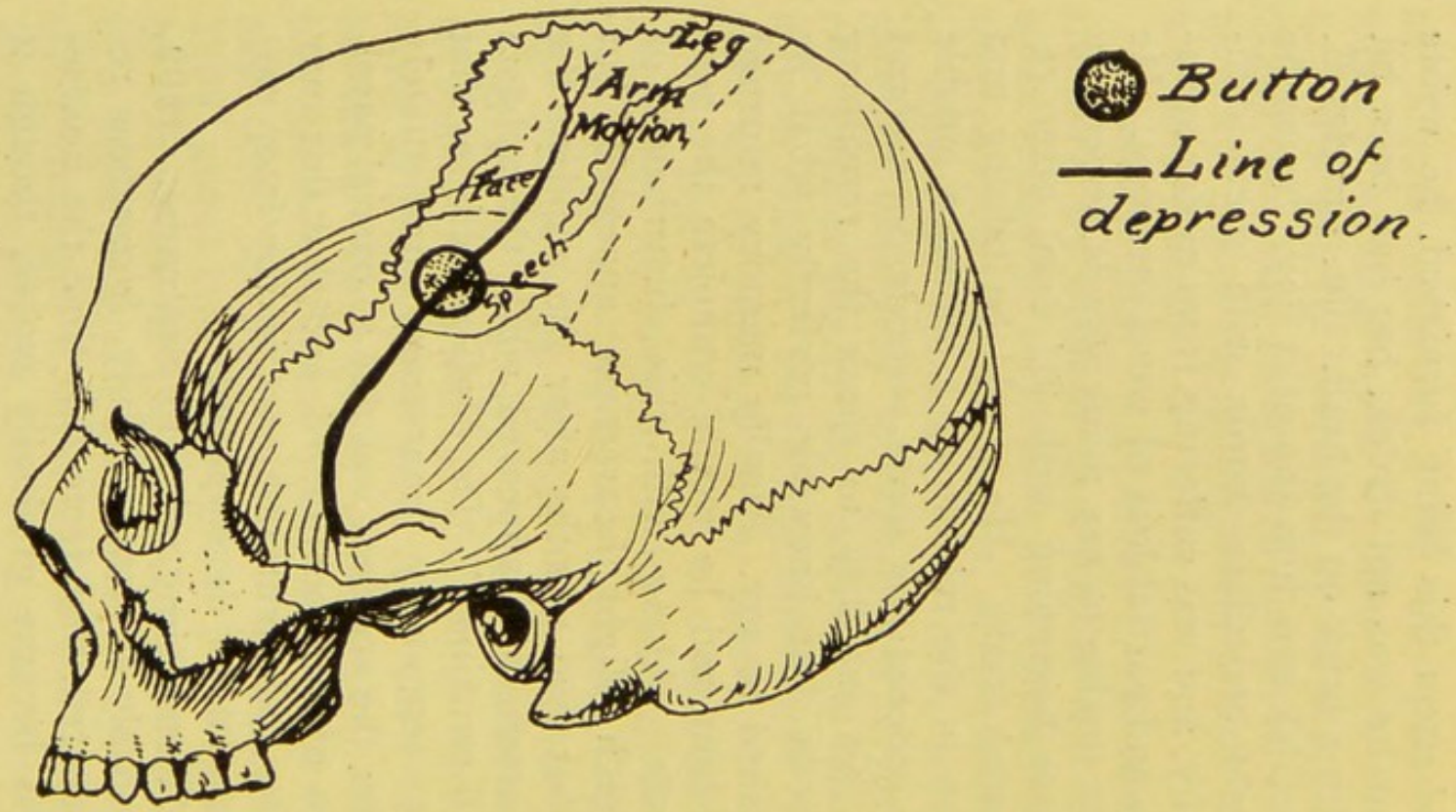

FIG. 1.—Showing the line of depression and the site of the button of bone removed (McGirk).

(Figs. 1 and 2). Dr. McGirk reports that "the depression extended from before backward and was about one and a half inches in length, the deepest depression being about its middle, and extended over the lower portion of the anterior and posterior central convolutions. The inner surface shows the groove for the middle meningeal artery and also the fractured inner surface. The external surface shows

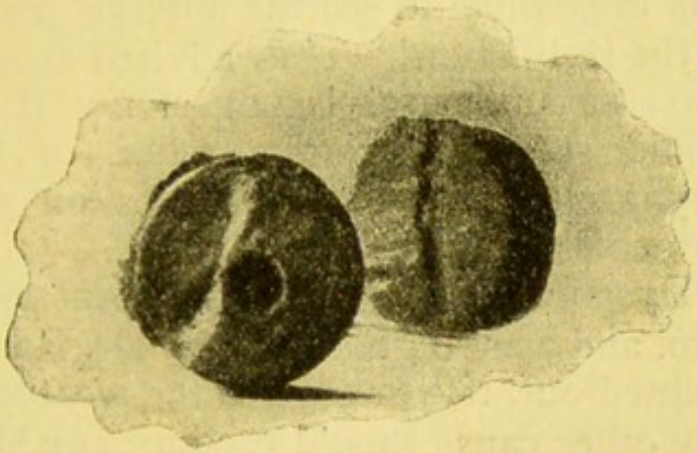

FIG. 2.—Photograph of the button of bone. The left-hand figure shows the external surface and the depression caused by the blow. The right-hand figure shows (by a mirror) the internal surface, the fracture and depression of the bone, and the groove for the middle meningeal artery.

a very marked depression of the skull. He was anesthetized with ether and oxygen. He took the anesthetic with great difficulty, and was cyanotic to a greater or less degree during the entire operation." He made an uneventful convalescence; word memory returned in two weeks, but his hoarseness remained, as well as soreness, which had become worse within the prior four or five weeks. Finding that the throat condition was growing worse,

with marked dyspnea, Dr. McGirk had him consult Dr. Randall December 4, 1902, and Dr. Randall asked Dr. Freeman to see him. They examined the larynx carefully and determined that "the rough, enlarged left vocal chord extended beyond the middle line and presented outgrowths, which are almost certainly epitheliomatous. There is little evidence of glandular involvement" (Randall). It was impossible to see the anterior portion of the right chord. They advised an operation—a unilateral laryngectomy if this would seem to promise relief, or total laryngectomy should the operation show its necessity.

Dyspnea was a very prominent symptom, and was so great that, as Dr. Randall pointed out, if exposure to the weather or any other cause should produce any slight increase in the obstruction to breathing, an instant tracheotomy would have to be done. This would be extremely difficult. The man weighed nearly 200 pounds, his neck was short and thick, and the trachea, of course, was very deeply situated.

First operation, unilateral laryngectomy, December 16, 1902. Drs. McGirk, Randall, and Freeman were kindly present. Drs. Stewart and Craig assisted me at the operation, and Dr. Spencer gave the anesthetic. In view of Dr. McGirk's experience with the anesthetic at the former operation and of the existing excessive dyspnea, I feared that a general anesthetic would cause such sudden in-

crease of dyspnea from spasm that instantaneous tracheotomy would be necessary. I decided, therefore, to operate under local anesthesia until I could split the thyroid, and by opening it widely determine whether unilateral or complete laryngectomy would have to be done. This plan was carried out, the patient being in the Trendelenburg position. He suffered but little pain, but as soon as the larynx was widely open began to cough so constantly and violently that it was very difficult to make any accurate observation. Finally, however, we were able to ascertain clearly that the entire left vocal chord was diseased, and that a very small part of the anterior end of the right vocal chord undoubtedly was thickened, and I suspected a beginning disease there. On consultation, however, we deemed that unilateral laryngectomy, together with removal of the anterior end of the right chord, would be a sufficiently radical operation. Accordingly I removed, first, the anterior portion of the right chord without trouble. On attempting to separate the soft parts on the left side of the larynx from the thyroid cartilage, he felt so much pain in spite of the local anesthesia that I decided to give him some chloroform. This was done by means of the von Esmarch mask over the mouth and nose, with an additional piece of gauze over the laryngeal opening. He struggled a great deal. It was impossible to get him quieted with the chloroform sufficiently to go on

with the operation without producing such cyanosis as to render Dr. Spencer and myself very anxious. The partial laryngectomy, however, was finally effected under very great difficulties; part of the time he was struggling and part of the time, though quiet, he was cyanotic. I then placed a tracheotomy tube above the cricoid and closed the wound. He made a perfectly smooth and good recovery in spite of the fact that the wound necessarily communicated with the fluids of the mouth. Prior to the operation, and also during convalescence, the mouth, nose, and laryngeal wound had been sprayed with hot listerine and boric acid every two hours while he was awake. His temperature only rose above 99° for two days, the fourth and fifth, and it reached 99.8° on one occasion only. The tracheotomy tube was removed on the fifth day, and he went home on the seventh day after the operation, the wound being almost healed.

Professor Coplin, to whom the specimens were given for examination, pronounced the disease a squamous epithelioma not only of the left chord, but also beginning to involve the right chord. Naturally, therefore, I looked forward with a great deal of anxiety to his future.

About the 20th of January, 1903, his dyspnea returned and rapidly increased. On the afternoon of February 4 he returned to the city, his dyspnea being so great that his wife was afraid he would die on the train. He was able, however,

to wait until February 6, the earliest date at which it was possible for me to do the operation.

Second operation, total laryngectomy, February 6. Anticipating the possibility of an instantaneous tracheotomy, chloroform and oxygen were given him, but not until he was upon the operating table. He was then placed in the Trendelenburg position, and I did a very low tracheotomy, but with a great deal of difficulty, because again, as before, when a moderate amount of chloroform was given he struggled, and when enough was given to keep him quiet he became so cyanosed as to make me very anxious even for his life. As soon as the tracheotomy was done, chloroform was given through a tube which was connected with a long rubber tube and the inhaler (Trendelenburg's apparatus). The larynx was then dissected out, the trachea divided at the first ring below the cricoid, and the entire remaining portion of the laryngeal box was removed. The hemorrhage gave a considerable amount of trouble, but was finally checked. I then sewed the anterior wall of the pharynx to the tissues around the hyoid bone and the upper end of the trachea to the skin. Just as I finished suturing the parts and was ready to close the wound, his pulse suddenly failed and his face became very blue. The operation and the administration of the chloroform were immediately stopped, pure oxygen was administered, 1/20 of a grain of strychnine was given hypoder-

mically, artificial respiration was instituted with rhythmical traction upon the tongue (although I doubted whether, in the absence of the larynx, this would be of any value), and the battery was applied over the phrenic. In spite of all of this his heart continued to beat much faster and weaker, he became more cyanotic, and in two to three minutes the heart ceased beating and he was dead. After continuing the above means as nearly as I could judge for ten minutes, as a last resort I opened the upper abdomen, introduced my hand into the abdominal cavity, and between this hand and the right hand, which made counterpressure on the anterior wall of the chest, I masséed the heart. These efforts were continued for nearly half an hour, but without avail.

Examination of the specimen by Professor Coplin and Dr. A. G. Ellis confirmed the diagnosis of epithelioma.

Case II (Igelsrud).—*Abdominal hysterectomy; chloroform collapse; massage of the heart; recovery.* Dr. Igelsrud calls attention to the fact that the case is not entirely convincing, for the ordinary means for resuscitation were only tried for three to four minutes, and also traction on the tongue was employed during massage of the heart. He states, however, his personal belief that the massage of the heart was the most effectual of all the means employed. (He has not given me the date of the operation, but it was prior to 1902, probably in 1901.)

"A thin, lean, rather cachectic woman, aged forty-three, with cancer of the uterus. Total abdominal hysterectomy was performed. When the operation was almost finished the patient passed into collapse; artificial respiration, lowering of the upper portion of the bed, faradization, and the other usual means were used for about three to four minutes. The heart was then laid bare by a resection of parts of the fourth and fifth ribs. The pericardium was opened and the heart seized between the thumb and fore and middle fingers on the anterior and posterior surfaces. Quite strong and rhythmical pressure was made for about one minute, when the heart began to pulsate of itself. Then observing that the pulsations were becoming weaker, massage of the heart was practiced for about one minute more. From that time the pulse was perceptible and the contractions of the heart became regular. Of course the estimate of time of the various stages is only approximate, as accurate observation of a timepiece is impossible under such circumstances. The patient was discharged from the hospital after five weeks."

REMARKS.

The physiologists led the way in efforts to reëstablish the pulsation of the heart, Schiff in 1874 being the first to succeed by means of rhythmical compression of the ventricles by the hand. At first defibrinated blood was injected, but later various

artificial fluids more or less resembling blood in their dissolved salts and specific gravity have given even better results. Finally the addition of 1 per cent of grape-sugar added to Locke's fluid was found to be the most desirable means.

The earlier experiments were made upon the heart retained in the body, but later hearts removed from the body even for a long time and even after being frozen were more or less successfully resuscitated. Not only was the effect of filling the heart with fluid tried, but direct massage of that organ was used.

In 1889 Prus, of Lemberg (*Wiener klin. Wochenschrift,* 1900, Nos. 20 and 21), made a new series of experiments upon dogs. He experimented upon forty-four dogs killed by asphyxia, twenty-one by chloroform, and thirty-five by electricity. His attempts to resuscitate them were sometimes begun as late as an hour after the heart had ceased to contract. He then seized the heart laid bare *in sutu* with the right hand, the thumb being applied on the right ventricle, and the other fingers on the left ventricle, when he instituted rhythmical movements. Out of the 100 experiments he was successful in reëstablishing contractions of the heart forty-seven times in a wholly normal manner after efforts varying from fifteen seconds to two hours, and eight times incompletely.

In 1900 Batelli (*Jl. de Physiol. et de Pathol. Gén.,* 1900, p. 443) made further

studies in the same direction. He was able to recall to life several dogs. Both he and Prus advocated the application of the method to man in case of cardiac arrest from chloroform asphyxia.

Kuliabko (*Arch. Gesammte Physiol.*, 1902, vol. xc, p. 461) established artificial circulation in a rabbit's heart which had been removed from the body. It was kept at a temperature of 40° C. and showed regular contractions. After an hour it was placed in an ice-chest for eighteen hours, when the experiment was repeated, and after less than half a minute the heart recommenced its rhythmical contractions around the openings of the vena cava. In half an hour fairly strong but rhythmical contractions of the right ventricle were observed, but none of the left. In four and a half hours the pulsations ceased. In another case after the heart had been kept twenty-four hours in ice, contractions were reëstablished, and in another case after forty-four hours pulsations continued for over three hours.

Kuliabko (*Centralblatt für Physiologie*, 1902, vol. xvi, p. 330) also reports that instead of the hearts from healthy animals which had been killed, he took the hearts from rabbits that had died, and even on the second, third, and fourth day after death, after a longer or shorter circulation of Locke's fluid, the isolated heart was made to pulsate again and continued to pulsate for several hours. In August, 1902, he tried the same experiment on

the heart of a boy three months old who had died from double pneumonia. Twenty hours after death the heart was removed from the body and Locke's fluid was used. For a long time the heart remained still, but finally after about twenty minutes feeble, long, rhythmical contractions of the auricle began, which later extended to the ventricle, and finally the entire heart began to pulsate and continued to do so for over an hour. Later he says that in a number of instances on the human heart as long as thirty hours after death pulsations were produced.

Velich (*Münch. med. Woch.*, Aug. 19, 1903, p. 1421) also placed a heart removed from a dog's body in snow for six hours, and was able to reëstablish contractions both in the auricle and ventricle. Again in a heart lying in snow for eighteen hours, and again after being frozen in salt solution for twenty-four hours, contractions of the auricle and even slight contractions of the ventricles were reëstablished.

Spina, of Prag, according to Velich's very interesting article, proposed a new and apparently less dangerous method, which so far as I know has not been adopted in man. Up to this time most of the attempts had been made by mechanical methods to start contractions of the heart together with various devices for the purpose of filling it. Spina injected into an artery (not a vein), in the direction toward the heart, a considerable quan-

tity of normal salt solution (200 cubic centimeters in a dog) at 35° to 40° C. Just before it reaches the cavity of the heart the fluid closes the aortic valves and finds its way into the coronary arteries, thus stimulating the heart muscle itself. In this way Spina and his pupils in many researches were able almost regularly to revive the action of the heart, both in animals in which the brain and cord had been destroyed and also in animals in which the heart's action had been arrested by poisoning with alcohol or other poisons. In one instance of a dog poisoned with nicotine he states that ten minutes after the heart had remained quiet artificial respiration was begun, and 200 cubic centimeters of normal salt solution with one per cent of grape-sugar were injected into the femoral artery in the direction of the heart. Even during the injection pulsations of the heart began. These became stronger, until the circulation was reëstablished as in a normal animal.

As early as 1896 Velich, and in 1899 Gottleib and Cleghorn, made experiments with adrenalin.

The latest experimenter in this direction is Crile, of Cleveland, in whose admirable study of "Blood-pressure in Surgery," just published, the results are fully given. He rightly calls attention to the fact that *we cannot expect to restore the apparently dead to life by resuscitation of the heart alone.* Not only must the heart

be made to beat, but the respiration must be reëstablished, and the vasomotor center must be stimulated into renewed activity. To massage of the heart, therefore, we must add artificial respiration, and to both of these the means to restore vasomotor activity. These means he has shown by experiment to be infusion of adrenalin in salt solution and the pneumatic rubber suit. By the above means, without the rubber suit, he has repeatedly resuscitated animals whose heart had entirely ceased to beat for fifteen minutes. The pneumatic rubber suit can be inflated at will, and thus the blood-pressure be maintained at any given level. He relates several instances in which its use in man during operations seemed to be of great value. The most striking is that of a man with a severe depressed fracture of the skull whose heart had ceased to beat for nine minutes. The heart was restored to rhythmical action with a full radial pulse for thirty-one minutes, and while the bone was being elevated he made voluntary movements of the head. I have had no experience with the pneumatic suit.

I append below résumés of all the cases in which massage of the heart has been employed which I have found recorded in surgical literature, in order that we may see the practical results in man up to the present time.

As nearly as can be judged (for some of the cases are rather vaguely referred to), massage of the heart has been at-

tempted in twenty-seven cases. Of these twenty-four have been failures, and in three (Cases 16, 25, and 27) restoration has followed—a very meager showing so far, but not a surprising number of failures when the gravity of the condition is considered. In fact the surprising thing is rather that any of them recovered. How far the other means used have been instrumental in recalling them to life—whether these alone would have been sufficient, whether the massage of the heart was essential to their restoration to life—it is difficult, if not impossible, to state with certainty. Moreover, in a few cases success seems to have been so nearly achieved that but little more would have been necessary to turn the balance.

Of one thing I feel assured, that Crile's position is correct when he says that surgeons as well as physiologists so far have fixed their attention too exclusively upon restoring merely the pulsation of the heart. This alone will not reëstablish life. The vasomotor and the respiratory centers must be awakened into rhythmical action as well as the blood be started on its vital round before we can hope to recall the apparently—or shall we say really?—dead to life. To accomplish this, massage of the heart, artificial respiration, the infusion of adrenalin in salt solution, and I think very possibly Crile's ingenious pneumatic rubber suit, will all aid.

The methods by which the heart has

been made accessible for massage are threefold:

First, by compression between the hands, one being applied outside the chest and the other directly upon the heart after an abdominal section, but without opening the diaphragm.

Secondly, by abdominal section, and after opening the diaphragm seizing the heart within the pericardial sac.

Thirdly, by resection of the chest wall, incision of the pericardium, and grasping the heart with one or both hands.

If abdominal section has already been done, the first or second method will usually be adopted, so as to avoid delay and the additional traumatism caused by opening the chest wall. If the operation which is being done does not involve an abdominal section, then an independent quick section is to be made in order to get access to the heart.

Of the successful cases, one of them, Starling and Lane's (Case 16), was done by this method. In my own case also I practiced the same method, but I must confess that I do not think as a result of this one experience that the heart is so easily seized and manipulated as by either the second or the third method.

In the second method, either a definite incision can be made through the diaphragm to the left of the middle line and posterior to the border of the ribs, or, as in Poirier's case, the finger may be thrust

through the diaphragm and the aperture enlarged simply by tearing.

The third method, exposure of the heart by resection of the chest wall, was used successfully in Igelsrud's case although the abdomen was already open. Fig. 3 shows the more usual method of gaining access to the heart. This is by resection

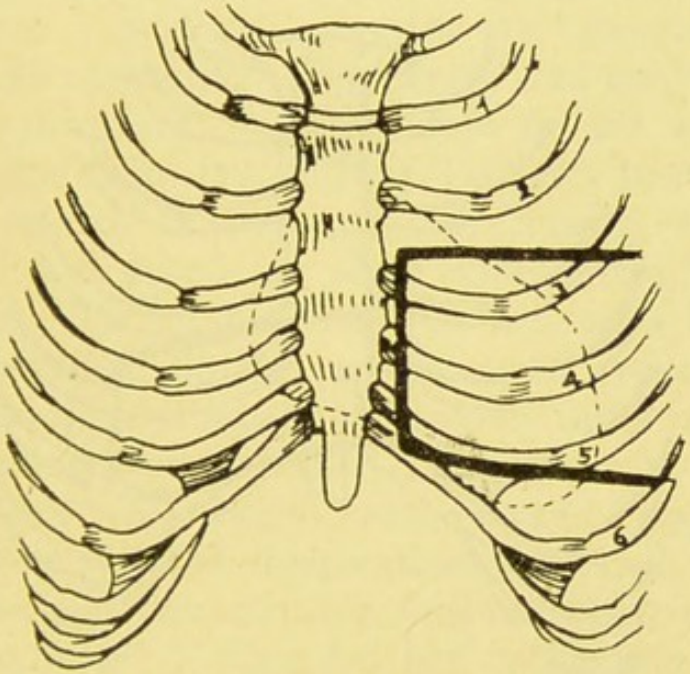

FIG. 3.—Usual incision to uncover the heart.

of the third, fourth, and fifth ribs. In this particular figure I have made the incision run parallel to the third and fifth ribs, joining them by a vertical incision along the left border of the sternum. The base or hinge of the flap is external. Different authors have preferred to make the base or hinge above, toward the median line, or below, and to make the flap rectangular or U-shaped. The great advantage of this incision is that the division of the bones can be made next the sternum through

the cartilages of the ribs, and that a stout pair of scissors enables us to divide the ribs at other points. These instruments would always be in readiness.

Fig. 4 shows the incision proposed by Wehr (*Centralblatt f. Chirurgie,* 1899, Beilage, p. 74). In this incision only the fourth and fifth ribs are resected, and the

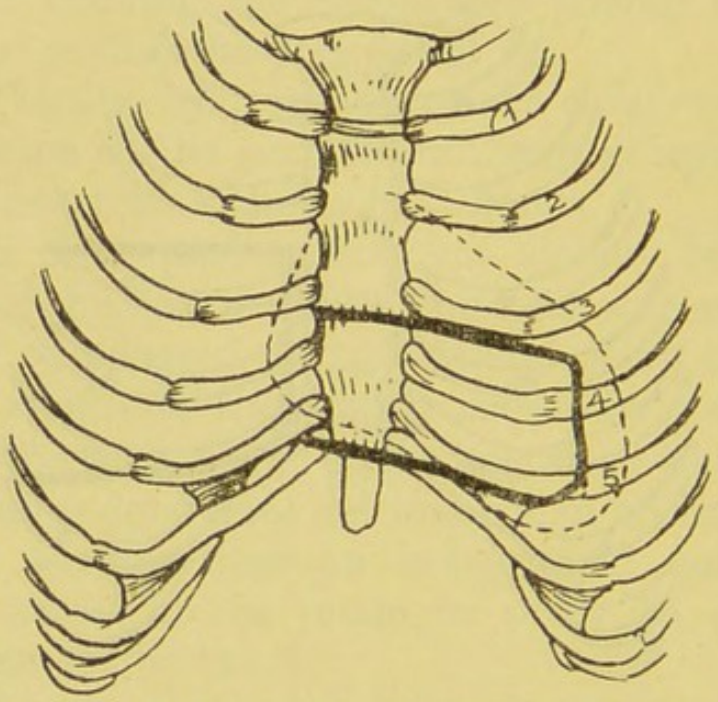

FIG. 4.—Wehr's incision to uncover the heart.

base of the flap is on the right border of the sternum. This requires a saw or chisel to divide the sternum. These instruments might very possibly not be provided for the operation in hand, and of course there would not be time to disinfect them if they were not ready.

In any case care must be taken, if possible, to detach the pleura and not open its cavity, as this necessarily complicates the injury very much by adding a pneumo-

thorax and possible collapse of the lung to the already serious condition of the patient. The pericardium is then incised, the heart is seized by the hand and rhythmical compression instituted.

Case I.—Tuffier and Hallion (*Bull. et Mém. Soc. de Chir.*, 1898, p. 937). A man, aged twenty-four; appendicitis. On June 16, 1898, Tuffier operated and found a pericæcal abscess and gangrene of the appendix. The cavity was emptied and drained. For four days he did well. On the fifth day, during Tuffier's visit in the ward, the patient was feeling very well and asked for some wine instead of milk. Tuffier had only left his bed a few steps when he had an attack of syncope. Certainly not more than two or three minutes intervened before Tuffier was at his bedside; his body was relaxed, pupils largely dilated, respirations arrested, no pulse was discoverable, and the heart was immobile. Tuffier did not doubt that he had died as a result of an embolus. Artificial respiration and traction on the tongue were practiced, and the patient was thought to be dead. Tuffier immediately made an incision in the left third intercostal space, separating the pericardium with the index-finger, and made rhythmical compression for one or two minutes. The heart undulated at first irregularly, then followed a frank contraction, the pulse reappeared, the patient took deep inspirations, the eyes were widely open, and the pupils contracted. He turned his head

as after a syncope. The wound was closed with an aseptic compress. After a few deep respirations the pulse again failed. Renewed rhythmical compressions established the circulation again for some minutes, but only to fail in spite of all his efforts. The autopsy showed a clot in the pulmonary artery with atelectasis of the left lung.

CASE II.—Bazy (*Bull. et Mém. Soc. de Chir.*, 1898, p. 939) states that in 1892 he saw one of his colleagues in the hospital employ the means described by Tuffier in a case of syncope from chloroform. The patient died.

CASE III.—Micheau (*Bull. et Mém. Soc. de Chir.*, 1898, p. 976) states that in a patient suffering from syncope following the administration of chloroform he instituted the same measures as described by Tuffier. Laying bare the heart after having used all the other means, the heart was compressed, but without result.

CASE IV.—Prus (*Wien. klin. Woch.*, No. 21, 1900, p. 486). A man, aged forty-eight, on January 19, 1900, hung himself. Wehr first did tracheotomy, and then opened the chest wall without injury to the pleura after his method. This, it is stated, was two hours after the attempted suicide. The heart showed no trace of movement. Prus seized it and began massage of the heart. At the same time air was driven into the lung by a long bellows. After the massage had been continued for fifteen minutes the first trace of

independent rhythmical contraction of both auricles was observed; the systole started as a wave beginning at the junction between the auricle and ventricle and proceeded in the direction of the tip of the auricle. When massage of the heart was interrupted for some minutes the contractions of the auricle gradually became weaker until they entirely ceased. Upon renewed massage, however, they reappeared; but in spite of the continuance of the massage and injections of normal salt solution in the veins, the contractions of the auricle became gradually weaker and finally ceased.

Case V.—Depage (*Annales Soc. Belge de Chir.*, 1901, p. 52). A man, aged forty-seven, with an irreducible inguinal hernia reaching to the knees. Radical cure was attempted. He had occasional suffocative attacks, and had the aspect of Bright's disease. The right heart was dilated and the pulse was irregular. There was a slight blowing sound with the first beat of the heart at its apex. Pulse 96; lungs normal; urine 1.031, neutral, a trace of albumin with pus, renal cells, and cylindrical epithelium. Chloroform was given with great care drop by drop. Ten grammes had been given and the patient was not completely relaxed, when he suddenly became pale, the respirations became superficial, and then ceased. The heart also ceased to beat. Artificial respiration was used with rhythmical traction on the tongue; head was depressed. Occa-

sionally some deep inspirations were noted. After fifteen minutes an application of the cautery was made to the precordial region. No result having followed, he opened the chest by a curved linear incision at the border of the sternum from the second to the fifth rib. The flap was turned outwardly, the pericardium opened, massage of the heart with artificial respiration and rhythmical traction on the tongue was made. Slight spontaneous contractions of the heart followed after a few minutes, but they progressively diminished, and at the end of twenty or thirty minutes ceased entirely.

Case VI.—Maag (*Centralbl. f. Chir.*, 1901, p. 20). A man, aged twenty-seven; nerve stretched under chloroform for sciatica. His heart was sound, there was no sugar or albumin in the urine. The patient had been a strong drinker, but of late years had entirely abjured alcohol. October 24, 1900, at 8 A.M., the narcosis was begun drop by drop on an Esmarch inhaler. After ten minutes he was sufficiently anesthetized for them to begin cleansing the area of operation. This continued for about five minutes, during which the patient lay quietly with good respiration, pulse, and contracted pupils. As the incision was made in the skin he struggled, and the anesthetist was requested to give him some more chloroform. Only a few drops were given, because almost immediately he became asphyxiated. Up to this time he had only received 15 grammes. The ordinary

means of restoration were successfully used, and the operation was concluded in a few minutes without giving him any more chloroform. He, however, again became asphyxiated. The same restoratives as before, namely, traction on the tongue, artificial respiration, striking the precordium, etc., were used, but in vain. After ten or fifteen minutes tracheotomy was done and air was blown through the cannula into the lung. The patient was pulseless, without respiration, cold, and cyanotic. Accordingly the third and fourth ribs were cut close to the sternum, and a flap about 7 centimeters long reaching to the left mammary line was turned back. The hand was introduced into the pleural cavity and seized the heart in the unopened pericardium. There were no contractions. After a few rhythmical compressions the heart began to beat again feebly, and then gradually stronger and stronger. The compression was made sometimes simply by the hand which seized the heart; at other times against the posterior surface of the sternum. The air was blown into the lung through a rubber tube which fitted closely in the cannula. The nose and lips were compressed, so as to prevent the escape of the air that was blown in. After about a half-hour the first quick shallow respiration was taken, and these became deeper and deeper, but there seemed to be only one of these voluntary respirations; but when air was blown in they were repeated, so that there

were first two and then three spontaneous respirations, and so on. Three hours after the anesthetic was begun the patient was able voluntarily to breathe about ten times. By 11.30 he began suddenly to take deep and regular respirations, the heart was beating seventy times in the minute, and only occasional compressions were made in order to stimulate it. The arteries in the area of the resection now began to bleed and were ligated. The tracheotomy wound also began to bleed, the pupils were contracted, the color of the face had been for some time normal, and the patient shut his mouth so tight that it was almost impossible to open it. The wounds were sewed, the resection wound only partially, so that if necessary the heart could be compressed anew. Some sterile strips of gauze were carried into the pleural cavity, the wound was dressed, and the patient placed in bed.

It seemed as if all danger were over excepting that the patient was not clear mentally. At 12 o'clock, as the surgeon was about to leave the hospital, his breathing suddenly became weaker, and after a few minutes ceased entirely. Air was again blown into the lungs, artificial respiration, faradism of the phrenic, infusions of oil of camphor, salt solution, etc., were used. Under these means the heart beat full and regularly until 8 P.M., when it suddenly ceased. During all these twelve hours the patient resembled one who was asleep, the color of the face was red, and the

pupils contracted. The moment, however, that the heart contractions ceased he looked as one dead; the temperature fell slowly—at 4 P.M. 36.9°; at 5, 36°; at 6, 35.6°; at 7.30, 34°C. With this considerable meteorism developed, the stomach and the intestines being distended with the air that had been blown in.

Necropsy twenty hours after cessation of the heart pulsation. There were slight pleural ecchymoses, adhesions of the posterior portion of the right pleura, the heart was soft, valves and aorta sound, the diaphragm arched strongly upward by the distention of the stomach and intestines; otherwise nothing abnormal was noted. [This same case is also described by Freyberger, and is the subject of an editorial notice in the *Lancet* of April 13, 1901, p. 1092.]

CASE VII.—Mauclaire (*Gaz. des Hôp.*, Dec. 5, 1901, p. 1347-8) does not give the date. His account is as follows: "I have had occasion to put in practice direct massage of the heart once for syncope coming on at the end of an operation. Neither a return of respiration nor of pulsation of the heart was observed. The heart was reached by a resection of the fifth and sixth ribs, the pericardium was opened, and the heart seized in the hand. In view of the pneumothorax which inevitably is produced in this heroic intervention, I believe that it would be better to open the abdomen and incise the dia-

phragm corresponding to the pericardium."

CASE VIII.—Mauclaire (*Gaz. des Hôp.*, June 24, 1902, p. 701). April 14, 1902, a man, aged twenty, was crushed between a wall and a wagon wheel. There was a fracture of the third, fourth, and fifth ribs to the right and the second and third ribs to the left. There were exaggerated resonance on the left side of the thorax. The precordial dulness was not increased. The sounds of the heart were deadened and distant, and crepitus was present. The patient was dull and stupid, the respiration was arrested from time to time, the face pale, the pulse very slow, and it seemed that he would die from syncope. In view of the probability of lesion of the thoracic viscera and of some bloody exudate either inside or outside the pericardium, he decided to explore the pericardium and the heart, not by the anterior thoracic route, but by the diaphragmatic route. Chloroform was given. An incision was made from the xiphoid appendix to the umbilicus, the abdomen opened, the hand of an assistant pressed down the left lobe of the liver, and the stomach was depressed by compresses. The respiratory movements rendered the incision of the diaphragm very slow. Through the diaphragm the beating of the apex of the heart could be seen. It was not possible to determine whether there was any blood in the pericardium. An incision was made 5 to 6 centimeters to the right of

the point where the beating of the apex was felt. The incision was made in several steps because of the depth of the region and the movements of the diaphragm, the xiphoid cartilage being subluxated upward. The pericardium being opened, a teaspoonful of a serous non-bloody fluid escaped, and along with it a puff of air showing the existence of a pneumopericardium, as was thought, but as no such lesion was found at the autopsy it was presumed that the movements of the diaphragm sucked the air into the pericardial cavity and then expelled it. A transverse incision of 3 centimeters made much more facile the introduction of the finger to explore the heart. A drain was then inserted in the incision through the diaphragm, but in such a manner that it projected but little into the pericardial cavity. It was secured by catgut to the edges of the diaphragmatic incision, which then was closed, followed by closure of the external wound. The patient, without showing symptoms of asphyxia or hemorrhage, died at 1 A.M.

The necropsy showed that there was no important lesion of the pericardium. There was a contusion on the posterior surface of the heart with some slight subpericardial ecchymoses.

The operation, as he points out in this case, was exploratory and not therapeutic. No massage of the heart was made.

He then recounts two cases of massage

of the heart by the anterior thoracic route, Cases 9 and 10, as follow:

Case IX (Mauclaire).—In February, 1899, he resected the sternal extremities of the third, fourth, and fifth costal cartilages, producing a pneumothorax. The pericardium was opened in order to massé the heart as a consequence of chloroform syncope, but without result. No further details are given.

Case X (Mauclaire).—In May, 1902, he saw a case of syncope from chloroform. After artificial respiration, rhythmical traction on the tongue, and tracheotomy produced no effect, he made a similar incision through the diaphragm and practiced rhythmical massage of the heart, without result.

The operative method which he recommends is slightly oblique from right to left and from in front backward, starting from the middle of the concavity of the diaphragm slightly in front of its summit. The beating of the heart against the diaphragm can be recognized, and the incision is a little in front of this point. The incision should be 4 to 5 centimeters long in the direction of the point of the heart, but without involving it. As soon as the diaphragm is penetrated, the rest of the incision should be made with scissors on the forefinger as a guide.

Case XI.—Poirier (*Bull. et Mém. Soc. de Chir.*, 1902, p. 43). December 5, 1901; a woman aged fifty-eight. She was very cachectic and so feeble that she could not

walk. The diagnosis was a gastric tumor. All food was rejected. Operation under chloroform. She was anesthetized quickly and easily without any resistance or mental fright. The stomach was found adherent throughout to the liver by old adhesions. They were separated without much trouble. A few sutures were placed in the liver to arrest a little oozing. A very extensive disease of the stomach being discovered, a posterior gastroenterostomy was decided upon. As the omentum was raised the patient made a few movements and the recti muscles contracted. The anesthetist was requested to give a little more chloroform. Scarcely had the compress been placed over her face when her heart suddenly ceased to beat. She became very pale, pupils dilated, respirations ceased, and everything characteristic of death was present. At the same instant rhythmical traction of the tongue, artificial respiration, and flagellation were all used, but without the least result. Tracheotomy was immediately done by puncture and oxygen administered; the phrenics were also stimulated by electricity, movements of the chest only being obtained. As all efforts seemed to be in vain, by suddenly pushing his thumb Poirier split the ensiform portion of the diaphragm and seized the heart. This was found relaxed and empty. No part of it responded to pressure or pinching. Artificial respiration was continued for a long time, but without avail. The

amount of chloroform used was between 30 and 35 grammes.

Cases XII and XIII.—Gallet (*Rev. de Chirurgie,* 1902, vol. xxvi, p. 625) states that his colleague, Dejace, has practiced massage of the heart twice without result.

Case XIV.—Gallet (*Jl. de Chir. et Annales de la Soc. Belge de Chir.,* November-December, 1902, p. 165). A man aged twenty-eight; inguinal hernia with a tuberculous peritonitis discovered at autopsy. After a few inhalations of chloroform, he died from cardiac syncope. The usual means were employed in vain. Massage of the heart was made twenty minutes after the syncope began, the chest being opened, but the pericardium not opened. The massage was done rhythmically, and also artificial respiration. The blood flowed in abundance in the jugular vein, and even at the level of the femoral artery the finger could perceive a pulse at each artificial systole. The only evidence of returning life were fibrillar trembling of the heart and slight coloration of the face.

Case XV.—Gallet (same reference). A woman, aged thirty, with a pelvic abscess. The same history as the preceding case, excepting that the massage of the heart was performed a half-hour after the syncope began, and that the pericardium was opened.

In experimenting on a dog he found that the arterial pressure in a large vessel is about 14 centimeters and is elevated

slightly at each systole. When cardiac syncope occurs, the pressure descends to zero, and with each pressure of the heart only rises to 4 or 5 centimeters, and immediately falls to zero in the interval between the compressions. In the veins the pressure only rises from 2 to 3 centimeters above zero. Gallet thinks that such an intervention is useless and also dangerous, no matter by what route the heart is reached.

Case XVI.—Starling and Lane (*Lancet,* Nov. 22, 1902, p. 1397). A man sixty-five years of age was operated on by abdominal section for adhesions about the colon. Ether was given by a Hewitt's large-bore inhaler, preceded by gas. The patient was of the thin, nervous type, with a muffled bruit of the first sound at the apex. The anesthesia proceeded normally. The appendix was removed. The pulse then began to flag; the respiration, which was shallow, was not affected. More ether was given, but during the trimming of the stump both pulse and respiration stopped altogether. Artificial respiration was tried without effect. Mr. Lane, the surgeon, then introduced his hand through the abdominal incision, and through the unopened diaphragm squeezed the motionless heart once or twice. It started beating again, but the respirations were still in abeyance. Artificial respiration was still continued, and other restorative measures adopted. The artificial respiration was continued for about twelve min-

utes, when natural respiration began again with a long sighing respiration. The operation was then completed without any further anesthetic. The patient felt the skin sutures slightly. Excepting for a little soreness about the diaphragm for two days the patient made a good recovery.

CASE XVII.—Zesas (*Centralblatt f. Chirurgie,* 1903, p. 588) relates that in 1880, while he was assistant to Niehaus in Berne, he observed the following case: A man of forty, who was operated upon for goitre, which was producing both dysphagia and dyspnea. Heart and lungs were normal, no arteriosclerosis, urine normal. The narcosis was proceeding regularly, when suddenly, before the beginning of the operation, his breathing ceased and he became cyanotic. The pupils were widely dilated and immobile, pulse disappeared, no trace of heart contraction was either felt or heard. Artificial respiration was used for some time, when Niehaus resected the ribs, laid bare the heart, and began rhythmical compression. Artificial respiration was continued. The heart, which at first was soft, became somewhat firmer, later twitchings were felt in its muscular wall, but there was never a normal contraction. The necropsy by Langhans showed nothing abnormal.

CASE XVIII.—Sick (*Centralblatt f. Chirurgie,* Sept. 5, 1903, p. 981). A boy of fifteen with tuberculous ascites, but with normal lungs and heart, was operated

on December 18, 1902, by laparotomy. About one liter of turbid serum was removed. In the parietal and visceral peritoneum and the mesentery countless tubercles were discovered. The liver and spleen were enlarged. As he was about to close the wound the patient began to struggle and vomit. Chloroform was therefore again given in order to quiet him. Only a few drops were given, but in from five to ten minutes sudden cyanosis set in and the pulse ceased, breathing continued for a moment, and then also ceased. The upper air-passages were free. Artificial respiration and compression of the heart through the chest wall were instituted; breathing returned for a minute, and the dilated pupils contracted. The cyanosis was unaltered; the pulse could not be felt, but slight pulsation of the heart could be heard; breathing and the heart's action, however, again ceased. The same means for restoring were repeated, and continued for half an hour without result. At this moment Sick entered the room. There was no movement of the heart; the pupils were widely dilated, cyanosis was marked, the whole body cold. He immediately exposed the heart by the method of Rotter. It was now three-quarters of an hour since the heart ceased to beat. The flaps did not bleed, the pericardium was also bloodless, the heart lay relaxed and was cool. Artificial respiration was continued, beginning with energetic rhythmical compression of the heart itself. After

a quarter of an hour breathing returned, and the first perceptible systole was observed. This had been preceded by irregular vermiform twitching of the muscle of the heart. The first contraction and firm consistence of the heart muscle followed directly as a result of hot compresses, which during the compression of the heart were quickly and constantly changed and applied to the heart. The patient also had applications of hot towels and a hot enema. A half-hour after laying bare the heart—that is, one and one-quarter hours after disappearance of all signs of life—the heart was beating regularly and strongly. Breathing returned, the pupils were normal, his color was good, his radial pulse could readily be felt. The pericardium, therefore, was closed with a continuous catgut suture; the slightly bleeding walls of the thorax were closed with tamponage. Two hours after the termination of the operation the patient became conscious, and complained of great thirst and dyspnea. Respirations 60, pulse 144. Camphor, salt solution, with some alcohol, etc., were used, and the condition of the patient remained about the same for twenty-four hours. His speech was indistinct, but not unintelligible. After this time he collapsed, and after suffering with great dyspnea died three hours after return of unconsciousness.

The necropsy showed a firm contraction of the heart, a right fibrinous peri-

carditis, an old double pleurisy, recent swelling of the liver and spleen, and marked tuberculosis of the peritoneum and mesentery.

Case XIX.—Djemil Pacha (*New York Medical Record,* Jan. 23, 1904, p. 146) relates the case of a man of thirty, upon whom he was operating for fistula in ano, who had inhaled 10 grammes of chloroform, when heart syncope occurred. "After two minutes' trial of ordinary means to restore animation without success, he opened the thorax and practiced massage of the heart, which had ceased to beat. The heart movements were reëstablished and some respirations were secured. Unhappily the patient succumbed."

Dr. Geo. W. Crile, of Cleveland, Ohio, has kindly furnished me with the following cases:

Cases XX and XXI (Crile).—Two Hungarian laborers were struck by a pony engine near Lakeside Hospital, causing compound depressed fractures of the occipital bone and compound fracture of the base of the skull. On arriving at the hospital both were in a dying condition. One died on being carried in to the accident room. Nine minutes later efforts at resuscitation were begun. This consisted in rhythmic pressure upon the thorax over the heart, artificial respiration by means of the Fell-O'Dwyer apparatus, the infusion of 1-to-50,000 solution of adrenalin chloride into the median basilic vein, and the applica-

tion of the pneumatic rubber suit. Directly following this the heart suddenly resumed a good, vigorous action, more vigorous than the normal. This continued for twenty-eight minutes, when the circulation failed. He did not regain consciousness, and spontaneous respirations were not reëstablished. At autopsy it was found that the base of the skull was severely crushed, and with it the tissues of the brain.

The second patient was not observed during the resuscitation of the first, and when it was obvious that the first one could not be resuscitated, I examined the second case and found him dead. From the time of this observation until the efforts at resuscitation were begun was eight minutes. Precisely the same treatment was carried out in this case as in the first. In sixteen minutes the heart suddenly began to beat strongly as in the first case, also showing an overaction at first. At that time Dr. Ford made a blood-pressure observation with a Riva-Rocci sphygmomanometer, and found it to be 80. The pulse was full, regular, and about normal rhythm. Spontaneous respirations soon began, and his condition seemed promising. His head was scrubbed, shaved, and prepared for operation. An incision was made, the depressed skull was raised, bleeding arrested, and the wound closed. During the operation the patient moved his head rather vigorously away from the operative field, but uttered no

sound. During this time spontaneous respiration was maintained. The patient lived thirty-four minutes, when the heart and respiration rather rapidly failed, and he died. Further efforts were of no avail. At autopsy the brain showed extensive lacerations at the base. In both cases the lesions were necessarily fatal.

Case XXII (Crile).—Male, aged thirty-eight; tumor at the base of the brain. Died during operation; resuscitated; died again two hours later. The patient presented a clear history of a tumor of the brain, which was supposed to be located well down toward the base. A large osteoplastic flap had been made, through which the right side of the tempo-ro-sphenoidal and occipital lobes as well as the cerebellum were explored. The tumor was located underneath the occipital lobe, and while raising up this lobe and trying to dislodge the tumor, the patient, who had been growing weaker during the operation, suddenly collapsed and died. The rubber suit had been applied and had been inflated during the failure of the circulation. In eight minutes an infusion of adrenalin chloride, 1 to 25,000, in normal saline solution was administered in the median basilic vein. Artificial respirations were maintained by means of the Fell-O'Dwyer apparatus, and rhythmic pressure upon the thorax over the heart was systematically made. The pressure in the rubber suit was increased. In nine minutes after beginning of resuscitation,

and seventeen minutes after complete cessation of the heart, the latter suddenly began to beat, and in about twelve minutes spontaneous respirations were reëstablished. The wound was then closed and the patient removed to the ward, during which time a continuous flow of adrenalin solution at the rate of 3 cubic centimeters per minute was continued. The patient died two hours after the time of the resuscitation.

Case XXIII (Crile).—Male, forty years old; struck by a telephone wire falling across the street-car conductor. Was seen at the morgue 2½ hours after the accident occurred. From that time attempts at resuscitation were made by Drs. Ford, Heath, and Dickison, as in the cases above described. Resuscitation was not accomplished. Rigor mortis was in evidence at the time of beginning the attempt at resuscitation.

Case XXIV (Crile).—Electric lineman, aged twenty-six. While repairing a wire received an electric shock, causing his immediate death while suspended from the wire about thirty feet above the surface of the ground. Four hours later an attempt at resuscitation by Drs. Lower and Ford by the above methods was made, but did not succeed.

Case XXV (Crile).—Sudden death during excision of exophthalmic goitre, Lakeside Hospital, Feb. 2, 1904. Female, aged twenty-eight, who had been in the hospital for nine weeks for treatment of

exophthalmic goitre, by medical means had not improved. During this time the pulse varied from 90 to 150. The exophthalmia became more marked. All her nervous symptoms were greatly increased, there being delirium at times during the week past. There were attacks of syncope, though in bed and at the most perfect rest. The patient was operated under ether anesthesia, with every precaution against the loss of blood or the manipulation of the tumor. During the operation her general condition was closely watched by her physician, Dr. H. J. Lee. The heart had been beating at the rate of 144 to 150 per minute during the entire operation. After the completion of the dissection, and after almost all of the ligatures had been tied, the patient went into a sudden collapse. The heart's action entirely ceased; respiration continued for less than a minute later. A pneumatic rubber suit as a precautionary measure had been put on, but not inflated, before the operation was begun. Rhythmic pressure upon the thorax over the heart was at once made, and the rubber suit inflated as rapidly as possible. After an interval of between five and six minutes the heart slowly began to recover its beat and the circulation was reëstablished. It was intended to use the infusion of adrenalin, which was ready to be given just as the heart began beating. Spontaneous respiration was resumed. The operation was completed, and the patient sent to bed

with the circulation supported by the rubber suit, which was gradually decompressed during a period of one and a half hours. Following this the patient did well. The pulse in the meantime had fallen from 160 to 132.

CASE XXVI.—Keen (*vide ante*).

CASE XXVII.—Igelsrud (*vide ante*).

[*Postscript.* — By an unaccountable oversight, although I had a note of the case of massage of the heart reported by Dr. Cohen in the *Journal of the American Medical Association,* November 7, 1903, it was omitted from my tables. This would make 28 cases and 4 recoveries.]