

A WORLD WITHOUT VACCINATIONS?



DISEASES WE'VE FORGOTTEN ABOUT THANKS TO VACCINATIONS

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AKADEMIA
LEONA KOŹMIŃSKIEGO

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Warsaw 2024



WHO IS THIS GUIDE INTENDED FOR?

Do you have small kids and are wondering whether it would be better to vaccinate them now or wait a few months? Or maybe you've heard that experiencing the disease provides better immunity than getting vaccinated?

Most of the diseases which vaccines are supposed to protect us against you probably only know by name. Maybe you think that, thanks to scientific advancements, modern medicine is able to deal with each of these diseases, even if your child or you contract them?

If this is the case, be sure to read this guide. You will find answers to most of the questions that are bothering you, about vaccinations and the diseases they protect against. Our doctors and experts talk interestingly about diseases that we mainly know from literature and which most of us have never encountered. They also show us what a world without vaccinations would be like.

THE BEGINNINGS OF IMMUNIZATION

It's 1757. Gloucester, Great Britain. An eight-year-old boy observes, with a mixture of disgust and fascination, a small scratch into which a doctor is rubbing a powdered scab removed from the body of a smallpox patient. This is inoculation – a procedure popular in 18th-century England. Its aim is to induce a mild course of the disease and protect the patient against a potentially fatal infection. Our hero is one of thousands of British children subjected to a procedure, which had arrived on the islands from Turkey a few decades earlier.

Inoculation carried a huge risk, as some of the people subjected to it developed full-blown infection. Nevertheless, many parents decided to undergo the procedure, understanding that another smallpox epidemic could wreak havoc in their homes. We should remember that, at that time, one in three infected patients died, and in the case of children, the mortality rate was as high as 80%. Inoculation seemed to be a reasonable choice.

Fortunately, our hero underwent the procedure without complications. He will soon become a doctor himself. His name is Edward Jenner and forty years later he will invent the world's first vaccine.

Jenner wanted to find a safer way to immunize the body against the dreadful disease. To achieve this, he combined inoculation with folk knowledge. People living in rural areas had long associated exposure to the milder cowpox with immunity to smallpox. He wondered what would happen if, instead of the deadly virus, he introduced its less harmful cousin into the patients' bodies.



Edward Jenner administered the first vaccine against smallpox on May 14, 1796. He collected infectious material from the hand of Sara Nelmes, a milkmaid suffering from cowpox, and then vaccinated eight-year-old James Phibbs with it. Painting by Ernest Board.

*Boston Common
Brewer Fountain,
Massachusetts, USA*

Jenner's invention turned out to be groundbreaking. Soon, vaccinations became widespread in Great Britain and other countries. Gradually, an increasing number of children were provided with safety. But it was only thanks to the introduction of mandatory vaccinations and a systematic vaccination plan for the entire global population that something of which Jenner could not even dream about became possible. In 1978, the last case of smallpox was recorded in the world. Since 1980, the disease has been considered eradicated (i.e. completely eliminated). The virus that killed hundreds of millions of people in recent history simply ceased to exist. There was no one left to be infected. Everyone had been vaccinated.

HISTORY OF VACCINATIONS – SMALLPOX



EDWARD JENNER

English doctor,
pioneer of vaccination against smallpox
and father of immunology

1796

Edward Jenner announced the invention of the world's first method of protection against smallpox

1980

The World Health Organization declared eradication of the smallpox

300 million

people died of smallpox in the 20th century
all over the world

Despite these spectacular results, Jenner's idea did not initially meet with understanding. It aroused fear and outrage, becoming the subject of mass protests. Since 1853, when compulsory vaccination against smallpox was introduced in the British Isles, alarming reports about alleged sinister effects of immunization appeared almost every year.

Vaccines were presented, among other things, as the „mark of the Beast” foretold in the Book of Revelation, as a source of animal diseases or even as a tool to transform children into animals (after vaccination, cow horns or hooves were supposed to grow on them). Some also claimed that vaccines prevented entry into heaven, caused mental illnesses, or served as a tool for marking slaves and criminals.

Similar voices can also be heard today. Surprisingly, there is much more discussion going on about the risks associated with vaccinations than about the benefits that we all experience every day thanks to their existence.

Let's try to follow these voices for a moment. What would a world without vaccinations look like? How would we live if Edward Jenner hadn't made his groundbreaking discovery in 1796?

SMALLPOX VACCINE

In 1796, Edward Jenner invented the first vaccine in history – against smallpox. It is estimated that before his invention the mortality rate due to smallpox exceeded 80% in children. Smallpox epidemics caused entire communities to vanish from the map. In the Inca Empire, it caused the death of 95% of the population. The last case of smallpox was recorded in 1978. In 1980, the disease was declared eradicated, meaning it no longer occurred in the natural environment.



Shortly after the discovery of the smallpox vaccine by Edward Jenner, skeptics claimed that vaccinated people grew cow horns. Caricature by James Gillray from 1802.

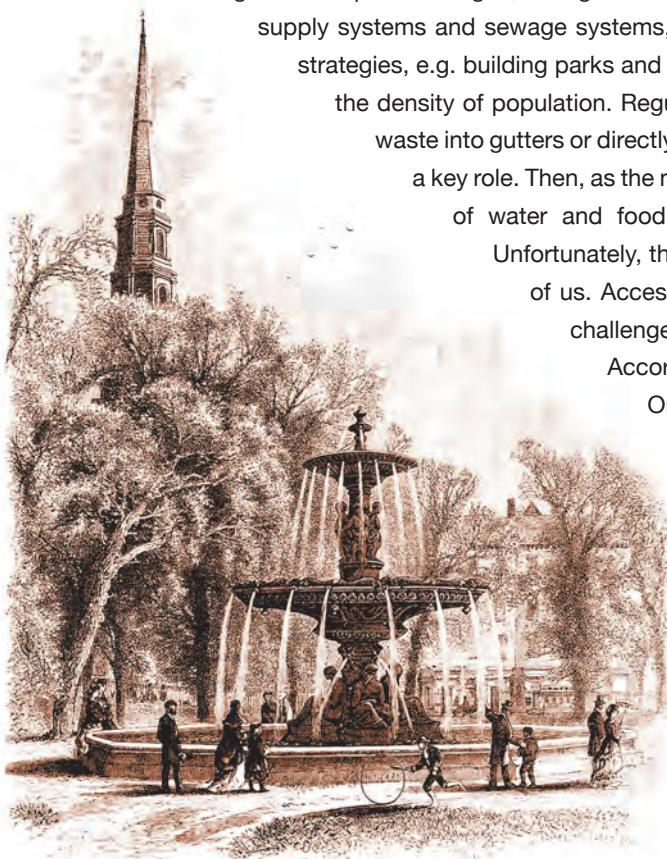
THE SANITARY REVOLUTION

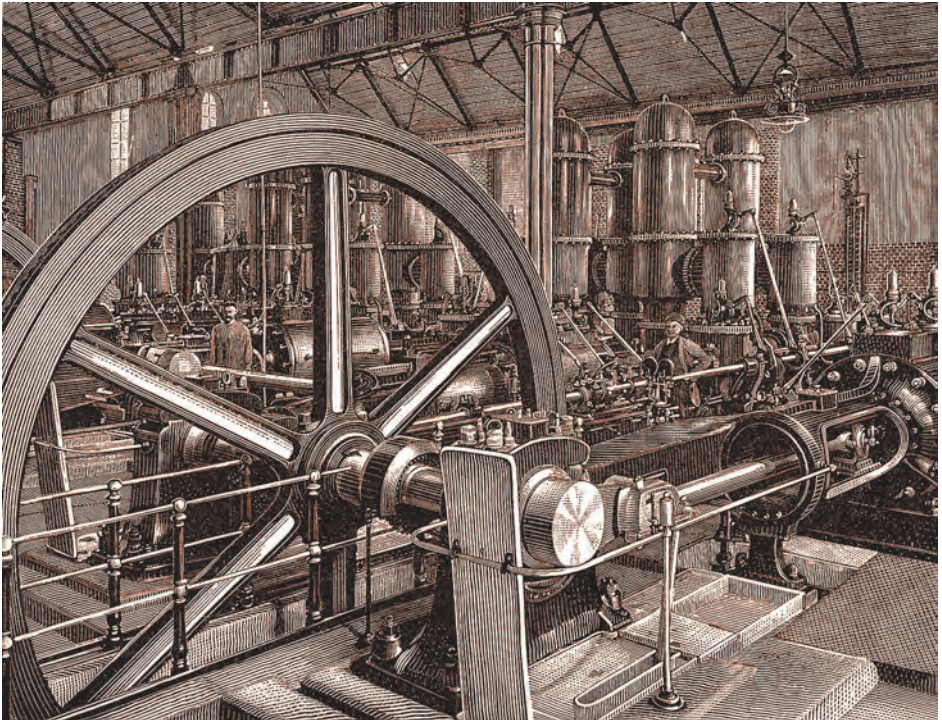
We need to begin with stating that vaccination is not everything. To appreciate and understand its role, we must view vaccines as part of a huge change, which – with no exaggeration – can be called a true revolution.

For many centuries, people believed that diseases were a divine punishment for sins, that they resulted from an imbalance of elements in the body, or that they were spread through mysterious „miasmas.” Regardless of which version was chosen to be believed in, diseased were considered a blow from fate and there was little that could be done about it.

In the 19th century, it was finally possible to prove that local epidemics of typhoid fever and cholera were related to contaminated water sources. The fight against the epidemic began, through the construction of modern water supply systems and sewage systems, as well as urban planning strategies, e.g. building parks and squares in towns to reduce the density of population. Regulations prohibiting pouring waste into gutters or directly onto the street also played a key role. Then, as the next step, the quality control of water and food on sale was introduced. Unfortunately, there's still a long way ahead of us. Access to clean water remains a challenge in many parts of the world.

According to the United Nations Organization over the next decade access to clean and safe drinking water may decline. It is estimated that by 2050, the demand for water will double, and more than half of the world's population will be at risk of water scarcity.

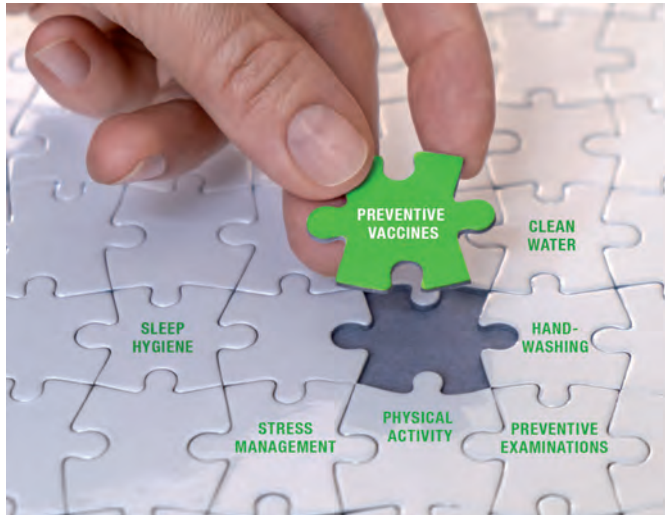




Urban water supply system

Other components of the health revolution include: personal hygiene through hand washing, physical activity, and balanced diet. All of these are preventive measures aimed at maintaining good health. The more often we implement them, the less often we need to resort to medications and other methods of combating diseases.

Vaccinations have become a key component of the shield protecting us from diseases. If we reject vaccinations, should we also give up on clean water and handwashing? After



all, these other elements of the hygiene revolution are based on the same principles, they also stem from scientific research. Why trust doctors when they talk about the importance of handwashing, but reject their opinion on vaccination programs?

WHAT ARE VACCINATIONS?

Vaccinations take advantage of our body's natural ability to learn. Each vaccine contains „information” about a disease, enabling our bodies to develop defensive responses (in Jenner's first vaccine, this „information” was a related cowpox virus).

Vaccination opponents often talk about „artificial immunity.” This is misunderstanding. Vaccines use a natural mechanism to strengthen our defense system. A vaccinated person achieves a certain level of safety against infection, at the same time remaining safe to others. The more vaccinated people there are in society, the lower the risk of developing dangerous infectious diseases.

A world without vaccinations would be a world where the only way for us to develop immunity would be through experiencing each disease one by one, which would be extremely risky. It would be specially threatening to the most vulnerable individuals, who today can take shelter behind the wall built by their vaccinated family, neighbors and friends.

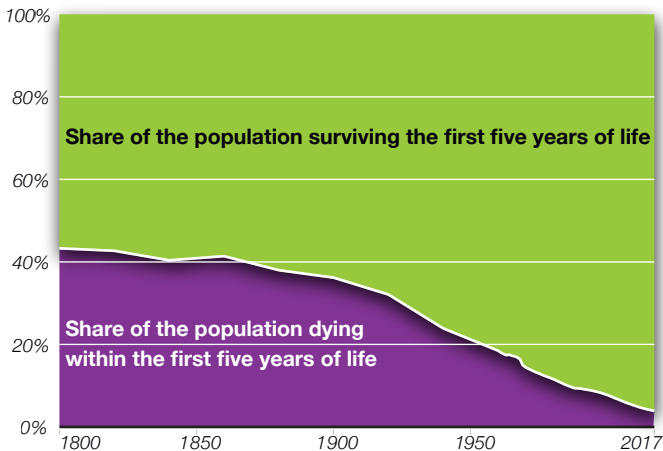
WHAT WOULD A WORLD WITHOUT VACCINATIONS LOOK LIKE?

MORTALITY OF CHILDREN UNDER FIVE YEARS OF AGE

A world without vaccinations was especially cruel for the weakest ones. No longer than 100 years ago, the death of a child was a daily experience for millions of parents. It was very common. Every third child died before the age of five.

The chart below clearly shows the effects of the revolution mentioned here. Nowadays, the mortality rate among children under five years of age is lower than 4%. Over the course of less than three decades, child mortality has dropped by over 50% – from 12.5 million in 1990 to 5.2 million in 2019. The decrease in infant and child mortality observed over the years is the result of increasing prosperity worldwide, better access to education, and healthcare. A key factor responsible for this decline is also widespread vaccination.

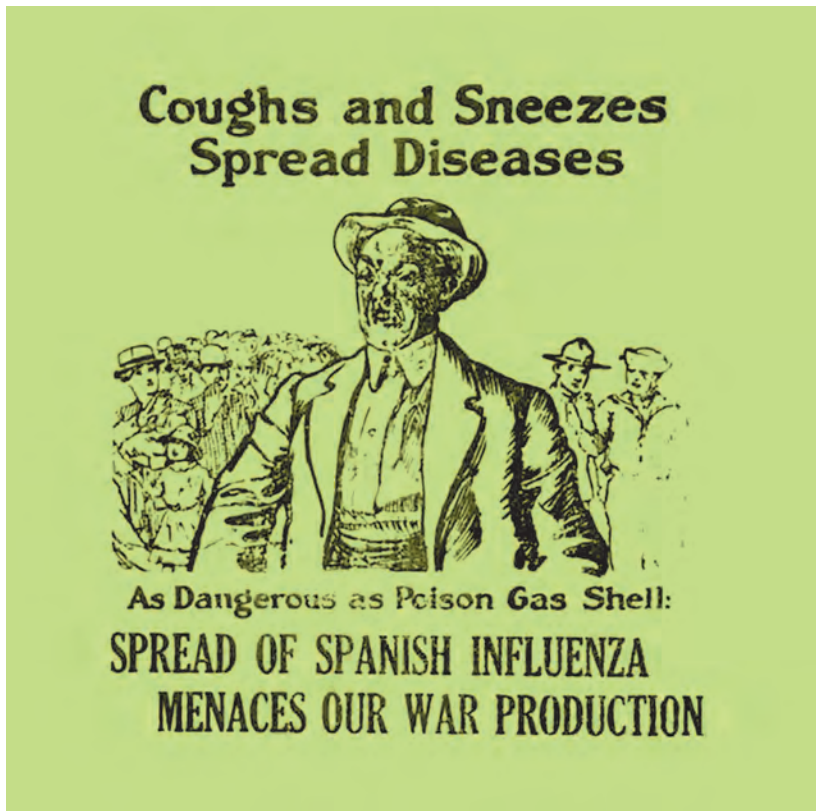
A world without vaccinations would be a world where a significant portion of children die from infectious diseases. Look around. Look at yourself, your children, your friends. Every third one wouldn't be here with you if it weren't for vaccines and the hygiene revolution.



Child mortality around the world. Share of the population dying and surviving the first five years of life.

GREAT EPIDEMICS

Few phenomena have impacted the world's history as profoundly as epidemics. The „Black Death“, an epidemic of the plague that ravaged Europe, Western Asia and North Africa from 1347 to 1352, killed from 25% to 30% of the population of Europe at that time, turning the economy and social order upside down. The „Great Plague of London“ (1665–1666) caused the death of one-fifth of the city's population.



*Spanish Flu: American flyer with the slogan
"Cough and sneezes spread diseases"*

The largest pandemic of the 20th century was the Spanish flu. It occurred in the years 1918–1919 and claimed more lives than World War I. It is estimated that the pandemic was responsible for the deaths of 50 million people across all continents. The Spanish flu mainly caused the death of young and healthy individuals, aged 15 to 44, although the mortality rate was also very high among infants and the elderly.

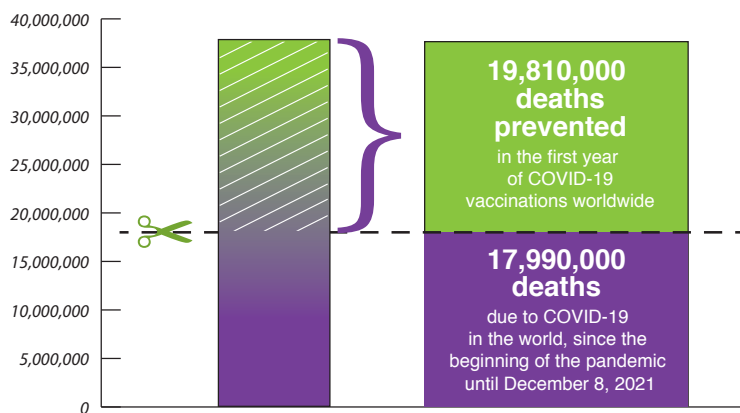
The first flu vaccine was developed nearly 20 years later, in 1937, by an American physician Max Theiler. In 1941, he proved the effectiveness of his invention by vaccinating a group of soldiers in the U.S. Army. As a result, he demonstrated a seventy percent effectiveness of the administered vaccine and protected the soldiers from an epidemic of type A influenza.



*Smallpox in Wrocław in 1963.
A patient in the smallpox hospital in Prząśnik*

In 1963, an epidemic of smallpox (the very same disease against which Jenner developed vaccinations) broke out in Wrocław. The source of the infection was a security service officer who contracted the smallpox virus during a business trip to India. The state of epidemic lasted 95 days. 2,500 people were placed in isolation, nearly 100 became ill, and only seven died. It was one of the last epidemics of flu in Europe.

A world without vaccines would be a world constantly at risk of further epidemics. Recent experiences with COVID-19 have painfully reminded us what that means. Fortunately, once again vaccinations have allowed us to return to normalcy.

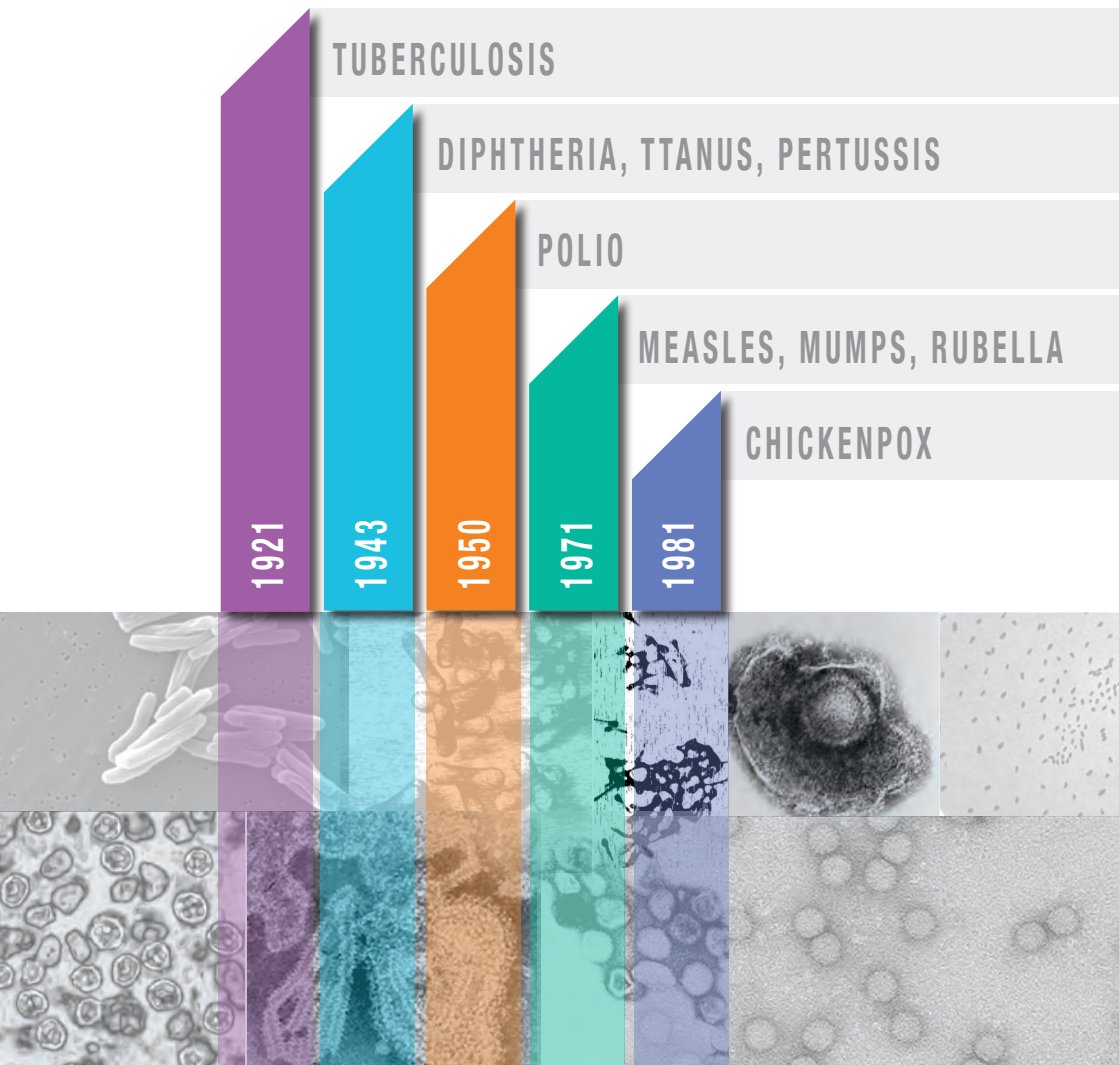


Number of deaths prevented in the first year of COVID-19 vaccinations worldwide

MILESTONES IN THE AREA OF VACCINOLOGY

Another milestone in the field of vaccinology, after the discovery of the smallpox vaccine by Edward Jenner, was the invention of the anthrax vaccine in 1881 and the rabies vaccine in 1885 by the forefather of microbiology, Louis Pasteur. In 1892, Waldemar Haffkine invented the cholera vaccine. Then, nearly 30 years later (in 1921), the vaccination against typhus (also known as spotted fever) was discovered. In the same year, there was another breakthrough in the field of vaccinations - the invention of the BCG vaccine (Bacillus Calmette-Guérin) against tuberculosis by Albert Calmette and Camille Guérin. It is a very serious and severe disease, often resulting in the death of the patient.

ABOUT INFECTIOUS DISEASES AND THE HISTORY OF VACCINATIONS



TUBERCULOSIS

DESCRIPTION OF THE DISEASE

Tuberculosis is an infectious disease caused by acid-fast bacilli from the *Mycobacterium tuberculosis complex group*. **Tuberculosis bacilli are true masters of survival – they can survive for hundreds, or even thousands of years, and withstand adverse conditions quite well.** In a dried state, they can lurk in specks of dust, on book pages, or in unwashed clothing. They can also survive in soil, poorly processed dairy products, hospital sewage, water from water mains, water from wells adjacent to animal barns, disinfectants, dialysis fluids, medical waste, and on many other surfaces.

In the initial stages of tuberculosis, symptoms are not very characteristic. The systemic and nonspecific symptoms of tuberculosis include:

- Fever and low-grade fever, especially in the afternoon
- Decreased appetite and weight loss
- General weakness and fatigue
- Malaise
- Excessive sweating, particularly at night

Symptoms of pulmonary tuberculosis include: chronic cough (lasting more than eight weeks), coughing up blood, shortness of breath, and high fever. Tuberculosis can also have an extrapulmonary form, in which symptoms depend on the location of the disease. Among the most common forms of extrapulmonary tuberculosis nowadays are tuberculosis of the: pleura, lymph nodes, bones and joints (which can lead to spinal fractures), genitourinary system (which can cause infertility), gastrointestinal tract, and tuberculous meningitis.

1921

*Tuberculosis on a chest X-ray*

Tuberculosis bacteria are resistant to majority of the known antibiotics. They can enter a latent (dormant) state, which is why treatment must last a sufficiently long time. **However, it's important to remember that some anti-tuberculosis drugs can cause numerous side effects, such as acute kidney failure.**

MORBIDITY

Tuberculosis is one of the most common infectious diseases in the world. Currently, the percentage of people infected with tuberculosis bacteria is estimated at around 30% of the world's population, and approximately three million people die from this disease each year. Over 95% of tuberculosis-related deaths occur in developing countries. According to the World Health Organization (WHO), in 2020, tuberculosis was diagnosed in 5.8 million people worldwide, with 1.5 million deaths. The WHO estimates that by 2050, approximately one billion people will be infected with tuberculosis bacteria, over 40 million people will fall ill, and 8 million will die. Since 2010, the number of tuberculosis cases in Poland has dropped by more than 50%, with 3,237 cases recorded in 2020 compared to 6,992 in 2010. Men get sick much more often than women. In 2020, 2,413 men and 824 women were diagnosed with tuberculosis. Cases of tuberculosis are more commonly observed in older age groups (over 50 years old), as younger generations are immunized thanks to widespread vaccinations.

VACCINATIONS

In Poland, infants are required to receive a single vaccination of BCG (*Bacillus Calmette-Guérin*), which is the most commonly administered vaccine in the world. Why is the BCG vaccine important or indeed, necessary? Let's ask the expert:



Why are infants vaccinated against tuberculosis shortly after birth?

Expert – The schedule of childhood immunizations was developed by experts of various fields (including immunology, vaccinology, neonatology, pediatrics) from the U.S. Centers for Disease Control and Prevention (CDC) and the World Health Organization. It is based on clinical data and scientific knowledge so that it's safe and effective in protecting children from numerous diseases that can be prevented by immunizations.

The vaccination schedule uses the knowledge about how the immune system of children responds to vaccinations at different ages and the likelihood of the child being exposed to the disease-causing agent.

Vaccination provides protection for many years, also against severe complications of tuberculosis such as meningitis. Vaccination provides protection at an early stage of life when the immune system is not fully developed and would not be able to cope with the disease. A child achieves full antibody production capacity by the age of three, while the remaining elements of immunity develop and mature until the time that the thymus fades away, typically between the ages of 16 and 18. Delaying vaccinations carries the risk of contracting disease together with its serious complications, particularly for young children with immature immune systems.

Vaccinating right after birth aims to protect the child from exposure to pathogens present in the environment (at home, daycare, preschool, etc.). Maternal antibodies passed through the placenta during pregnancy and later through breast milk gradually decline by the third month of the child's life. Sometimes, an unvaccinated mother may not have them at all, leaving the newborn completely unprotected.

Delaying vaccination beyond the period of the newborn's hospital stay after birth requires additional testing before vaccine administration (a tuberculin skin test involving the subcutaneous injection of protein obtained from a tuberculosis bacterium culture should be performed).

1921



Gustaw Holoubek – Polish stage and film actor, director, theater manager, educator, president of the Association of Polish Theater and Film Artists (SPATiF), member of the Polish Academy of Sciences (PAN), member of the Polish Sejm (lower of the Polish parliament -7th and 8th term, 1976–1982), senator (1st term, 1989–1991). One of the most outstanding actors and directors in the history of Polish theater and film. In the 1940s, he contracted tuberculosis. He died in Warsaw in 2008.



Renée Adorée (born Jeanne de la Fonte (1898–1933) – French and American stage and film actress, a star of silent cinema. She died of tuberculosis a week after her 35th birthday.

Tuberculosis, for decades considered a disease of the poor, now threatens everyone, regardless of socio-economic status. Many artists and famous people have died from tuberculosis. Some of those who lost the battle against this serious disease include:

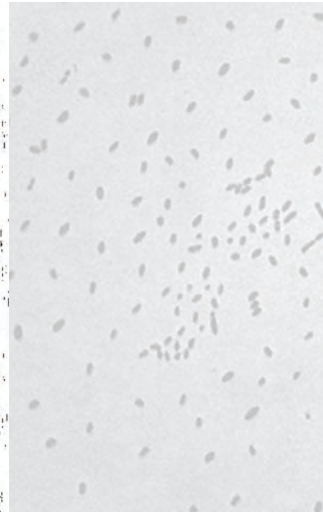
- Stanisław Grzesiuk (singer)
- Vivien Leigh (actress)
- Jerzy Jurandot (Polish poet, playwright, satirist)
- Juliusz Słowacki (poet)
- Renée Adorée (actress)
- George Orwell (British writer and journalist)
- Jens Peter Jacobsen (Danish writer and biologist)
- John Keats (English Romantic poet)
- Zygmunt Krasiński (poet)

The BCG vaccine not only prevents tuberculosis. It is also used in the treatment of cancerous lesions, for example, the treatment of bladder cancer or colorectal cancer. Other applications of BCG include the therapy of type 1 diabetes and leprosy.

1943

DIPHTHERIA, TETANUS, PERTUSSIS

In 1940, in the United States, the pertussis vaccine was introduced for widespread use. Research on this vaccine was initiated in the 1930s by two women: Pearl Kendrick and Grace Eldering. At that time, pertussis was an exceptionally dangerous infectious disease among infants and young children. In 1943, Pearl Kendrick, Grace Eldering, and also Loney Gordon developed the first combination vaccine DTP against diphtheria, tetanus, and pertussis (also called Di-Per-Te, from the Latin names of the diseases). In Poland, the vaccine was introduced in 1960 and is still used today. Vaccinations against tetanus, diphtheria, and pertussis are recommended as a package because they require the same cycles and schedules.



1943



A throat operation saved the life of a boy from Indonesia who fell ill with diphtheria – still one of the fatal infectious diseases.

DIPHTHERIA

DESCRIPTION OF THE DISEASE

Diphtheria, also known as croup, is an acute and severe infectious disease caused by the diphtheria bacillus (Lat. *Corynebacterium diphtheriae*). Infection may occur through respiratory droplets or by direct contact with an infected person or carrier. It can also occur through contact with infected animals, including dogs, cats, or horses. The first symptoms typically appear in the throat, on the tonsils, and in the larynx. Less commonly, the disease manifests in the nose, on the conjunctiva, or on the mucous membranes of the genital organs. The bacteria cause tissue necrosis at the sites of entry into the body. During the course of the disease, an enlargement of the cervical lymph nodes may occur, which together with neck swelling can lead to narrowing of the throat and larynx, and subsequently death due to respiratory failure or cardiac arrest. The diphtheria bacillus produces a potent diphtheria toxin, which, when spread in the body, can lead to many types of dysfunctions, such as myocarditis or necrosis of the renal tubules. As a result of the disease, neurological complications can also occur, including paralysis of the soft palate and the back wall of the throat, paralysis of the muscles responsible for eye movements, limb paralysis, and facial muscle paralysis. 10–20% of children affected by diphtheria die despite receiving treatment.

1943

TETANUS

Tetanus is a nervous system disease caused by tetanus bacilli (Lat. *Clostridium tetani*). This bacterium produces tetanus toxin (neurotoxin), considered one of the most potent poisons. **It is commonly found in soil, dust, water, on rusty objects, and in the gastrointestinal tract of animals.** The spores of this bacterium enter the human body through contaminated broken skin (e.g., as a result of a bite, injury, or wound). Infection can also occur during childbirth or miscarriage if hygiene practices are not followed. Tetanus is a severe disease characterized by very strong and prolonged muscle contractions (which can even lead to bone fractures), seizures, loss of consciousness, breathing difficulties, and nerve damage. Complications of tetanus include vertebral fractures, myocarditis, pneumonia, intramuscular hematomas, and ultimately death. **Between 10 to 50% of patients die, even with appropriate treatment.**

A newborn with symptoms of tetanus



It's important to remember that recovering from tetanus does not provide immunity against future infections, and every injury carries the risk of tetanus bacterial infection, especially if the wound becomes contaminated with dirt, soil, or animal feces. Tetanus spores are commonly present in nature, so everyone should be vaccinated after exposure.

1943

PERTUSSIS

Pertussis (also known as whooping cough) is a very serious disease caused by the bacterium called *Bordetella pertussis*, causing a chronic, paroxysmal, and very intense cough. Coughing fits are very exhausting and end with a strong inhale (a characteristic, loud „whoop”), and often also with vomiting. Several such attacks can occur within an hour. In the youngest children, pertussis can lead to apnea, seizures, and even exhaustion (especially in infants). Complications of pertussis include pneumonia and brain damage caused by oxygen deprivation or bleeding. The illness typically lasts from four to six weeks, but symptoms of airway damage (including persistent coughing) can persist for several months.

In infants, pertussis can lead to death.

SERUM SICKNESS

Diphtheria, tetanus, and pertussis are treatable diseases. However, it is important to remember that the treatment can also be dangerous to health and life. For example the so-called serum sickness may occur, which is an allergic, systemic reaction to the intravenously administered heterologous serum, especially tetanus or diphtheria antitoxin. As a result of contact with this type of allergen, the body releases antigen-antibody complexes, which damage the endothelium of blood vessels and cause local inflammatory changes. Serum sickness can cause serious complications, including glomerulonephritis, optic neuritis, and systemic vasculitis.

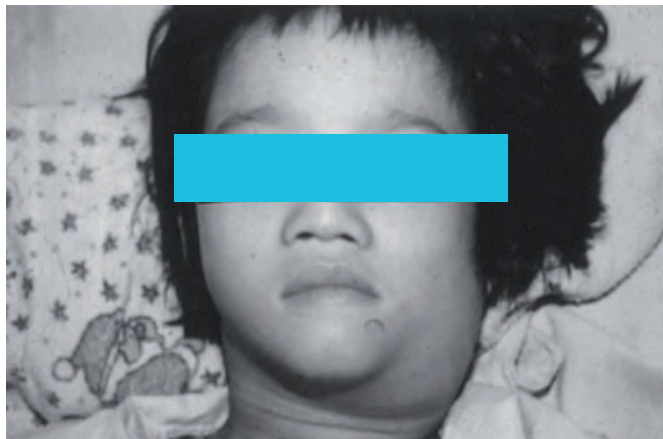
“PREVENTION IS BETTER THAN CURE”

Diphtheria, tetanus, and pertussis perfectly show the truth of the saying „prevention is better than cure,” because their treatment also poses risks to health and life. In the case of what is commonly referred to as „natural immunity acquisition,” that is „immunity against infectious diseases acquired through illness,” it is important to remember that for diseases such as tetanus, diphtheria, or pertussis, the risk of severe complications and death is high, and their treatment can cause much greater adverse effects than administering the vaccine to a child. Vaccinations use the body's natural immunity to fight disease. Thanks to minimal intervention, we build protection for our health. We get vaccinated out of concern for our own health and that of our loved ones. Treating diseases for which children should be vaccinated, carries unnecessary risks of adverse effects during therapy. Since vaccines against these infectious diseases are available, having in mind the safety of children our decision to vaccinate them should be obvious.

BULL NECK

In severe cases of diphtheria, a characteristic enlargement of the cervical lymph nodes, as well as swelling of the tissues in the neck area occurs. This clinical picture is called bull neck.

A 10-year-old girl sick with diphtheria, with the so-called "bull neck," on the fourth day of the illness



THE HISTORY OF BRIE

Seth Mnookin in his book „The Panic Virus: The True Story of the Vaccine-Autism Controversy” describes the story of Brie, whose parents did not manage to vaccinate her against pertussis:

“By the time [...] entered Brie’s unit, all four of the pediatric intensive care unit’s doctors were waiting for them. The bleeding on the right side of Brie’s brain was still clotted off they said, but now there was extensive bleeding on the left side. It was time to turn off the machines that were keeping Brie alive. „They told us she could still live for a little while once the machines were off,” Danielle says.

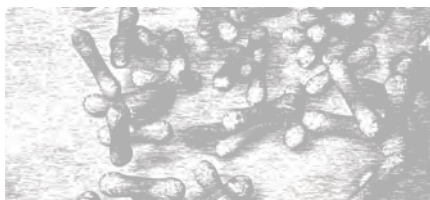
“It took a doctor and three nurses to turn off the machines. Technically they weren’t supposed to move her when she was on ECMO because of where the tubes were connected, but we hadn’t held her in two weeks – since she’d been on the ventilator - so the doctor said, “We’re going to get as many staff members as we need in here so mom and dad can hold their baby while she’s still alive”. ... This doctor made sure that there were seven or eight people there to move her so that my husband and I could hold her before she passed away. And she survived probably for about half an hour once the machines were turned off”.

On March 6, seven weeks and three days after they became parents, Ralph and Danielle Romaguera held their daughter in their arms as she died. Had she survived, she would have been scheduled to receive the first dose of the pertussis vaccine four days later.”

1943

VACCINATIONS

Years of experience with administering vaccinations against diphtheria, tetanus, and pertussis have demonstrated high efficacy and safety of these vaccines. However, it is important to remember that immunity to diphtheria, tetanus, and pertussis decreases over time. **Therefore, booster doses of the vaccines are recommended for adults every 10 years.** In Poland in 2021, no cases of diphtheria were reported. However, it is worth noting that currently over 100 cases per year are reported in countries of the former Soviet Union (Russia, Ukraine, Kazakhstan), and moreover, this disease is commonly found in Iran, Iraq, India, Mongolia, and Syria.



The chest X-ray image shows bilateral lung congestion with left-sided pleural effusion in a five-week-old girl with pertussis.

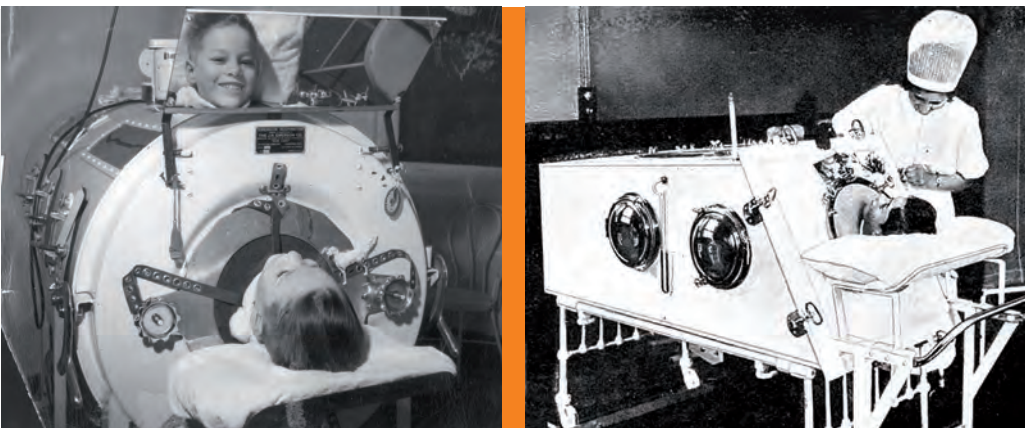


The chest X-ray shows a new partial collapse of the right lung in the same child. The hospitalization of the child lasted for seven weeks. Then the girl was placed under pediatric, pulmonological, and neurological care.

POLIO

DESCRIPTION OF THE DISEASE

Polio (*poliomyelitis*), also known as Heine-Medin disease (Latin: *poliomyelitis anterior acuta*), is an acute, highly infectious childhood paralysis, a viral inflammation of the anterior horns of the spinal cord. It is a viral infectious disease caused by the poliovirus, transmitted through the fecal-oral route or respiratory droplets. The course of the disease varies, ranging from mild to fatal. The most common symptoms are gastrointestinal disturbances, fever, and headache. In about 1% of infected individuals, inflammation of the meninges (meningitis) may occur. The mortality rate of paralytic forms ranges from 2% to 10% and increases with age. One in every two hundred infected individuals experiences irreversible paralysis, leading to weakness, mobility impairment, paralysis, and even respiratory failure. Among 5–10% of patients with paralysis, a paralysis of the respiratory muscles leading to death occurs. **In 20–30% of individuals with a history of paralysis, post-polio syndrome (PPS) occurs, appearing 15–40 years after the infection.**



Patients with polio in iron lungs

An iron lung (negative pressure ventilator) is a device that enables breathing when the respiratory muscles are ineffective. It is a type of respirator which provides non-invasive ventilation. The device was first used in humans in 1928 at the Children's Hospital in Boston. The unconscious girl placed in the iron lung regained consciousness in less than a minute. Iron lungs gained popularity in the 1950s and 1960s, when they were used to save the lives of polio victims with respiratory muscle paralysis (including the diaphragm). For some of them, independent breathing was never possible again, so they had to spend their entire lives in iron lungs.



He lived in iron lungs for over 70 years,
died on March 11, 2024 at the age of 78

Paul Alexander was born in the USA in 1946. At the age of six, he contracted polio. Within six days, he lost the ability to move and also stopped breathing independently. Since then, to survive, he has needed an iron lung. Today, serious problems for Paul include power outages or malfunctions of the iron lung device, as his life depends on it. A few months after Paul contracted polio, a vaccine for this disease was invented. A few more months, and Paul could have led a normal life, could have been able to travel, to have children, grandchildren, and above all – healthy lungs.

POLIO EPIDEMIC IN POLAND

The polio epidemic in Poland occurred in the 1950s. In 1958, over six thousand people were affected by polio, with nearly 350 fatal cases. The epidemic was contained thanks to a mass vaccination program carried out between 1959 and 1960. The creator of the vaccine was the distinguished Polish scientist, Hilary Koprowski, who, in 1950, developed the first oral polio vaccine. In 1980s mass polio vaccination campaigns were also carried out by the World Health Organization, UNICEF, and other humanitarian organizations. According to the WHO, since 2000, over 10 billion doses of oral polio vaccine have been administered worldwide. Nearly three billion children have been vaccinated. It is estimated that vaccinations have prevented around 13 million people from contracting the disease. In Poland, the last case of poliomyelitis caused by wild poliovirus occurred in 1984.

NEW CASES OF POLIO

The discovery of the polio vaccine and the implementation of mass vaccination against this disease represent a big success of modern medicine. In 2002, polio was declared eradicated, meaning it no longer occurs in nature. But can we now say that the threat of polio has been averted? Or should we rather acknowledge that polio eradication was close but has not been achieved? Currently, new cases of the disease are increasingly observed in Europe and worldwide. In 2019, Afghanistan and Pakistan reported 143 cases of wild poliovirus, which is more than a fourfold increase compared to 33 cases in 2018. Currently, Europe is considered polio-free. However, the risk of importing cases into the region remains high because countries such as Bosnia and Herzegovina, Romania, and Ukraine still remain at risk. According to the Regional Office for Europe in the WHO, these countries are experiencing suboptimal vaccination coverage, vaccine shortages, and weak epidemiological surveillance. The circulation of wild poliovirus in countries outside of Europe, as well as outbreaks caused by type 2 and type 3 poliovirus in several African countries and Syria, facilitate further international spread of polioviruses. In September 2021, the Ukrainian Ministry of Health reported the first, since 2105, confirmed case of polio in a one-and-a-half-year-old child, additional 19 individuals were confirmed to be infected with the virus, but without paralysis occurring. In January 2022, a second case of polio was confirmed in Ukraine. In 2022, the USA reported the first case of polio in nearly a decade. According to the WHO, the current situation may result in a failure of the long-standing global program aimed at completely eradicating polio worldwide.

Decisions of individuals to avoid vaccinations have a significant impact on the fact that the fight against polio „has slipped out of control.”

MASS VACCINATIONS

Thanks to vaccinations, we can avoid dangerous diseases but also the permanent disabilities that may result from them. **It's important to remember that a disease doesn't have to kill, but it may lead to a lifelong disability.** We're fortunate that polio is no longer present in Poland, but our grandparents remember cases of illness and deaths from polio among their loved ones. Before the discovery of the vaccine, the chances to fight polio were very limited, so the morbidity and mortality were very high. Nowadays, as long as there are cases of polio happening in the world, it is necessary to continue vaccination to prevent the recurrence of the disease. Let's ask the expert:



Are we currently able to effectively treat patients with polio?

Expert - Infection with the polio virus results in lifelong, type-specific immunity. After an acute episode, many patients partially regain muscle function, and the prognosis for recovery can usually be determined within six months of the onset of paralysis symptoms. Total recovery from polio is only possible in cases that do not result in permanent paralysis. The clinical symptoms of the disease typically subside spontaneously within a few days. However, if the disease is severe and complications such as flaccid paralysis develop, they will remain as permanent consequences of polio. It's also important to remember that even children who seem to fully recover can develop new muscle pain, weakness, or paralysis as adults, 15 to 40 years later. It is called post-polio syndrome (PPS). People affected by PPS experience muscle weakness, fatigue (both physical and mental), and joint pain. Treatment for polio is therefore only symptomatic. There is no causal therapy that would eliminate the virus. Patients are given antipyretic and pain-relieving medications, and any disturbances in fluid and electrolyte balance are corrected.

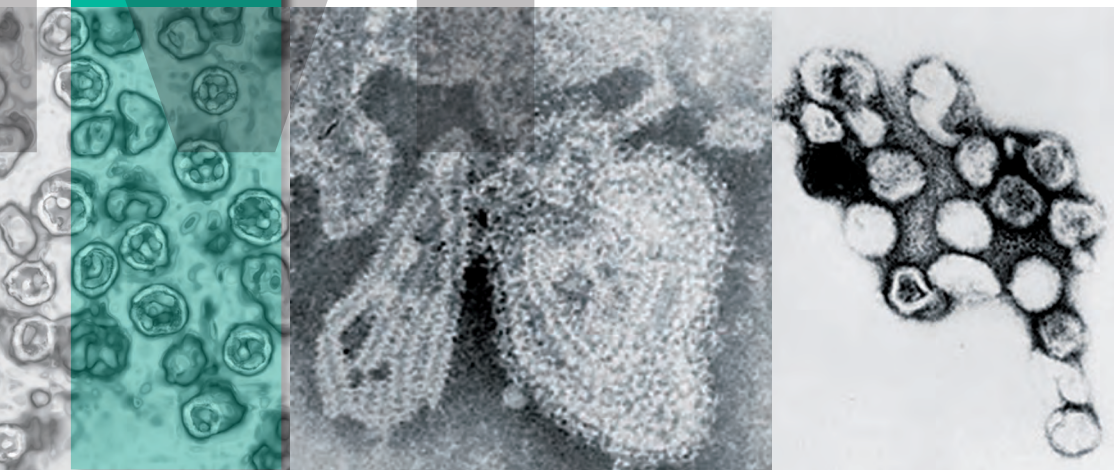
1950



Hilary Koprowski (born in 1916 in Warsaw, died in 2013 in Philadelphia) was an outstanding Polish physician, virologist, immunologist, academic teacher, and the creator of the world's first effective polio vaccine (developed in 1950), on which he worked from the late 1940s in the USA. For 35 years, he served as the director of the Wistar Institute in Philadelphia. In the years 1958–1960, he vaccinated 75,000 children in Rwanda and Belgian Congo, achieving a 70% immunity rate. He donated nine million doses of polio vaccine to Poland, saving millions of children from the threat of disablement. After the polio epidemic was eradicated, Professor Koprowski continued his work in the field of virology. His next achievement was the improvement of the existing rabies vaccine. He also worked on tumor immunogenetics and food vaccines. Professor Koprowski is one of the most prominent figures in the history of Polish and world medicine.

MEASLES, MUMPS, RUBELLA

In 1967, American microbiologist and vaccinologist Maurice Ralph Hilleman invented the mumps vaccine, and two years later, he developed the measles and rubella vaccine. In 1971, a team led by Maurice Hilleman combined three vaccines into one, creating the original version of the MMR vaccine (named after the English names of these three diseases: measles-mumps-rubella). In Poland, universal vaccination against measles started in 1975, and rubella vaccination began in 1988. Since 2004, Poland has mandated two doses of the MMR combined vaccine against measles, mumps, and rubella. **Currently, single (i.e., monovalent) vaccines against measles, mumps or rubella are not available. The only option for immunization against these three diseases is the use of a combined vaccine.**



1971

DESCRIPTION OF THE DISEASE

Mumps, measles and rubella are all viral infectious diseases. **Measles** manifests itself with high fever and a characteristic rash on the skin (reddish spots and bumps). **Even if the course of the disease is mild, serious complications may occur, such as pneumonia or encephalitis, leading to permanent brain damage, coma, or even death.**

A characteristic symptom of **mumps** is inflammation of the parotid salivary glands, accompanied by fever, as well as pain and swelling located in front of the earlobe and below it. **In most children, the disease has a mild course, but in some cases, serious complications may occur, such as inflammation of the meninges and brain, other neurological complications, deafness, pancreatitis, inflammation of the heart, testicles, or ovaries.** More severe complications are observed in adolescents and adults.

Rubella has a mild course. It manifests itself with fever and a skin rash. In adults, it may not show any symptoms or resemble the flu. Similarly to other diseases, rubella can lead to serious complications such as arthritis or encephalitis.



Mumps. Epidemic parotitis. On the left, a healthy child; on the right, a child with mumps

CONSEQUENCES OF THE DISEASE

Very dangerous complications occur if rubella is contracted by pregnant women. There's a risk of **miscarriage, fetal death, or the development of severe congenital defects (known as congenital rubella syndrome)**. It's important to keep in mind that measles, mumps, and rubella can be contracted at any point in life. Pregnant women most commonly contract them from their older sick children. Contracting measles, mumps, or rubella, much like contracting the flu, may just be the starting point for further negative consequences. These diseases may be followed by serious complications, just like it is with the flu, which despite its mild course may lead to permanent hearing damage. **There are no medications that can cure measles, mumps, or rubella. Only timely and consistent MMR vaccination can protect against these diseases.** Long-term observations confirm that MMR vaccination has a high level of effectiveness and safety.



The characteristic rash in a woman with measles. The skin changes are red, merging, maculopapular, with uneven shapes. At the beginning, the skin rashes appear behind the ears, then gradually they spread to the face, neck, torso, back, arms, and legs.



Some people may be concerned about the composition of the vaccine, so let's ask an expert:

Why does the MMR vaccine contain live virus?

Expert - Vaccines containing the measles virus cause subclinical or mild, non-contagious infection. Currently available and popular vaccines, used in everyday prevention, may contain killed forms, live attenuated forms, or fragments of microorganisms (known as toxoids). The potency of a vaccine depends on the quantity and strength of the antigen



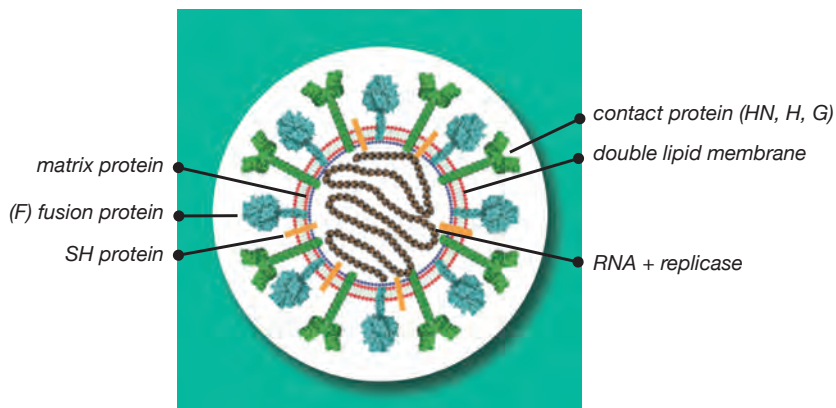
it contains. The more of this antigen there is in the vaccine, the stronger impact it has on the body, which stimulates effective and long-lasting immunity. Therefore, vaccines containing live pathogens have the strongest effect. This is because the live microorganisms contained in them exist in the host's body for a short period, causing long-term stimulation of immune defense mechanisms. Such an immune response typically remains throughout the person's life. Contemporary live vaccines are produced using a natural „wild” virus, attenuated or weakened under laboratory cultivation conditions. This process involves inducing mutations in the virus that lead to a loss of virulence (infectivity) while preserving the antigenic properties (the ability of the virus to elicit an immune response and produce protective antibodies). Such immunization process is much safer than contracting the disease after infection with the actual virus, because this always carries the risk of severe complications, and even death.

Possible complications after measles, mumps and rubella

Measles	Mumps	Rubella
severe pneumonia	inflammation of the meninges (meningitis - inflammation of the meninges)	arthritis
middle ear infections, which may lead to deafness	inflammation of the brain (<i>encephalitis</i>)	inflammation of the brain
inflammation of the brain (encephalitis), can be fatal in about 30% of children or lead to permanent mental and physical disability	loss of hearing	miscarriage
SSPE – subacute sclerosing panencephalitis	Swelling and inflammation of the testicles (in about one in four adolescent or adult males)	fetal death
brain damage manifested by:	infertility	developmental defects of the eyes, ears, heart or brain in the fetus (so-called congenital rubella syndrome)
• progressive dementia (initially learning difficulties, memory disorders, sleep disorders) • myoclonus (involuntary movements) of limbs and trunk • frequent convulsions • spasticity – abnormal, excessive muscle tension (hypertonia), manifested by resistance to passive muscle stretching	Pancreatic damage resulting in diabetes	
partial loss of immunological memory cells (disorders of acquired immunity)	deafness	
diarrhea	Myocarditis, inflammation of the heart muscle	
vision disorders leading to blindness	inflammation of the ovaries (usually in older children and adolescents)	

Source: own study based on many sources.

Schematic structure of the measles and mumps virus



Source: Own study based on Abdis T., Tagesu T. Review on Newcastle Disease of Poultry and its Public Health Importance. *Journal of Veterinary Science and Technology* 2017; 8 (3): 1000441. DOI:10.4172/2157-7579.1000441



We also asked the **Expert - Why are measles, mumps and rubella vaccines administered together?** Here's the answer: The two vaccines (only one until 2022) currently available in the world contain three closely related viruses:

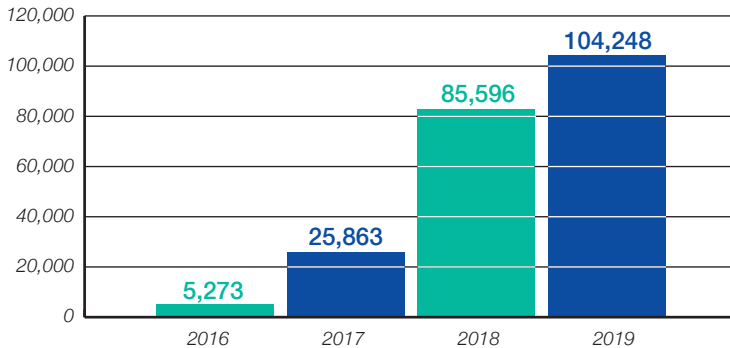
- Measles morbillivirus (MeV), also known as the measles virus, a single-stranded, enveloped RNA virus belonging to the genus *Morbillivirus* in the family *Paramyxoviridae*.
- The mumps virus, also containing single-stranded ribonucleic acid (RNA) surrounded by a capsid and a viral envelope, assigned to the genus *Orthorubulavirus* in the subfamily *Rubulavirinae*, family *Paramyxoviridae*.
- The rubella virus (*Rubivirus rubellae*), which is a member of the genus *Rubivirus* and belongs to the family *Matonaviridae*, whose members typically have a single-stranded RNA genome, transmitted through respiratory droplets between humans.

Due to their belonging to the common *Paramyxoviridae* family, the close relatedness of the described RNA viruses, similar routes of infection spread, and the safety of combining them in a single preparation, they are placed in one vaccine. Also, if vaccination against measles, mumps, and rubella were to be administered separately, it would expose a child to an additional threefold stress due to injections and unnecessary associated pain. It would also prolong the vaccination time, as single vaccines, according to safety principles, are administered either simultaneously in different locations (limbs, three injections) or at four-week intervals.

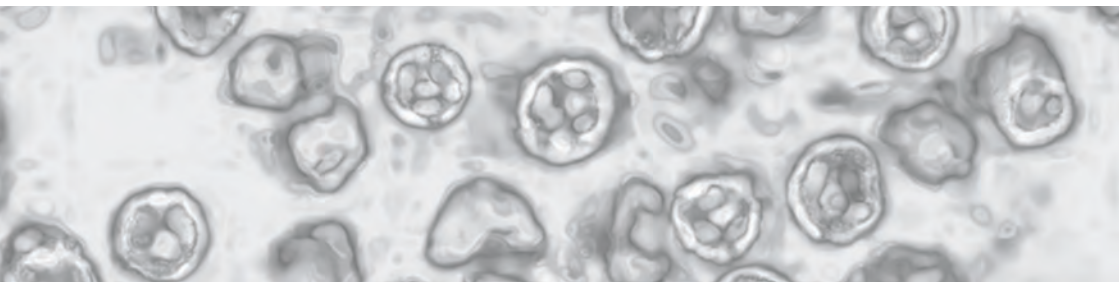
MEASLES INCIDENCE

Currently, there is an increase in the number of measles cases in Europe. In 2018, the World Health Organization reported three times more measles cases in the European Region compared to 2017 and fifteen times more compared to 2016. The vast majority of affected people were not vaccinated. Similarly in Poland, there was an epidemic increase in measles cases in 2019, following a period of nearly ten years during which the disease was very well controlled and was close to being eliminated. Such a high increase in measles cases is associated with a systematically decreasing percentage of individuals vaccinated with two doses of the MMR vaccine.

Measles cases in the European Region
World Health Organization



Source: own study based on
<https://szkolenia.pzh.gov.pl/szczecinki/odra/>





A girl with measles

In 2018, a ten-month-old child died in an Italian hospital in Catania due to complications caused by measles. The child had not yet reached the age suitable for vaccination and contracted the disease from someone who had not been vaccinated. A twenty-five-year-old woman had also died from measles in the same hospital a month earlier.

1971



Death of Huascar (1532). His father, Huayna Capac, died in 1525 during a smallpox epidemic among the Incas

Colonization of the Americas

In the 16th century, during the colonization of the Americas by Europeans, over the course of two years more than three million Native Americans died from diseases such as smallpox, syphilis, measles, mumps, and rubella. In most cases, the death of Native Americans was the result of accidental and unintentional infection by European settlers, as well as the lack of immunity to European diseases among the indigenous population. There were also instances of intentional infection of Native Americans with smallpox.

GLOBALIZATION

The world today is very different from that of the 19th century. Thanks to civilization advancements we have wider knowledge about health risks, but at the same time, travel between countries or continents is now not a problem for most societies. The fast flow of goods and services and high population density facilitate the spread of diseases. Consequently, infectious diseases once again pose a challenge to public health. Fortunately, we have protective vaccines, which are one of the key elements in preventing diseases and their consequences.

CHICKENPOX

DESCRIPTION OF THE DISEASE

A characteristic symptom of chickenpox is an itchy rash with blisters. Chickenpox is often accompanied with fever. The blisters can be present all over the body, including conjunctiva, the oral cavity, and the external genitalia. The course of the disease cannot be predicted. **Chickenpox may be followed with various complications, also neurological ones. It can also lead not only to a child's death or disability but, very often, to a permanent disfigurement.** Hence, in "Le Roman de la Rose" (The Romance of the Rose - by Guillaume de Lorris and Jean de Meun, 13th century), we find the concept of „*smooth face*” to be a firmly established canon of female beauty. Historically, the term „smooth face” meant a face not disfigured by chickenpox scars. Even in those times, there was fear of this disease, not only for health reasons but also for aesthetic ones. The chickenpox vaccine was only invented in 1981.

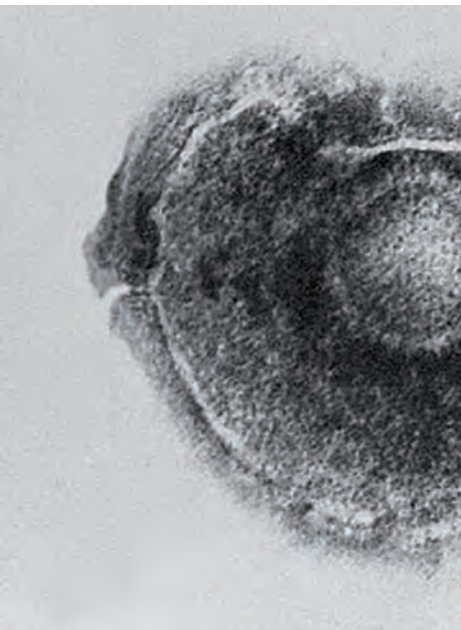
Izabela Czartoryska (1746–1835) was a Polish aristocrat of the Enlightenment era, the wife of Prince Adam Kazimierz Czartoryski. She was a writer, an art patron, and the mother of, among others, the politician Prince Adam Jerzy Czartoryski and the writer Maria Wirtemberska.

(Alexander Roslin Portrait of Isabella Czartoryska nee Fleming /1794, oil on canvas, 63.5 × 52 cm, National Museum in Krakow, inventory no. MNK XII-a-616)



THE HISTORY OF IZABELA CZARTORYSKA

„My mother shortly before her wedding, while visiting a peasant's cottage, found there in a cradle a child greatly afflicted with chickenpox. My mother was greatly alarmed by this, for several of her sisters had already died of smallpox. She herself fell ill to such an extent that doubts arose about her survival. Having recovered her health, as the fathers hastened the union, she was dressed for the wedding. She came to the wedding with her face covered in scabs and red spots, and wearing a wig on her head because she had lost all her hair. The Princess Lubomirska was in despair and fainted at the thought of her brother being given such an ugly wife; and although she had great influence over her father, this did not prevent the family union, which was considered very advantageous and after which my mother, having completely recovered, soon regained her remarkable beauty. (source of quote: Adam Jerzy Czartoryski, „Memoirs and Political Memorials 1776–1809”, Publishing Institute „Pax”, Warsaw, 1986, pp. 78–79).



Necrotizing fasciitis (NF) as a complication of chickenpox infection in immunocompetent children

Here is an example of serious complications from chickenpox infection, threatening limb loss or life. It is the story of a four-year-old girl from the United Kingdom who was admitted to hospital three days after contracting chickenpox. The hospitalization was necessary due to a rapidly progressing, intensely painful erythematous rash surrounding a single chickenpox lesion on the right thigh. The pain was so intense that the girl wouldn't allow the blanket to rest on her thigh or let any member of the staff touch her. She had to be given morphine to control the pain. The child required intravenous antibiotics, two surgical procedures, a skin graft, and an extended stay in the pediatric intensive care unit. Ultimately, doctors managed to save the girl's life as well as her limb. Necrotizing fasciitis is a complication of chickenpox characterized by high incidence and mortality rates, necessitating prompt and specific treatment.



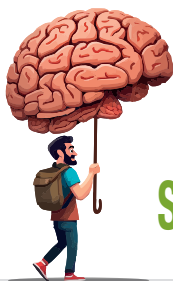
Preoperative lesions on the thigh (1)
 Degree of cleansing of necrotic lesions during surgery (2)
 Thigh after skin transplantation (3)
 Extent of postoperative scars (4)

VACCINATIONS

Each of the vaccines was born out of observations of natural processes occurring in nature, the smallpox vaccine being a good example. In Poland, vaccination against smallpox lasted from 1951 to 1980. The eradication of smallpox is a milestone for human health. However, it's important to keep in mind that viruses mutate. Look at the Mpox virus (previously known as monkeypox), which is related to the smallpox virus and is considered a milder version of it. A vaccine against Mpox has not yet been invented. The most common complications of this disease are scars, which can persist on the skin for several years, and damage to internal organs.



Mpox. Photos of a rash in a four-year-old boy eight days after the onset of symptoms



SUMMARY

Epidemics of dangerous infectious diseases are with us to this day. Since the 18th century, we have known that the most effective method of combating infectious diseases is vaccination, which, along with advancements in science and technology, is constantly being improved.

Currently, there are vaccines protecting against 26 infectious diseases, as well as against complications and permanent disability resulting from them. It is estimated that approximately 122 million people worldwide owe their lives to vaccines.

If it weren't for widespread childhood vaccinations against diseases such as tuberculosis, measles, diphtheria, pertussis, poliomyelitis, or pneumococcal pneumonia, millions of children wouldn't have a chance to survive childhood.

It's important to remember that vaccinations are just one of the tools in preventive healthcare and are as important as regular check-ups, a healthy diet, physical activity, and hygienic living.

It is better to prevent infectious diseases than to treat them, much like with chronic non-communicable diseases such as diabetes, hypertension, or obesity. However, the choice ultimately rests with each of us.

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