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Pathogenesis and Treatment of Respiratory Disorders in Botulism

By: L.M. POPOVA (Moscow)

Neurological Institute (director: Member of the Academy of Sciences, USSR - prof. N.V. KONOVALOV), Academy of Medical Sciences, USSR

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(Translated by: Edward Lachowicz, Maryland, Medical-Legal Foundation, Inc., 700 Fleet Street, Baltimore, Maryland, 21202)

The treatment of acute cases of botulism presents great difficulties, consequently the lethality rate varies between 76.7% (DOLMAN, 1961) and 28% (A.M. KORITSKII, 1937). Respiratory disorders are one of the main causes of death. Yet, the pathogenesis of these disorders still remains insufficiently explored. It is to this day unexplained, which sections of the nervous system - that participate in the respiratory function - are the most affected by botulism. N.V. KIRTOVSKII et al., (1937) links respiratory disorders with the paralysis of the diaphragm. E.K. EVZEROVA and V.M. ZHITOMIRSKAYA (1937) consider that death from botulism follows due to "respiratory paralysis" and due to "asphyxial collapse". DOLMAN (1961) explains fatal consequences by the paralysis of respiratory and circulatory centers, and N.A. GOVSEEV (1937) by the involvement of reticular formations in the myelencephalon. The inconsistency of opinions as to the pathogenesis of respiratory disorders is one of the main reasons why there is a lack of well developed methods

of treatment of respiratory disorders in botulism (S.YA. SHTEINBERG et al., 1937).

The first attempts to treat respiratory disorders in botulism were made by ROSEN (1938), WATSON (1939) and GEIGER (1941). The authors used rigid-dome respirators in cases of acute botulism. Yet, their effectiveness was limited on account of pulmonary complications of the aspiration type that harassed the patients (GREI, 1948). Taking into consideration some similarity of bulbar impairments in botulism to those in bulbar poliomyelitis (BOFENKAMP et al., 1949) and utilizing a greater experience in the treatment of bulbar type of poliomyelitis, they performed (first time in botulism) a successful tracheostomy with a subsequent artificial respiration using a lateral respirator. The struggle with pulmonary complications (atelectasis and accumulation of purulent secretions in bronchi) was accomplished by withdrawing secretions with the aid of bronchoscope inserted through the tracheostomy opening (ORTON, 1951), or by usual method (SUTHERLAND, 1960). Records indicate that RICE (1949) effected the longest (71 days) successful artificial respiration by using a rigid-dome respirator and operating it in conjunction with repeated bronchoscopies by way of tracheostomy.

We submit here a report relating own observations.

Patient B., 25 years old, was admitted on February 11, 1962 to the Respiratory Ward of the Neurological Institute on recommendations of the Clinic of the 7th Hospital for Infectious Diseases. He became ill in the morning on February 4, suffering from

dimmed vison, nausea and staggering gait. A little later, a double vision appeared as additional symptom and the patient's condition became aggravated between the 6th and 7th day of February with the appearance of muscular weakness, ptosis of both eyelids and a difficulty in swallowing. As his voice acquired a twang on February 8, liquid food was repeatedly ejected through the nose and he had difficulties in holding his head erect. On February 9, with his disease diagnosed as food toxinfection, the patient was transferred to the Hospital for Infectious Diseases, where the latter diagnosis was disclaimed. Later, the patient was admitted to the Neurological Ward with the diagnosis of truncal encephalitis.

The patient's condition on February 11 was very poor. Conscious, but restless, he complained of breathing difficulties, urinated occasionally in bed and often tried to select the most comfortable position to relieve his breathing difficulties. Diplopia. Bilateral ptosis was determined, i.e. more severe on the right side, also a considerable restriction of eyeballs' movements and nystagmoid twitchings on attempts to look to the left. The right corner of the mouth was drooping, swallowing was very difficult and the soft palate became rigid. The pharyngeal reflex was reduced. Then appeared acute paresis in the neck muscles, the head was dropping forward and the patient supported it with his hands. The strength of cleidosternal-mammillary muscles was weakened. The tongue deviated slightly to the right. Slight dysarthria. No pareses in extremities. Tendon reflexes D > S. No impairments

in the sensory sphere and no disorders in coordination.

In order to relieve his restlessness, the patient was administered aminazine. As serious suspicions indicative of botulism aroused, the patient was given (by intramuscular injection) 60,000 BU of antibotulinal antitoxic serum of the A and B types. Then, we tried to feed him by tube and this aggravated his conditions, also respiratory difficulties increased considerably.

About 6 A.M., on February 11, the patient's condition was extremely poor: he waked up conscious, but irritable and pale, he could not talk, but made gestures to express the condition in his thorax. His respiration was bubbled. He received injections of cordiamine and continous flow of oxygen from an airtight bag. Yet, the respiratory difficulties increased and tachypnea developed. Thus, in view of very grave conditions, the patient was transferred to the Respiratory Ward.

Also his general condition was very poor at the time of admittance. A serious general pallor and yellowish discolorations covered his skin. Mucous membranes and sclera were slightly yellow. A general dehydration and decreased turgescence were apparent. His nourishment was reduced. The respiration weakened sharply in lungs, its rate was 30 per minute. The type of respiration was paradoxical, i.e. at the height of entry a retraction took place in the epigastric region. A periodic emergence of the stenosal type of respiration occurred with the drawing back of jugular fossa at the height of entry. Absence of cough impulses were due to extensive paresis of abdominal muscles. Heart sounds were muffled. The arterial

pressure was 150/90 mm. Normal temperature. His tongue was furred with a thick white film, mucous membranes were dry and a purulent coating was detected on rear wall of the pharynx. A fetid odor emanated from his mouth and the abdomen was moderately distended. No evacuation of bowels occurred in the last 4 days. Ischuria developed.

Pupils of normal form, D > S. Convergence and accomodation adjustments were lacking. Ptosis of both eyelids was symmetrical. Absence of eyeballs' movements. The tension of mastication muscles was considerably weakened. The mouth could be opened with difficulty, but no wider than 1 cm. Effective movements of mimetic muscles were sharply reduced: only a hint of closing the eyelids could be brought out; the same applied to contracting of brows, to movements of jaws, to puffing up cheeks and to showing his teeth. The soft palate was rigid. The pharyngeal reflex and the soft palate reflex were absent. The epiglottis was stiff, vocal folds became invisible, the voice was nasalized and the swallowing impossible. He could hardly move his tongue. Considerable dysarthria. Acute paresis of the neck muscles. The volume of movements in arms and legs remained full, but the strength was reduced in all groups of muscles. The patient could not turn around independently. A general severe adynamia. Diffused muscular hypotonia. Fascicular twitchings in major thoracic muscles. Tendinous reflexes live. Absence of pathological reflexes; abdominal and sole reflexes diminished considerably and showed a rapid enervation. No impairrents of sensitivity.

X-ray pictures revealed a rigid diaphragm. On the right side a deep and homogeneous shading was visible in lung tissues that corresponded to an average lobe of the right lung. Blood test: Hb 80 units alkali; erythrocytes 4,600,000; color index 0.97; leukocytes 18,100; "P" (TN: polymorphonuclear cells?) 3.5%; "S" (TN: stab cells?) 78%; lymphocytes 6%; monocytes 5%; E.S.R. 5 mm per hour (sic!). Urine test: albumin 0.99%, specific gravity 1020; no sugar; leukocytes 5 to 8 in visual field. Erythrocytes not changed, granular 0 to 1 in the preparation. Residual nitrogen on February 11 was 79.2 mg%. Cerebrospinal fluid: albumin 0.33‰; cytosis 1, Pandy's reaction slightly positive. Bilirubin in the blood (according to van den Bergh's test) was 2.2 mg% and direct reaction was negative. General protein 6.77 gm%, albumins 4.57% and globulins 2.2%.

As ascertained later, three mild cases of poisoning with slightly salted herring were reported from the community of the patient's vicinity. In connection with this, the patient received additionally, each day, for 3 days, 75,000 BU of antibotulinal antitoxic serum of the A and B types by intramuscular injections.

Recognizing that the patient's life was in danger due to respiratory difficulties and bulbar involvements with the appearance of hypoxia, also due to cardiovascular disorders and pulmonary complications (atelectatic pneumonia, right side), we performed a tracheostomy on the patient in accordance with his vital indications. We found in trachea an accumulation of purulent secretions with fetid odor. Seeding of purulent sputum revealed

a growth of staphylococci and Bacillus coli, which proved to be nonsensitive to antibiotics. After completed suction of purulent secretions, we connected the volumetric respirator of Angstrem's type to provide a constant endotracheal artificial respiration with a positive pressure that effected 18 rhythmic alternations per minute. The per-minute volume was 10 liters (8 l of air and 2 l of oxygen). With the alignment of artificial respiration, the arterial pressure was reduced to 120/95 mm and the rate of pulse dropped from 140 to 120 per minute. We noticed a mild pattern of alkalosis with pH fluctuations between 7.55 and 7.57 during partial CO_2 pressure at 21 to 28 mm Hg and the saturation of arterial blood with oxygen up to 96%.

Along with artificial respiration we administered to the patient a subcutaneous drip of fluid, then an injection of fluid into the stomach by a tube, also a suction of tracheal secretions by means of catheter, then application of antibiotics, first siphonal, later high enemas with the latter, both intended to evacuate the rectum and to cleanse it mechanically.

The patient's condition during the first 10 days was extremely poor. His temperature varied between 37.8 and 38.6°C; his natural respiration was negative. He endured a severe paresis of intestines for 20 days. Normal functions of intestines returned no sooner than on March 8. Up to February 19 we observed yellowish discolorations of skin and symptoms of increased bleeding. Blood tests revealed the number of leukocytes was between 17,800 and 16,800 and, even on the 23rd day of his illness, the E.S.R. was 60 mm per

nour (sic!).

A slight weakness in proximal parts of the patient's left arm appeared on the 14th day of his illness, then reflexes in arms diminished, while a general adynamia increased in muscles of the trunk and extremities. Inasmuch as similar conditions could result from additional arrival of toxin, we administered a subsequent injection of antibotulinal serum and this caused periodic shock chills accompanied by the increase in temperature to 40°C, by the increase in arterial pressure to 180/90 mm and by the increase in pulse rate to between 110 and 120 beats per minute. The general condition of the patient began to improve effective February 19 (15th day of illness). His temperature returned to normal on February 21st (17th day of illness). Yellowish discolorations decreased and the secretions taken with sputum specimens were less fetid. Now, as symmetrical restitution of the oculomotor nerve functions began from their neurolytic status, we disclosed only a monocular nystagmus; we also noticed some improvement in efforts of opening the mouth and in movements of mimetic muscles. Moreover, the patient was able to move his tongue forward. Yet, the paralysis of the soft palate muscles and of epiglottis still remained; the same persistence was in muscles of the neck and in respiratory muscles. We noticed a diminution of tendinous reflexes in the reflex peripheries. On 23rd day the patient was able to breath independently up to 2 hours in 24 hours. The respiratory rate was 23 and 24 per minute.

Considerable improvements of all respiratory functions began

on March 2 and they included: natural respiration up to 8 hours in 24 hours; restitution of the eyeballs' movements and of the functions of mimetic muscles. But, much slower progressed the restitution of the masseter and pharyngeal muscles, also of the soft palate and neck muscles. From March 6 the patient needed the respirator only at night, and from March 9, i.e. on 33rd day of his sickness, he was able to breathe freely for 24 hours. He began to swallow liquid food on 32nd day of his illness and a full restoration of swallowing took place on the 36th day along with the ability to speak, although the twang and diplopia still remained. We still observed accommodation paresis in neurolytic status on 42nd day of illness, also nystagmus and a moderate weakness of neck muscles, as well as a weakness in proximal parts of the left arm muscles. Breathing difficulties were not checked when vital capacity of lungs was 2.4 liters. The patient began to sit on 44th day and to walk on 56th day, but his gait was uncertain and staggering. Decanulation was performed on the 55th day of illness.

The patient was discharged in good condition from the hospital on May 20, i.e. after 106 days of illness. He carried a heavy scar in the vicinity of his tracheostomy. Vital capacity of lungs was 3.2 liters. We merely noticed a still resistant accommodation paresis in neurolytic status.

In this way developed a severe form of botulism in the patient: it was followed by respiratory difficulties that threatened his life. As far as we know, similar cases usually ended with death.

Our study of the pathogenesis of respiratory difficulties in

botulism revealed that this process assumed a combined pattern. The first respiratory difficulties (on the 3rd day of illness) were influenced by the pharyngeal paralysis which manifested itself by disturbances in swallowing, phonation and in speech. In connection with the pharyngeal paralysis, breathing difficulties developed due to paralysis of vocal cords and epiglottis, then due to retraction of the tongue, as well as from the aspiration of food, also due to vomited particles lodged behind the pharynx's constrictors, and all caused each time disturbances in the passableness of air passages. On the 6th day of illness were added to these dangerous symptoms also peripheral paralyses of the respiratory and abdominal muscles, and this caused an acute decrease in the ventilation of lungs and disorders in the mechanism of expectoration.

It is apparent from the described analysis of the clinical picture of respiratory difficulties in botulism that they develop a combined pattern; we denoted these difficulties as of the pharyngospinal type. During the entire course of the disease there was no reason to suspect in the patient any disorders in the central controls of breathing: the respiratory rhythm was normal and we failed to observe any discoordination in movements of the paretic respiratory muscles. Thus, among all parts of the nervous system that participate in realization of the respiratory event, we find in botulism that the most severely impaired were the functions of the lower group of cranial nerves that innervated the muscles of swallowing, those of the larynx and tongue, also of

the spinal cord at the neck level and at the level of the upper thoracic parts which protect the innervation of the diaphragm and of the intercoastal muscles.

The respiratory disorders in botulism differ from those usually observed in poliomyelitis and in other truncal encephalitides by a sharply expressed symmetry of impairments in respiratory and pharyngeal muscles, by the dryness of mucous membranes and by the absence of disorders in the central respiratory control. As we know, in bulbar forms of poliomyelitis the pharyngeal paralysis is accompanied by salivation and by abundant accumulation of secretions, consequently these forms of polio were named "wet". Mucous membranes in botulism are dry, thus a wrong impression may be created about the absence of obstruction symptoms in respiratory passages and concerning the indications to tracheotomy. At the same time, the indicants about the impaired passableness of respiratory tracts are always present as a result of the available pareses in constrictors of the pharynx, also in muscles of the soft palate and in larynx, as well as due to retraction of the paralyzed tongue.

Our method of treatment of respiratory paralysis in botulism differred from that used up to now by the factor that we conducted a prolonged artificial respiration without using a rigid-dome respirator and bronchoscopies for suction of secreta. We employed a method of the prolonged endotracheal artificial respiration under a positive pressure, with the aid of volumetric respirator of Angstrem, also a suction method and drainage of bronchi by means

of a vacuum in conjunction with the pulmonary therapy. We applied this method of treatment of botulism for the first time in the USSR. We failed to find in foreign literature any descriptions of the treatment of respiratory paralysis in botulism with the aid of Angstrem's apparatus. This method of treatment appeared to be more effective and sparing: the patient never received bronchoscopic treatment for removal of mucus, also the ventilation of lungs was performed more accurately. The insufflated air was well moistened and warmed, which prevented development of purulent crusts in respiratory passages and it also proved to be a good prophylaxis of atelectases. The use of volumetric respirator instead of a rigid-dome respirator permits to secure a better care and easier handling.

We consider necessary to point out that, in all acute cases of botulism, in which respiratory difficulties endanger the life, one must use unconditionally and at the proper time, well prepared modern methods of treatment of respiratory difficulties with the aid of respiratore. Since all measures of the struggle with respiratory difficulties in botulism are, at times, applied for many weeks, it is advisable to conduct such treatment in Respiratory Wards and Centers, where respiratory apparatuses are available, as well as a trained and well-organized medical personnel.

Summary

The paper describes a severe form of botulism in a 25-year old patient. The course of the disease was manifested by respira-

tory disorders of the pharyngospinal type. For treatment the author employed endotracheal artificial respiration under a positive pressure by means of Angstrem's respirator for a course of 27 days. Pulmonary complications were controlled by suction of the bronchial secreta with Timan's catheters in conjunction with pulmonary therapy. Recovery was complete with the exception of a mild accommodation paresis.

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