

Н.О. Карпович

**"ЖЕЛЕЗНЫЕ ЛЕГКИЕ" - ДЫХАТЕЛЬНЫЙ АППАРАТ ДЛЯ ПАЦИЕНТОВ,
ПЕРЕНЁСШИХ ПОЛИОМИЕЛИТ**

Научный руководитель: ст. преп. О.М. Костюшкина

Кафедра иностранных языков

Белорусский государственный медицинский университет, г. Минск

M.A. Karpovich

"IRON LUNGS" - BREATHING APPARATUS FOR POLIO VICTIMS

Tutor: senior teacher O.M. Kostiouchkina

Department of Foreign Languages

Belarusian State Medical University, Minsk

Резюме. В статье проанализированы основные аспекты полиомиелита: первые упоминания, эпидемии и создание вакцин. Описан тяжелый характер протекания болезни, приводящий к параличу. Для поддержания жизни такие пациенты помещались ниже плеч в специальный респиратор «железные легкие». Со временем этот аппарат получил несколько модификаций, но он до сих пор используется пациентами, пережившими эпидемию середины 1950-х годов.

Ключевые слова: полиомиелит, аппарат, искусственная вентиляция легких, "железные легкие", вакцина.

Resume. This article deals with the main aspects of poliomyelitis: the first records, outbreaks of epidemics and the creation of vaccines. A severe course of the disease, leading to paralysis, is described. To keep such patients alive, a special respirator of the body-encasing type called the "Iron Lungs" was invented. Over time, it has got several modifications, but the "Iron Lungs" are still being used by the survivors of the epidemic of mid-1950s.

Keywords: poliomyelitis, apparatus, artificial lung ventilation, "Iron Lungs", vaccine.

Relevance. Studying the experience of using the "Iron Lungs" device in the treatment, rehabilitation and life support of patients suffering from respiratory diseases can help to apply similar, but modified up to date methods in medical practice. In view of this, every year more high-quality and technologically advanced devices can be created that will prevent and help to fight a wide range of respiratory diseases, including at-present relevant COVID-19, facilitating its course and improving the patient's condition.

Objective: to study information about poliomyelitis epidemics and ways used in the past for its treatment and prevention.

Tasks:

1. To study the epidemiological facts about the disease.
2. To show general outcomes and complications caused by the disease in children.
3. To find out the information about the development of vaccines against poliomyelitis.
4. To study the information about the "Iron Lungs" apparatus as a method of maintaining the life of polio victims.

Material and methods. Scientific and educational literature, articles, textbooks as well as Internets resources published in our country and abroad.

Results and their discussion. Poliomyelitis is an acute viral disease characterized by inflammatory changes in the nasopharynx, intestines and damage to the nervous system with the development of paralysis.

Polio was common in ancient Egypt and Babylon. One of the tombstones depicts the priest of Ruma, who makes a sacrifice in the temple to the goddess Astarte, the patroness of earthly fertility and motherhood. The hieroglyphic inscription reports that Ruma was crippled since childhood. This is also confirmed by the deformation of the leg bones, characteristic of paralysis caused by poliomyelitis. Numerous mummies with traces of paralysis also testify to poliomyelitis.

The causative agent of this disease, which terrified people three millennia ago, was first described in the monograph “*La Poliomyélite aiguë épidémique*” in 1913 by famous virologists and bacteriologists C. Levaditi and K. Landsteiner, who had worked for 60 years at the Pasteur Institute and the Fournier Institute in Paris. They were among the first researchers to grow viruses on living cells. Poliomyelitis turned out to be a severe viral disease caused by several types of viruses. The creation of a safe vaccine was crucial to prevent this formidable disease.

In the 1950, a polio outbreak occurred in the United States. About 50 thousand people fell ill, more than 21 thousand remained paralyzed for the rest of their lives. In many countries, the epidemic took on the character of a national disaster. The main victims of the virus were children aged 6 months to 5 years. In the paralytic form of the disease, the polio virus infects the motor cells of the spinal cord. Muscles deprived of innervation fail. The child becomes handicapped for life. In the worst case, the parts of the brain responsible for the work of the diaphragm are affected. The patient dies of suffocation. [1]

The only thing that could save children was continuous artificial ventilation of the lungs. The technique of blowing a gas mixture into the lungs was developed during the Great World War and the artificial lung ventilation apparatus became an integral part of the anesthesia apparatus. But what was suitable for operating rooms and intensive care units was not suitable for small victims of polio.

In 1904, a young doctor, Ernst Ferdinand Sauebruch from Breslau, began to perform chest operations inside a chamber with variable air pressure, from which only the patient's head protruded. When the pressure in the chamber was lowered below atmospheric, the air rushed into the patient's lungs, and when it was increased, on the contrary, it left the lungs, simulating inhalation and exhalation. Artificial ventilation devices of this type were called "tank" ventilators.

On October 12, 1928, an eight-year-old girl with polio who was dying of suffocation was placed in a tank ventilator at the Boston Children's Hospital. Within a few minutes, the child's condition began returning to normal.

In course of time, the devices improved, became more convenient, cheaper and more reliable. In 1952 in Sweden, the first mass-produced apparatus constructed by C.G. Engstrom appeared. It served as a prototype for many products, including the Soviet AND-2 and the RO family. Engstrom found that existing artificial ventilation devices did not adequately ventilate patients with severe poliomyelitis. The Swedish physician solved this problem with his respirator, by blowing air into the patient's lungs via a simple tube

through the trachea. The respirator had a cylinder to determine the amount of air, and a pump. It was a device that received the name "Iron Lungs" (Fig. 1) which stuck in medical usage. The need for devices of this kind was so great that they were even produced at the car factory. For example, about 2000 such devices were produced at one of the automobile plants, but ten times more were required. Multi-seat devices were created. [2, 3]



Fig. 2 – Apparatus "Iron Lungs"

The scale of the catastrophe that struck humanity is clearly illustrated by a photograph taken in a hospital in California (Fig. 2). The halls of hospitals filled with "Iron Lungs", with children lying in them, have become part of the healthcare system and a typical plot for the mass media. Thousands of children lived in "Iron Lungs", who were forced to lie down and look at the world with the help of mirrors installed around them. Later, patients were discharged home. There they had also to be inside the apparatus, which their relatives were taught to operate.



Fig. 3 – California hospital hall with Engstrom machines

The treatment remained symptomatic. The classic measure for the fight against epidemic diseases – quarantine – has been actively used since 1916, but did not give any effect. Non-paralytic forms of the disease often were insidious, and so common that it would have been necessary to isolate virtually the entire population. Doctors had one more untapped tool to fight infection – vaccination.

In 1955, a vaccine made by virologist Jonas Salk appeared in the United States. He created an inactivated polio vaccine.

Salk's work on the vaccine was funded by the polio research support fund set up by the family of US President F.D. Roosevelt. It was believed that he had already suffered polio as an adult, after which he could only move in a wheelchair.

Russian scientists A.A. Smorodintsev and M.P. Chumakov in 1956-1958 created a vaccine in the form of syrup or dragee candies. They organized the production of a live polio vaccine. Its introduction into practice led to the elimination of polio outbreaks in the USSR and a number of other countries. Thanks to mass immunization in the USSR, poliomyelitis was completely eradicated in 1961.

In order to test the vaccine, someone had to take it. In the book "The Tamed Virus", A.B. Prutko writes: "A.A. Smorodintsev made up his mind: he vaccinated his beloved granddaughter. For the sake of the health of millions of children, this was done by a person who better than anyone imagined the consequences of a possible failure. It was feat in the name of millions of people." [5]

Children, placed in the "Iron Lungs", could not leave them without immediately being connected to another ventilator. The patient in the apparatus was forced to lie on his back and could not roll over on his stomach. He had to drink and eat using a straw. In addition, it was necessary to synchronize each sip with the rhythm of the apparatus: food could only be swallowed while exhaling, otherwise it could get into the windpipe. Patients required such nutrition for many months and years that they spent in the apparatus. They grew up in the "Iron Lungs", lived in them for decades, and died in them. However, it was thanks to the "Iron Lungs" that some of them became great people and achieved a lot in their lives.

76-year-old Texas resident Alexander Paul spends most of his time in the "Iron Lungs" machine (Fig. 3). Various diplomas of education, awards and photos with his family hang in his living room. When he "recharges" in the capsule, he types or answers messages on his phone with a pen. He ties the end of it to a stick he holds in his mouth. Despite his illness, Alexander graduated from the University of Texas and became a lawyer. He was not ashamed of his condition and moved a life support device to his dorm room. After that, the man became a local star – all the students wanted to look at this unusual capsule. At court hearings, the American took a portable breathing device and performed in a wheelchair.



Fig. 4 – Photograph of Alexander Paul with his mirror

Conclusions:

1. Poliomyelitis was almost stamped out in after the epidemics of the 1950s. But even today it reminds of itself again. The number of cases dropped rapidly and by 1988 there were 350 thousand infected in the world. After the joint work of the governments of different countries, this number also dropped sharply – in 2022, specialists recorded only 100 cases of the disease. Several cases of poliomyelitis have been reported in Ukraine due to vaccination failures. A dangerous variant of the virus was discovered in Israel. Outbreaks of infection have been noted in the Middle East and Africa. [4]

2. It is known that patients living in "Iron Lungs" also exist at the moment. They are three, aged 74 – 86 (Martha Lillard – 74, Alexander Paul – 76, Mona Randolph – 86), all of them are from the USA. During their lives they have achieved great success and they can really be called survivors of our time.

3. As long as there is one infected child left in the world, children in all countries are at risk of polio. This serves as a guarantee that the memories of the "Iron Lungs" device will go down in history, but it will still remind us the stages of the fight against such a formidable disease as poliomyelitis.

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