The true physiological method of restoring persons drowned or dead, and of resuscitating still-born children / by Henry R. Silvester.

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PHYSIOLOGICAL METHOD

OF

RESTORING PERSONS

APPARENTLY

DROWNED OR DEAD;

AND OF

RESUSCITATING STILL-BORN CHILDREN.

BY

HENRY R. SILVESTER, B.A., M.D.Lond.,

FORMERLY STUDENT IN HUMAN AND COMPARATIVE ANATOMY IN
THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

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A NEW METHOD OF RESTORING PERSONS APPARENTLY DEAD.

In the following paper, I purpose to describe a new method of treating apnœa, and of inducing respiratory movements, by means of which air may be drawn into the lungs of the asphyxiated person without the employment of any apparatus. The process is, moreover, of universal application; it is easy of performance, entirely in harmony with that of Nature, and does not prevent or supersede the use of those means in which much confidence has hitherto been placed. The subject is one of deep practical and physiological importance, and is of direct personal interest to every individual, since no one can claim for himself or his family security from the dangers against which this method proposes a remedy. Apnœa, or suspended respiration, may be the result of drowning, of still-birth, of epilepsy, of apoplexy, of the undue or excessive employment of opium, of chloroform, of certain gases, etc.

The means usually resorted to for restoring patients affected by suspended respiration are of *two kinds*, in addition to the various auxiliary plans adopted for exciting the reflex function of the nervous system by stimulants. The first provides for the maintenance of warmth and circulation. The second proposes to supply air to the lungs, either by mechanically forcing air into the chest, or by inducing certain movements in the thoracic parietes, in order to admit the passage of air, or draw air into this cavity.

With regard to the treatment by *warmth and friction*, it may be said that experience is greatly in its favour; greater numbers have been restored by it than by any other means. The Royal Humane Society, in its printed rules, particularly recommends it as a restorative in cases of the apparently drowned, and of the apparently dead, from intense cold, or from hanging.

"In one of the most remarkable cases of resuscitation on record, the individual had been fourteen minutes under water, and no signs of returning animation were evinced until the treatment, which consisted simply in the application of warmth and constant friction, had been persisted in for eight hours and a half from the time of the accident." (Taylor, *Medical Jurisprudence.*)

According to the experiments of Edwards and Brown-Séquard, an animal lives longest without respiration in the temperature of about 60° Fahr.; with respiration, the temperature may be carefully raised to 98°. Within certain limits, which may, in general terms, be fixed at 60° and 100° Fahr., the duration of life, in the case of suspended animation, is inversely as the temperature. "The practical conclusion at which Dr. Hall arrived was, that, in the treatment of apnœa, the continuous warm bath must be excluded. This inference is, we think, scarcely warranted by the facts. In the experiments he made, animals were completely submerged, so that there was no escape for the products of respiration; whereas, in the use of the warm bath, there would not be this obstacle." (*British and Foreign Medico-Chirurgical Review*, April 1858.)

"The duration of life in asphyxia seems to be proportionate, not to the warmth, but to the maintenance of a medium temperature of the patient or of the animal made the subject of experiment. The restoration of warmth can only be safely effected when the respiratory movements are maintained, and the circulation is promoted. The warm bath, used *alone*, appears to have been often fatal." (*Lancet*, December 13th, 1856.)

I think then we must conclude that the warm bath may be considered as an *auxiliary* means, and that much dependence is to be placed on friction and warmth, and that nothing should be allowed to interfere with the application of those means by which warmth is restored to the skin. "And it ought certainly to be borne in mind, that the practice of the Royal Humane Society, whose rules, Dr. Hall states, 'may be summed up in one word—warmth!' has been eminently successful." (*British and Foreign Medico-Chirurgical Review*, April 1858.) The impossibility of using the warm bath during the adoption of the postural method is universally admitted.

In the apnœa of still-born infants, momentary immersion in baths of from 50° to 60°, and 98° to 100°, alternately and quickly, might be tried, as recommended by Dr. Hall.

The mechanical introduction of air into the chest by means of the bellows, by Dr. Sibson's or some other apparatus, appears, theoretically speaking, to be strongly indicated; but the obvious objection is, that the means are not commonly at hand, and whatever is done on these occasions must be done quickly. A similar remark may be applied to the employment of electricity and electro-magnetism, and the inhalation of certain gases, oxygen, ammonia, etc. Mr. Mare states, that "more good is done by drawing air out of the lungs than by artificially inflating these organs".

We now come to the consideration of some of the various ways of imitating inspiration and expiration by means of certain *movements of the thoracic parietes*.

a. The essential part of the various plans formerly employed, consists in *alternate compression and relaxation of the chest.* On compression, the walls of the chest descend below their accustomed level, the capacity of the lungs is diminished, and air is expelled. Upon the removal of the pressure, or relaxation of the chest, the ribs rise again to their usual and ordinary height, and air is again introduced. There is no elevation of the ribs, such as takes place in natural deep inspira-

tion, in which they are made to rise above their ordinary or quiescent level, and the cavity of the chest greatly increased in size.

These methods have been made the subject of experiment. The apparatus employed was very simple, and consisted of three tubes, one of glass, to be passed into the trachea; another, a bent barometer-tube, graduated; and these two connected by a piece of India-rubber tubing. The glass tube was passed through an aperture made in the trachea, and firmly secured in its place by a ligature. A small quantity of coloured spirit was poured into

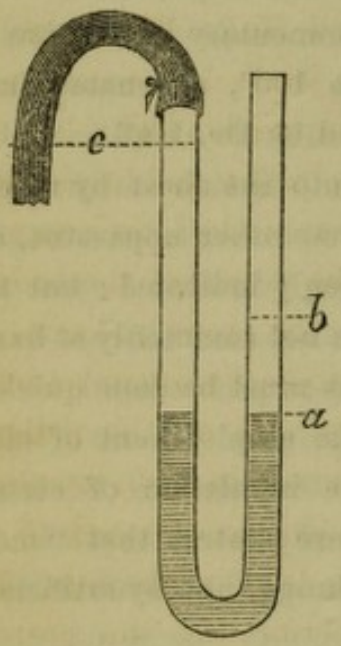

Fig. 1.—*a*. Natural level of fluid. *b*. Height to which fluid rose by pressure on the chest. *c*. Point to which the fluid receded in the first leg of the instrument by the drawing of air into the lungs when the chest was expanded by my method.

the barometer-tube, which was in the form of an inverted syphon, and was retained in an upright position, on a level surface, by an assistant who carefully noted the height of the column of fluid. Trials were made on persons of both sexes and of different ages, and at a length of time after death which varied from one hour and a half to two days, in those with lungs sound or otherwise. But practical deductions have been drawn from those cases only in which the results were obtained when the body was warm, and when two hours had not elapsed after death. The subject of experiment was placed in various positions; and, compression of the chest being made, the fluid

contained in the inverted syphon, connected with the lungs by the flexible tube, immediately rose; and, when the compression ceased, the fluid fell slowly to its previous level, demonstrating—

1. That air had been expelled from the lungs by pressure exerted on the parietes of the thorax.

2. That the air returned into the chest, though slowly, upon relaxation of the pressure, in consequence of the feeble elasticity of the chest.

3. That the actual capacity of the chest was not increased by this mode of practice.

b. Postural Method of Dr. Marshall Hall. The principle involved in this method of treatment is precisely the same as in the foregoing plan, in which simple compression and relaxation of the chest are employed to induce expiration and inspiration; the difference being that, in the postural method, the compression of the thorax is occasioned by the weight of the body of the patient resting on the chest during the prone position, followed by the removal of the pressure, and consequent return of the thoracic parietes to their ordinary level on the patient's assuming the supine posture. No attempt is made to enlarge the actual capacity of the chest by inducing an elevation of the ribs, such as takes place on making a deep inspiration. The following directions are given for performing the postural method:—"Place the patient on his face, supporting the chest on a folded coat, or other article of dress. Turn the body very gently but completely on the side, and a little beyond, and then briskly on the face, alternately repeating these measures deliberately, efficiently, and perseveringly, fifteen times in a minute only. (When the patient reposes on the thorax, that cavity is compressed by the weight of the body, and expiration takes place; when he is turned on the side, this pressure is removed, and inspiration occurs.) When the prone position is resumed, make equable but efficient pressure with friction along the back, removing it immediately before rotation on the

side. (The first measure augments the expiration; the second commences inspiration.")

Numerous experiments have been made on the dead body in order to test the influence the postural method has upon respiration. The following results were obtained by the aid of the apparatus mentioned above, namely, a glass barometer tube bent in the form of an inverted syphon graduated, and containing a little coloured spirit, made to communicate with the trachea by means of a long flexible tube, the joints well secured by ligature. *First:* The subject of experiment being placed in the prone position, equable but efficient pressure with friction was made along the back, as recommended by Dr. Marshall Hall, in his rules for restoring persons apparently dead from apnœa. The fluid rose in the bent tube, proving that the compression exercised on the thorax by the weight of the body, etc., did displace some air from the lungs. *Secondly:* On turning the body on the side and a little beyond, the column of fluid fell slowly to its former level, proving that the air returned into the chest, though slowly, upon the removal of the pressure, in consequence of the feeble elastic force of the parietes of the chest in their return to their natural level. *Thirdly:* It was proved, by the fluid in the bent tube not descending below its level, that the actual capacity of the chest is not enlarged. It must be remembered that it is only the "residual air," or that which remains in the chest after a forcible expiration, which is operated upon in the postural method. *Fourthly:* From the results of the experiments on simple compression exactly corresponding with the results of the experiments on the postural method, we may infer that these two methods of treatment are identical in principle.

This method of treatment has been found open to some objections; for instance:—

1. Expiration is made to precede inspiration, whereas originally expiration is second in order, and not the primary act.

In still-born infants, whose lungs have never been inflated, forced expiration, at first, is of course impossible.

2. The expansion of the thorax, or inspiration, being dependent on little more than the elasticity of the tissues, takes place feebly, inefficiently, and slowly, and therefore calls for more active mechanical aid.

3. It is scarcely possible to use the warm bath during the adoption of the postural method.

4. The patient is liable to have the mouth and nose compressed, the face bruised, or the neck twisted by the almost lifeless body being turned alternately on the chest and back fifteen times a minute for some hours. Moreover, to the operator this process is very arduous.

5. When the patient is turned on the face and pressure made on the back (pronated) the contents of the stomach are liable to pass into the œsophagus and windpipe.

6. When the patient is turned "completely on the side and a little beyond" (supinated), the tongue is apt to obstruct inspiration by falling back into the throat, with the epiglottis resting against the back of the pharynx.

7. Both sides of the chest are not equally inflated, one side only being called into action at the same time to any important extent.

8. This process is not entirely in harmony with that of nature. It is not the way in which we generally breathe.

9. The amount of air respired is exceedingly small; this is, doubtless, in consequence of the actual capacity of the chest not being increased.

As to the state of the tongue, I observe that, in cases of asphyxia the tongue is usually swollen, and falls back into the throat, the epiglottis resting against the back of the pharynx, so as to act as a plug to the pharynx, and a sort of valvular covering to the otherwise patulous orifice of the larynx. In the postural method, when the body is turned on the face, no doubt the tongue falls forwards and draws with it the epiglottis,

and leaves the glottis open. This, however, is of little consequence so far as respiration is concerned, for the very compression of the chest by the weight of the body itself forces out the air from the lungs, and so lifts up the valvular covering of the larynx, so that the tongue does not offer any serious obstacle to expiration when it is induced by compression of the thorax.

Moreover, in the postural method, the moment the patient is rolled "on the side and a little beyond", in order that inspiration may take place, the tongue is liable to fall back into the throat, and its semi-lifeless relaxed tissue to cover securely the orifice of the glottis, and its accurate closure is probably further insured by the suction generated by the return of the thoracic parietes to their natural level, so that the greater the previous compression of the chest, the more firmly is the tongue drawn down as a plug into the throat, when the pressure is relaxed, and effectually prevents the entrance of air into the lungs.

With reference to the amount of air respired in the Marshall Hall method, Mr. Wildbore states in a letter to the *Medical Times and Gazette*, Nov. 28th, 1858: "I believe that I am correct in saying that the experiments performed by Mr. Hunter and other gentlemen at St. George's Hospital on the dead subject, proved that nearly as much air entered the lungs as would be inhaled in an ordinary inspiration in a state of health"; that is, from six to thirty cubic inches.

I think there must be some fallacy here. The method of performing the experiments just mentioned is by no means satisfactory, and is, I believe, open to obvious objections.

The tube of the pnæometer was passed into one of the nostrils of the patient, the other nostril and lips being closed with adhesive plaster. The want of rigidity of the cheeks and the amount of air in the respiratory tract, and even in the stomach, etc., of the patient could scarcely fail to render the indications of the instrument, however perfect in itself, liable

to suspicion, if not entirely valueless, in point of scientific accuracy.

In the Marshall Hall method, the amount of air displaced from the chest and returning there is exceedingly small, being according to my experiments a fraction of 1 cubic inch.

c. The *new method* which I venture to bring before the profession is a simple imitation of natural deep respiration, and is effected by means of the same muscles as are employed by nature in that process. In ordinary deep inspiration we lift the ribs and sternum by the pectoral and other muscles which pass between the chest and the shoulders, and thus produce the threatened vacuum which inflates the lungs. In my method we lift the ribs and sternum by the pectoral and other muscles, which pass from the shoulders to the parietes of the thorax, by steadily extending the arms up by the side of the patient's head; by elevating the ribs the cavity of the chest is enlarged, a tendency to a vacuum is produced, and a rush of air immediately takes place into the lungs. Expiration is brought about by simple compression of the sides of the chest by the patient's arms.

The Principle. Forced enlargement of the capacity of the chest, producing a tendency to a vacuum, and consequently an inspiration of air into the lungs, induced by the constrained action of the muscles of ordinary and extraordinary inspiration upon the moveable walls of the thorax.

Diminution of the capacity of the chest and expulsion of the air from the lungs, and consequently an expiration, induced by compression.

The arms of the patient are to be used by the operator as handles to open and close the chest.

This new method has been tested by experiment on the dead body by the same apparatus, the elastic tube being securely fastened to the trachea, in order to avoid the sources of fallacy mentioned above.

The body was placed on its back, supported and a little

raised by a small pillow placed under the shoulders. The height of the column of fluid having been first carefully noted, the arms of the subject were raised, and steadily extended upwards by the sides of the head, so as to draw up the shoulders and put the pectorals on the stretch, elevate the ribs, and consequently enlarge the cavity of the chest. The result was that the fluid in the bent tube rapidly fell, and so considerably as to recede high up in the leg of the instrument nearest the body, that is to say, the tendency to a vacuum produced in the chest drew the air into the lungs. The shoulders and arms were next pressed down upon the sides of the chest, and immediately the fluid rose as much above its usual level in the

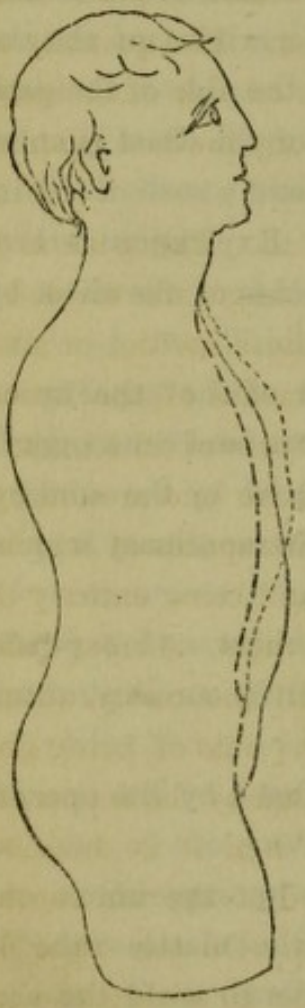

Fig. 2.—Continuous line represents the ordinary state of the chest. Broken line represents the depression of the chest under pressure. Dotted line represents the enlargement of the chest, produced by the *forced action* of the muscles of inspiration. The space between the continuous line and the broken line indicates the extent of respiratory movements in the postural method. The space between the dotted line and the broken line indicates the extent of respiratory movements in my method.

further leg of the apparatus as it did in the foregoing experiments; demonstrating:

1. That the actual capacity of the chest was increased, and air drawn into the lungs by the constrained action of the muscles of respiration upon the moveable walls of the thorax.

2. That expiration was produced by pressing the arms and shoulders down upon the sides of the chest.

The distinguishing feature of my method is the actual enlargement of the cavity of the chest—the elevation of the ribs above their ordinary or natural level.

It is, of course, of consequence to get as much air into the lungs as possible, because there can be but little doubt that fresh air is the proper stimulant to the respiratory efforts, just in the same way that light is to the eye and sound to the ear, but acting more entirely by reflex action. The quantity of air respired, according to my experiments on the dead body, appears to be about ten times greater in my method than in the postural method of Dr. M. Hall.

The Mechanism of Respiration in Man. The general principle of the operation is this:—The lungs are divided into cavities of extreme minuteness; and these cavities or air-cells are all connected with the trachea by means of the bronchial tubes. The lungs themselves are suspended in a cavity that is completely closed, being bounded above and around by the bony framework of the thorax, the interspaces of which are filled up by muscles and membranes, and being entirely cut of from the abdomen below by the diaphragm. Under ordinary circumstances, the lungs completely fill the cavity. But the capacity of the thoracic cavity is susceptible of being greatly altered by the movements of the ribs, and by the action of the diaphragm and abdominal muscles. When it is diminished, the lungs are compressed, and a portion of the air contained in them is expelled through the trachea. On the other hand, when it is increased, the elasticity of the air within the lungs causes them immediately to dilate so as to fill the vacuum that would otherwise exist in the thoracic cavity, and a rush

of air takes place down the air-tubes and into the remotest air-cells, to equalise the density of the air they include (which has been rarified by the dilatation of the containing cavities) with that of the surrounding atmosphere. The lungs themselves appear to be almost entirely passive instruments of the respiratory function. The dilatation of the cavity of the chest, which constitutes inspiration, is accomplished by two sets of movements—the elevation of the ribs, and the depression of the diaphragm. In tranquil breathing, the contraction of the diaphragm is alone nearly sufficient to produce the necessary enlargement of the thoracic cavity, the position of the ribs being very little altered. In the act of deep inspiration, the ribs (whose ordinary direction is forwards, sloping downwards), under the influence of their elevator muscles, namely, the pectoralis muscles, major and minor, the serratus magnus, the scaleni muscles, and the intercostals, pass from the sloping to the horizontal position. By this change, the dimensions of the chest are enlarged in the transverse as well as in the antero-posterior direction, for the middle curved portions of the ribs are carried outwards, and therefore brought further apart from each other, and their sternal extremities are moved forwards, accompanied by the sternum, the distance of which from the dorsal vertebræ is thereby increased. When the respiratory movement is very forcibly performed, the scapula is itself drawn upwards, thus producing an increased elevation of the ribs and an unusual enlargement of the upper part of the thoracic cavity. When deep expiratory action is to be performed, the ribs descend by the action of the muscles of the spine and the abdomen, the diaphragm being altogether passive. In this manner, by the regularly alternating dilatation and construction of the thoracic cavity, the air within the lungs is alternately increased and diminished in amount, and thus a regular exchange is secured. The number of the respiratory movements (that is, of the acts of inspiration and

expiration taken together) may be estimated at from fourteen to eighteen per minute. (Carpenter's *Physiology*.)

I may also remind you that, from the peculiar mode in which the ribs are articulated with the spinal column at one extremity, and from the angle which they make with the cartilages that connect them to the sternum at the other, the act of elevation tends to bring the ribs

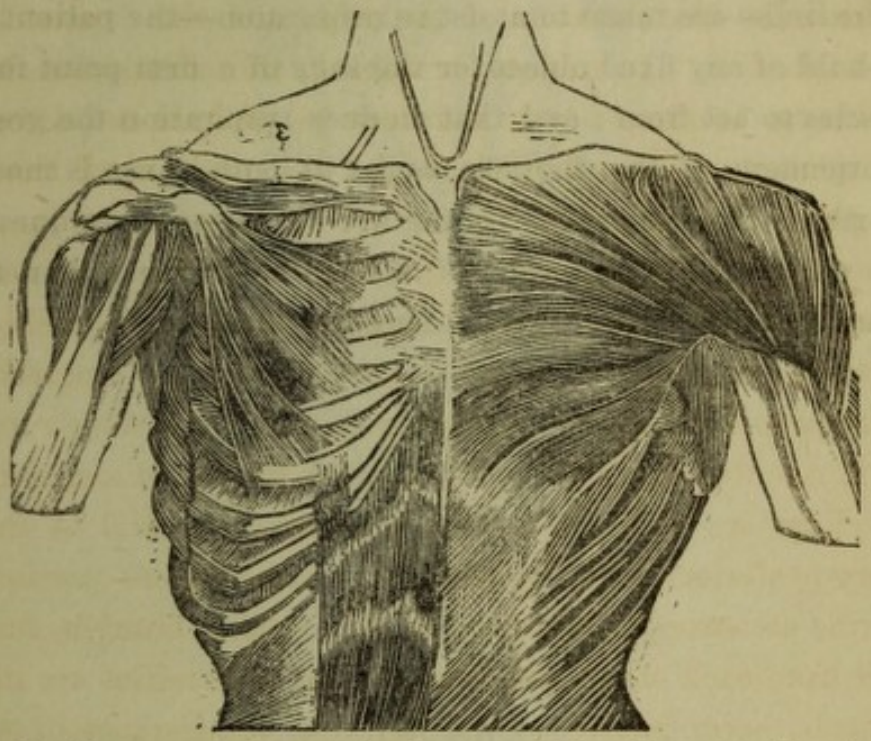

Fig. 3.—Diagram of the muscles in front of the chest, showing the *pectoralis major* arising from the clavicle and from the cartilages of the true ribs, and converging towards the tendon of insertion into the bicipital groove of the humerus.

e. The *pectoralis minor*, arising from the third, fourth, and fifth ribs, near their cartilages, and converging to a tendon, which is inserted into the coracoid process of the scapula.

The *subclavius muscle*, which arises from the first rib, and is inserted into the costal aspect of the clavicle for nearly half its length.

The *serratus magnus*, placed upon the upper and lateral parts of the thorax, arising from the eight upper ribs, and inserted into the scapula.

The *deltoid*, which arises from the external third of the clavicle and from the spine of the scapula, and is inserted into a prominence on the middle of the outer side of the humerus.

All these muscles are put on the stretch, and tend to raise the ribs, when the arms are extended upwards by the side of the head, as described in my method.

and their cartilages more into a straight line, and to carry the former to a greater distance from the median plane of the body, whilst the sternum is also thrown forwards. Conse-

quently the elevation of the ribs increases the capacity of the thorax, upwards, forwards, and laterally. Although the range of motion between each vertebra and the ribs attached to it is very limited, yet the whole framework of the chest enjoys such mobility, that by a deep inspiration its cavity is sometimes more than doubled.

I may also mention, that in difficult respiration the muscles of the limbs are made to assist in respiration—the patient seizing hold of any fixed object for the sake of a firm point for the muscles to act from; and that in deep respiration the greatest enlargement of the thoracic cavity in both sexes is made by the ribs, and not by the diaphragm. It appears very questionable whether the diaphragm is affected any further than being flattened, and that without descending.

Fig. 4.—Diagram to illustrate the manner of peforming my method.

The following Rules for the treatment of apnœa are deduced from actual experiment, and are in accordance with established physiological principles.

I. *To Adjust the Patient's Position.*

Place the patient on his back, with the shoulders raised and supported on a folded article of dress.

II. *To Maintain a Free Entrance of Air into the Windpipe.*

Draw forward the patient's tongue, and keep it projecting beyond the lips. If the lower jaw be gently raised, the teeth may

be made to hold the tongue in the required position. Should it be found necessary, the tongue may be so retained by passing a handkerchief under the chin and fastening it over the head.

III. *To Imitate the Movements of Deep Respiration.*

Raise the patient's arms upwards by the sides of his head, and then extend them gently and steadily upwards and forwards for a few moments. (This action enlarges the capacity of the chest by elevating the ribs, and induces inspiration.)

Next, turn down the patient's arms and press them gently and firmly for a few moments against the sides of the chest. (This action diminishes the cavity of the thorax, and produces a forcible expiration.)

Repeat these measures alternately, deliberately, and perseveringly fifteen times in a minute.

IV. *To Induce Circulation and Warmth, and to Excite Inspiration.*

Rub the limbs from the extremities towards the heart. Replace wet clothing by warm and dry covering. Occasionally dash cold water in the patient's face. These measures are perfectly compatible with the systematic performance of the imitation of the movements of respiration. A similar remark applies to the use of the warm bath, if indicated.

Explanatory Remarks.

Rule i. This posture is not essential; but in the position recommended the vital capacity of the chest is larger than in any other recumbent attitude. The bony framework of the chest is more free to move, and both sides can be expanded at the same time. This, in fact, is precisely the posture chosen by persons suffering from dyspnœa.

Rule ii. In this way the patulous orifice of the windpipe is raised and drawn forward, so that nothing intervenes

between it and the natural channel of air through the nose. The tongue is entirely prevented from falling back into the throat, whilst the extent to which the windpipe is put on the stretch is clearly indicated. The pharynx also is sufficiently opened to allow of the removal of liquids etc., from the mouth, nose, pharynx, etc., if those have not been completely displaced by previous suitable treatment.

Rule iii. This process in short accomplishes artificially for the patient exactly what he would himself effect, and by the same muscles, if he had but the will and the power to draw a deep inspiration.

Possibly the elevated position of the arms, together with the muscular compression exerted on the veins of the upper extremities, might favour the descent of blood from them into the chest at the same time that the tendency to a vacuum produced in the thorax by the elevation of the ribs was inducing a rush of fresh air into the lungs.

At the same time that the arms are extended steadily upwards, the lungs might be filled with air by a mouth to mouth inflation.

The following are some of the advantages of this new method :—

1. Inspiration may be made to precede expiration, or it may be second in order at the will of the operator.

2. The expansion of the thorax is artificially insured, and wholly under the control of the operator.

3. It may be adopted when the patient is in the warm bath.

4. The patient is not liable to be injured by the manipulation.

5. The contents of the stomach are not liable to pass into the windpipe.

6. The tongue is prevented from obstructing inspiration.

7. Both sides of the chest may be equally inflated.

8. This process is entirely in harmony with that of nature.

9. A larger amount of air is inspired than by any other method.

10. This method is most easy of adoption.

11. Pure atmospheric air is inspired.

12. No apparatus is required.

The Royal Humane Society directs its attention mainly to the circulation. Dr. Marshall Hall, principally to the respiration.

It is intended by my method to combine the advantages of both these plans.

A successful case of resuscitation has already been recorded.

Clapham, London.

T. RICHARDS, 37, GREAT QUEEN STREET.