

Intermittent Positive Pressure Breathing and Curare in the Treatment of Severe Pneumonic Respiratory Distress

By

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Following the success of intermittent positive pressure breathing in the treatment of poliomyelitic respiratory paralysis, the method has become widely used in respiratory distress accompanying a number of pathologic processes, such as neurologic and neurosurgical conditions, poisonings, acute exacerbations of chronic respiratory failure, postoperative complications, injuries, pulmonary oedema, etc. All these conditions are characterized by hypoventilation and the resulting CO_2 retention creates the indication for intermittent positive pressure respiration. It is remarkable that pneumonic respiratory disturbance, one of the most important and frequent conditions, should not figure among the indications. In the dyspnoeic, cyanosed patients, ventilation is not depressed, respiratory acidosis is an exception, and even an exaggerated CO_2 output is common. According to our previous observations, the leading symptom of pneumonic respiratory distress is an extreme decrease of compliance and tidal volume, due to insufficiency of the pulmonary parenchyma. Therefore, all things considered, the death

of the patient suffering from pneumonia is not caused by asphyxia, but by exhaustion.

On the basis of these observations it was thought that intermittent positive pressure breathing could have a beneficial effect in patients suffering from grave pneumonia with associated respiratory distress, not by correcting insufficient ventilation, but by relieving the surplus work caused by the pathologic respiration. For relieving the overstrained muscles, myoneural blocking is necessary, which may be anyway one of the essential conditions of intermittent positive pressure breathing in patients with respiratory centre irritation and intact muscles. In the terminal stage of pneumonia, when mechanical respiration is introduced after respiratory arrest as a direct life-saving intervention, the administration of curare is unnecessary.

In the following, we wish to demonstrate the effect of the method as observed in 10 patients with grave pneumonia.

TECHNIQUE

Artificial respiration was instituted following tracheotomy through a metal

cannula fixed, if necessary, by an inflated cuff. An Elektrosperator-type intermittent positive pressure apparatus was used, giving air with 40 to 50 cent O₂. This type of respirator has the advantage of allowing to work with a high respiratory rate (45/min) and a high pressure (over 45 cm H₂O) with a small dead space (under 5 ml) and that at the end of the inspiration phase the pressure returns to the atmospheric value, while during expiration no suction occurs.

As a muscle relaxant, tubocurarine (Tubarine Wellcome) was administered, first intravenously, then intramuscularly, usually in doses of 0.5 mg/kg, which, according to need, were repeated every 2 to 3 hours at the beginning, later on less frequently, to inhibit spontaneous activity of the patient. Simultaneously with the curare, usually in combination with chlorpromazine and pethidine, promethazine was administered in the same doses as the curare.

To administer fluids, electrolytes, and the necessary calories, intravenous drip infusion and later an indwelling gastric tube were used. Urine was collected regularly through an indwelling catheter; the bowels were cleaned with enema. The cornea was protected and to avoid decubitus, the patient lay on an inflated mattress.

Temperature, pulse rate and blood pressure were taken every hour; serum Na, K, Cl, and standard bicarbonate were determined regularly. Minute volume of ventilation, CO₂ and O₂ content of the expired air were controlled several times daily, as well as the arterial pCO₂ by means of gastrotonometry (2, 3).

At the beginning of treatment, to achieve adequate ventilation, a high output (in adults 35/min respiratory rate and 38 cm H₂O pressure, in one of the infants 46/min respiratory rate and 43 cm H₂O pressure) had to be maintained. When the state had improved according to the respiratory data, the output was gradually decreased. Improvement of the effect of

mechanical respiration served as a basis for the estimation of the pulmonary process and in establishing the time of discontinuing mechanical respiration.

For the treatment of the pneumonia, broad spectrum antibiotics were administered according to the sensitivity of the pathogene isolated from the respiratory tract. Most patients received cortisone in addition.

CASE RECORDS

In the following we shall present the 10 cases in chronological order.

Case 1. Gy. J., aged 9 months. Because of poliomyelitis with bulbar symptoms, tracheotomy had been performed. The patient had recovered but could not be decannulated. Four months later he developed an extremely grave pneumonia and was soon in a moribund state. Mechanical respiration was instituted without curare. The condition of the patient improved dramatically. Mechanical respiration was maintained continuously for 4 days, then with increasing intervals for 2 weeks. The process subsided, 6 months later the cannula was removed and the patient was discharged.

Case 2. D. A. as a newborn had had tetanus and as the seizures had threatened with suffocation, tracheotomy was carried out and mechanical respiration introduced, combined with curarisation. The condition improved in spite of an episode of extremely grave pneumonia. After 30 days the patient had been decannulated and discharged. 8 months later he again contracted pneumonia. To relieve the dyspnoea caused by the stenosed trachea, tracheotomy had again to be performed. When the pneumonia became gradually more severe and episodes of apnoea occurred, artificial respiration and curarisation had to be resorted to. Improvement was rapid, and soon the circulation was satisfactory. Curare was administered for 4 days, mechanical respiration for 2 weeks

with increasing intervals. The patient recovered, but the cannula could be removed only after several months.

Case 3. T. J., a female patient, 40 years of age. Following operation for myomatosis and hernia, pneumonia and respiratory insufficiency had set in and tracheotomy had been performed. After the condition had deteriorated and spontaneous respiration had ceased, the patient was transferred to our Department. During transportation she had to be subjected to manual artificial respiration. Administration of curare was unnecessary; mechanical respiration was needed for 2 days. The further course was uneventful.

Case 4. K. G., 22 months of age. Because of stenosing laryngitis, tracheotomy was carried out; soon pneumonia occurred. In spite of aimed antibiotic treatment, the process became more and more extensive and asphyxia set in. Through the tracheotomy cannula, manual artificial respiration was started. Because of the improvised character of this and transportation in open air for several hundred meters the patient arrived at our Department in the state of clinical death. On resuscitation with mechanical respiration heart sounds and spontaneous breathing appeared. The patient then was curarised with the result that circulation became normal and the blood pressure measurable, even slightly high. Sixteen hours later sudden circulatory failure occurred and death set in. Autopsy revealed air only in the borders of the upper two pulmonary lobes, the lungs were otherwise entirely infiltrated and contained several abscess cavities.

Case 5. Cs. S., aged 14 months. Tracheotomy had been carried out because of suffocating laryngitis complicating measles. Grave pneumonia had developed and the patient in a moribund state was transported by air-plane to our Department. Mechanical respiration and curarisation brought about rapid relief, the basic process improved gradually. After 6 days mechanical respiration was discontinued.

Decannulation was performed three months later and the patient was discharged.

Case 6. K. Á., aged 17 months. In the patient who had been tracheotomised because of suffocating laryngitis complicating measles, severe staphylococcal pneumonia developed postoperatively. Mechanical respiration was started in a critical situation; under its effect circulation became normal. Treatment was continued for another 3 weeks but the pneumonia did not respond to antibiotic treatment and increased to extreme degrees. The right upper lobe coalesced to a large abscess cavity. Two episodes of pneumothorax were successfully treated by suction. Arrosion of the bare pulmonary artery in the abscess cavity, however, led to death in a few minutes.

Case 7. M. I. 2½ years of age had suffered from influenzal laryngotracheobronchitis and been tracheotomised. At admission, the child was in a desperate state, excited, dyspnoeic, cyanosed. Inhalation of oxygen brought no relief. After a few hours, in a deteriorating state, curarisation and artificial respiration were introduced, with the result that cyanosis ceased, the pulse became normal, the state improved. After further improvement for a week, treatment with the respirator was discontinued. Decannulation and discharge occurred after further 2 weeks.

Case 8. M. J., one year of age was subjected to tracheotomy because of obstructive laryngitis following measles. Pneumonia developed. As this did not improve on conservative treatment, respiration combined with curarisation were necessary. Circulation and the general state of the patient soon improved, and mechanical respiration could be stopped after 6 days. Because of difficulties at decannulation, the patient was discharged only after further 2 months.

For the graphic demonstration of the clinical course, the data of Case 8 are illustrated in Fig. 1.

Case 9. N. J., aged 31 years. The patient was admitted after a preceding period of

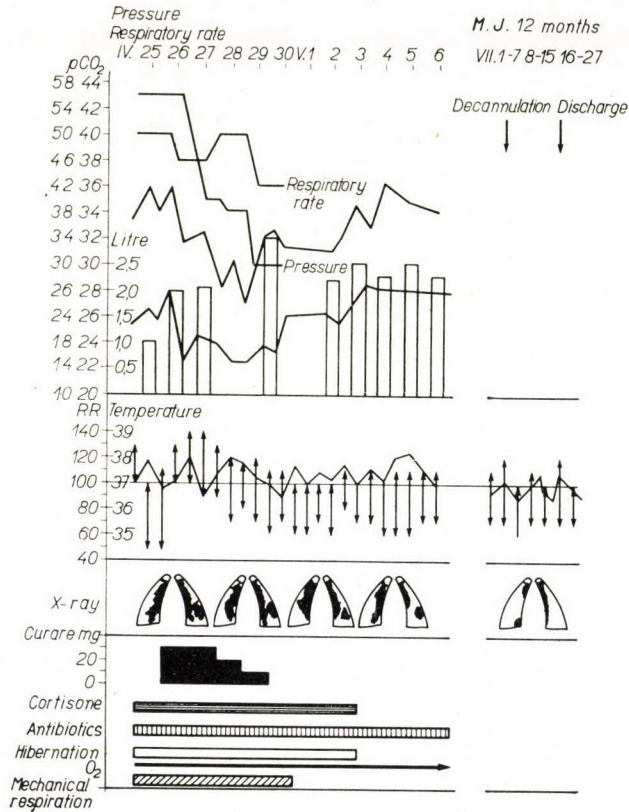


FIG. 1. M. J. Age, one year. In the upper part, respiratory rate; positive pressure in cm H₂O; pCO₂ in expired air measured by gastrotonometry, in mm Hg. The columns illustrate minute ventilation measured in the course of treatment. Further symbols show arterial blood pressure, temperature, X-ray findings and data of the treatment

illness of one week, in a very severe state, with extensive bilateral pneumonia. Grave cyanosis incorrigible by oxygen inspiration, high fever, abundant secretion in the respiratory tract and pulmonary oedema made it necessary, as a last resort, to carry out tracheotomy, to start continuous suction and to introduce positive pressure artificial respiration combined with curare and antibiotic treatment. As a result, the patient regained consciousness, breathed, however, against the machine. This state improved significantly on repeated administration of curare, so that half an hour later he was cyanosed only slightly and simultaneously the foamy serous discharge tinged with

blood, characteristic of pulmonary oedema, also disappeared. In the X-rays the bilateral extensive process was so severe that its dense shadow could not be distinguished from that of the heart. Mechanical respiration and curarisation were maintained continuously for 9 days, and periodically for another 3 days. The pulmonary process improved gradually. Recovery was complete after several weeks, during which a cerebral complication of unclear aetiology (presumably septic metastasis) was also experienced.

Case 10. D. L., 14 years of age. Extensive pneumonia had developed in this patient suffering from progressive polyradiculoneuritis with symptoms of muscle

palsy and paraesthesia, but with the respiratory muscles intact. He was referred to our Department because of respiratory insufficiency. He was admitted in a state of deep shock. Antishock treatment combined with artificial respiration without curarisation proved to be successful. Following suction of about 1 litre of exudate from the right half of the thorax, the X-rays showed such an extensive and dense pulmonary infiltration that neither the heart nor the diaphragm could be distinguished. After 10 days' treatment the respiratory distress improved but 3 weeks later the patient died of marasmus in consequence of the progression of the basic disease and septicaemia originating from the residue of the pleural process.

DISCUSSION

Intermittent positive pressure respiration in combination with curarisation was employed by some authors with a purpose identical with ours [1, 5, 8]. Though some of the reported cases were similar to our above described ones, the method was recommended only to relieve some special respiratory disturbances (respiratory distress of newborns and prematures, postoperative pneumonia) and not in general for the treatment of pneumonic respiratory distress.

In the above reported cases intermittent positive pressure respiration was applied in desperate, mostly terminal cases of pneumonia. This circumstance provided sufficient security in the estimation of the treatment's effectiveness. The fact that from among 10 cases only 3 died, must be regarded as a considerable success, the more so as from the lost subjects, one died of a late compli-

cation of an irreversible process and another patient in consequence of a different condition following recovery from pneumonia. Even more convincing was the dramatic improvement following the introduction of mechanical respiration in patients in a moribund state, with hardly functioning pulmonary parenchyma.

For this dramatic improvement of respiration and circulation several factors have been responsible. The therapeutic effect of tracheotomy itself is well known. Regular suction of the tracheal secretion is also a significant factor, especially if in the development of massive pulmonary shadows obstructive factors must also be taken into consideration. In the indication of intermittent positive pressure respiration for the treatment of pneumonic respiratory distress, a mechanical substitution of the increased pulmonary work was of primary importance [6, 9].

The problem, however, is more complex. It has to be considered that in the surroundings of inflammatory foci, oedematous areas develop in the pulmonary parenchyma. On the influence of mechanical respiration, oedema subsided, gas exchange improved and even in very extensive processes — at least as to O_2 output — significant hyperventilation has been observed during treatment. Oxygen therapy can be carried out with favourable results by a simple oxygen inhalator. Intratracheal respiration with a gas mixture of a controlled 40 per cent O_2 , is even more effective. The suppression by means of intermittent

positive pressure breathing of the shunted circulation arising through the venous network of the bronchial subepithelial capillaries, is regarded as an interesting possibility [7].

An important role is attributed to curarisation although in three of our cases curare administration proved to be unnecessary. It was repeatedly observed that on the cessation of the relaxant effect the circulation of the patient deteriorated; on the other hand, by curarisation rest could be achieved and circulation improved significantly. In this effect, next to muscle relaxation, other factors must have also played a role. Untoward effect of curare have not been observed; the simultaneously administered antihistaminic drugs were probably responsible for the absence of blood pressure fall following curarisation.

In spite of its convincing effect in pneumonia accompanied by respiratory distress, intermittent positive pressure respiration combined with myoneural blocking should be applied in the gravest cases only, since it means a fundamental interference with the vital processes. The patient subjected to such treatment demands exceptional care and a very regular control of circulation and respiration, first of all of CO₂ output. A serious disadvantage is the indispensability of tracheotomy; in small children this may constitute the source of new complications. According to our experience, however, intermittent positive pressure breathing combined with curarisation should be regarded as a method suitable for gaining time in the most desperate phase of pneumonia, until improvement is setting in.

SUMMARY

In ten patients with extensive pneumonia and in an extremely grave state, tracheotomy was performed and intermittent positive pressure breathing combined with continuous curarisation was applied. The aim was not to correct hypoventilation,

but to relieve the overstrain put on the organism by the forced respiration under unfavourable mechanical conditions. The method has been found suitable for gaining time in the gravest phase until improvement is setting in.

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