Epidemiology

of infectious diseases

Kolářová M., EPI Autumn 2019

EPIDEMIOLOGY

*is the **study*** (scientific, systematic, data-driven)

*of the **distribution*** (frequency, pattern)

*and **determinants*** (causes, risk factors)

*of **health-related states or events*** (not just diseases)

*in **specified populations*** (patient is community, individuals viewed collectively),

*and the **application*** (since epidemiology is a discipline within public health) *of this study to the control of health problems.*

In tracking a disease outbreak, epidemiologists may use any or all of three types of investigation:

a) **descriptive epidemiology**

is the collection of all data describing the occurrence of the disease

b) **analytical epidemiology**

attempts to determine the cause of an outbreak

c) **experimental epidemiology**

tests a hypothesis about a disease or disease treatment in a group of people.

Occurrence of Disease

- Incidence - the incidence rate refers to the number of new cases of a disease in a given population over a period of time.
- Prevalence - the prevalence rate refers to the number of total cases of a disease in a given population at a specific time.

Sporadic disease	Disease that occurs occasionally in a population.
Endemic disease	Disease constantly present in a population.
Epidemic disease	Disease acquired by many hosts in a given area in a short time.
Pandemic disease	Worldwide epidemic.

Epidemiologic investigations are largely mathematical descriptions of persons in groups, rather than individuals.

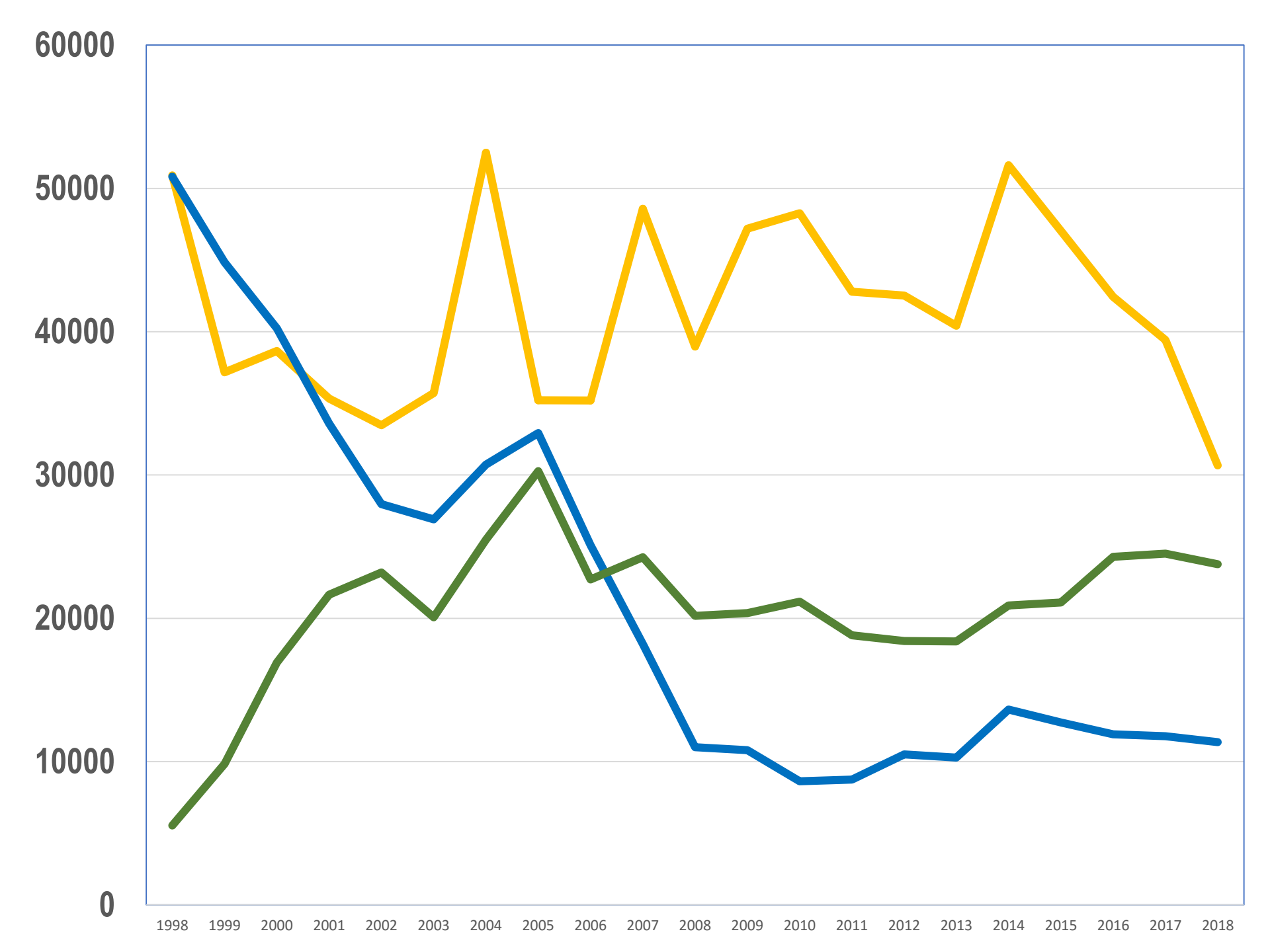
Epidemiologists arrange their data in various ways, depending on what aspect of the information they want to emphasize.

One of the most powerful tools an epidemiologist can use is case reporting: reporting specific diseases to

*** local,**
*** state and**
*** national health authorities,**

who accumulate the data

Modern infectious disease epidemiology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Varicella

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Varicella (chickenpox)

Varicella (chickenpox). Lesions at various stages, including vesicles, can be seen.

Plané neštovice

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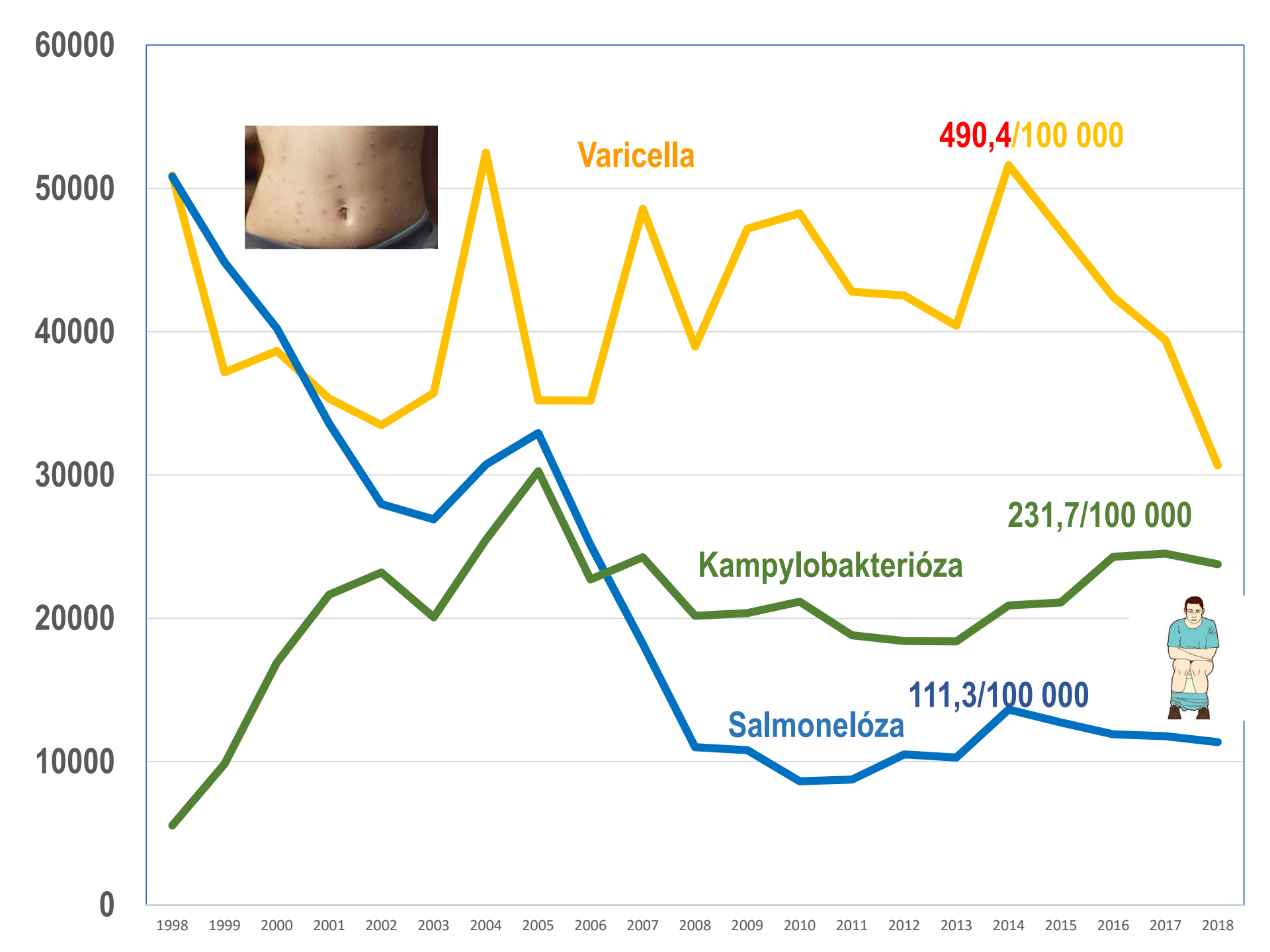
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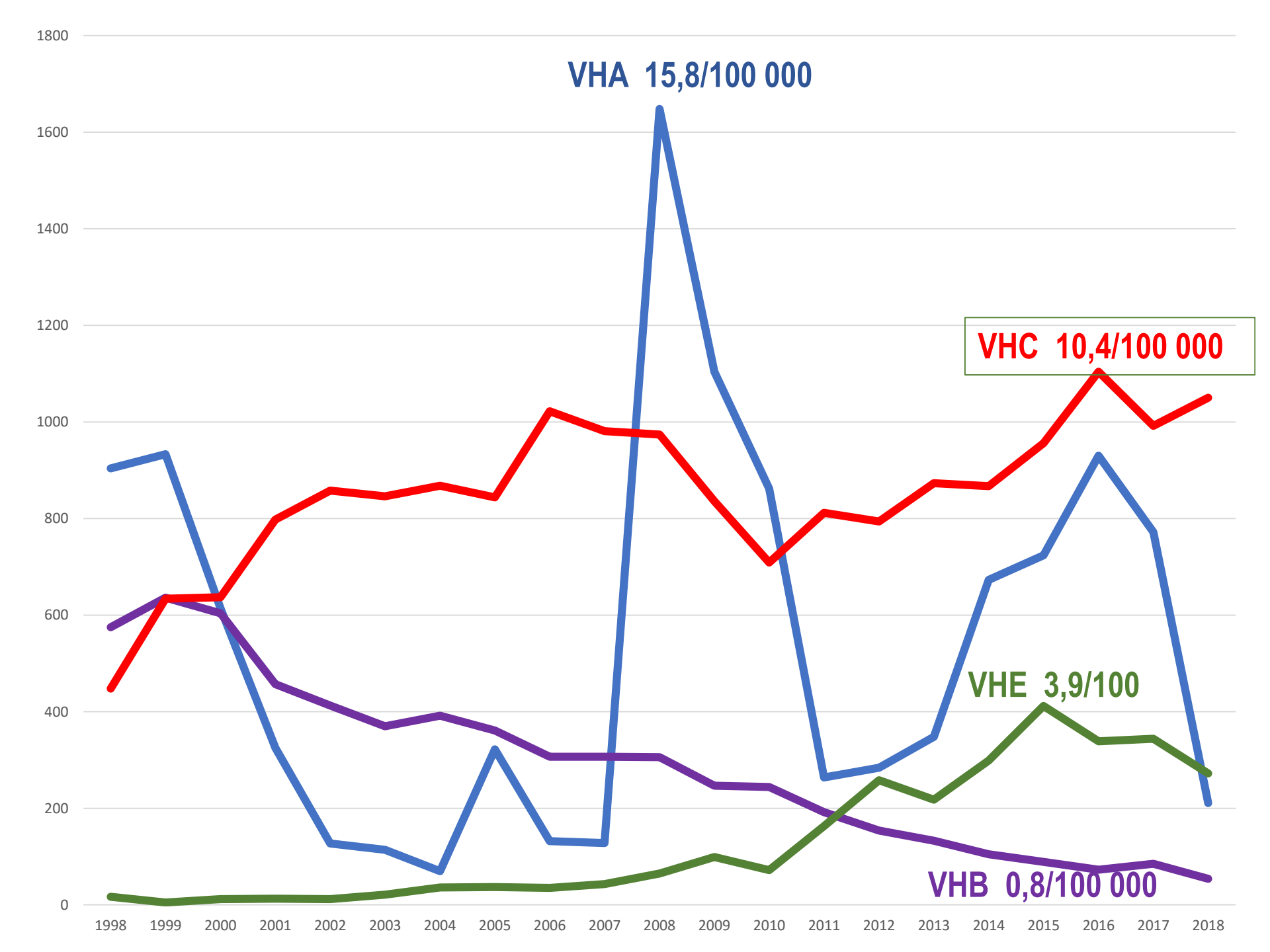
VHA 15,8/100 000
VHC 10,4/100 000
VHE 3,9/100
VHB 0,8/100 000
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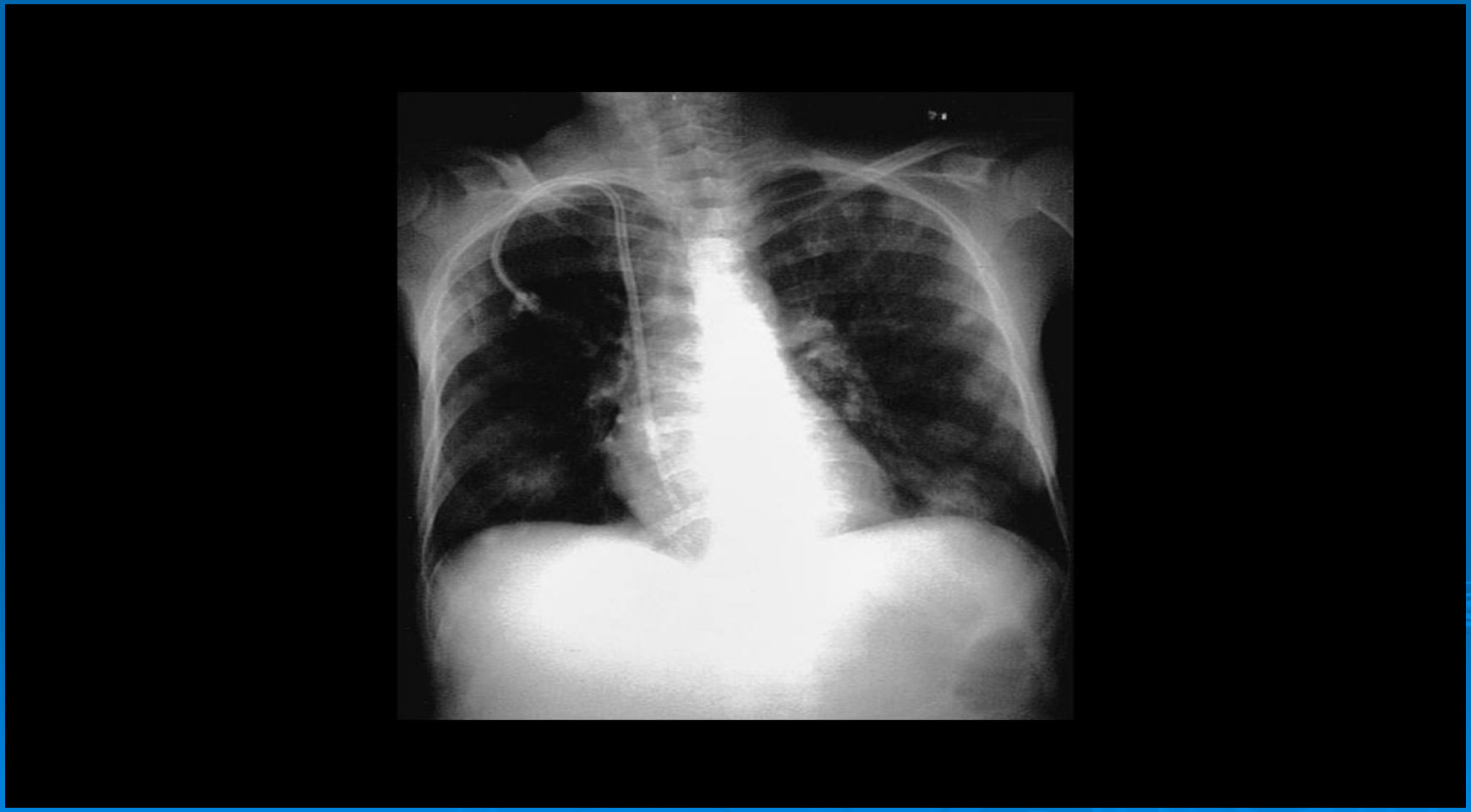
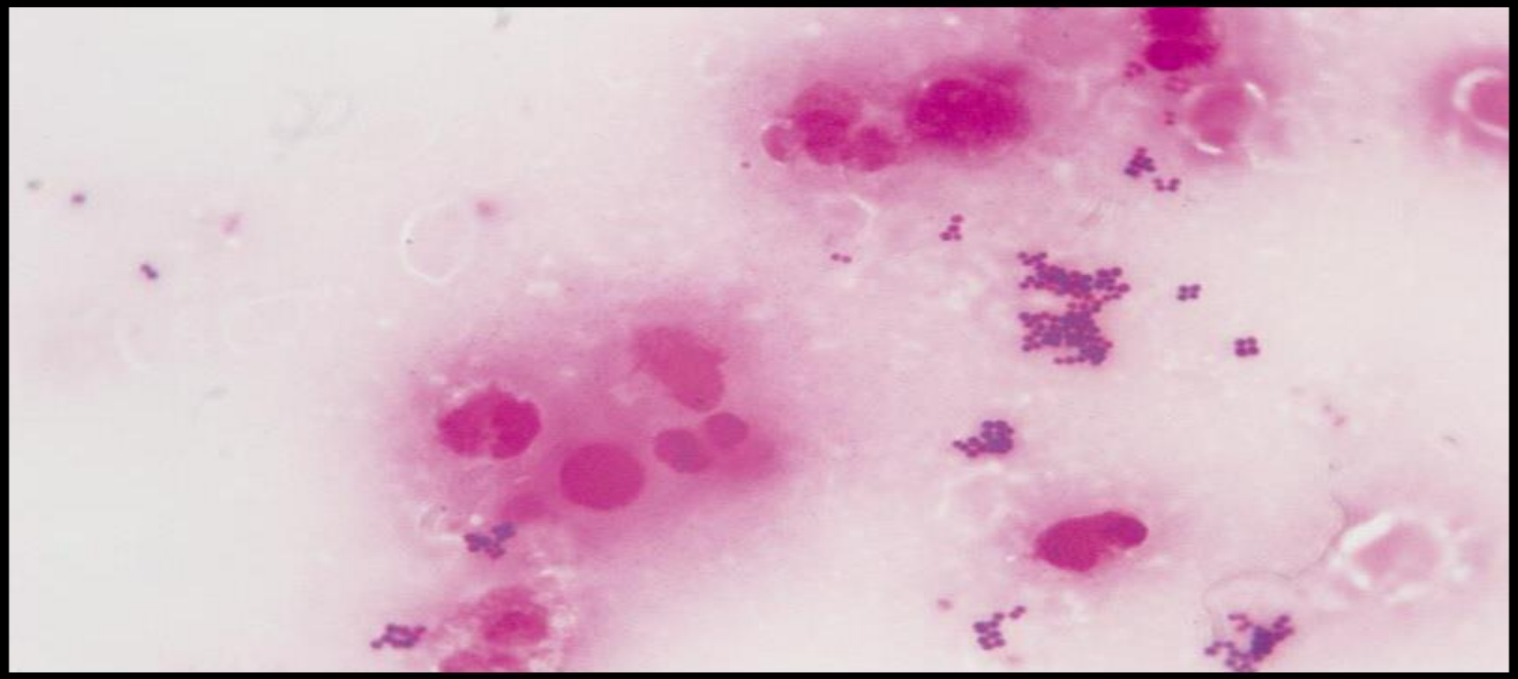
- Impetigo in a child.

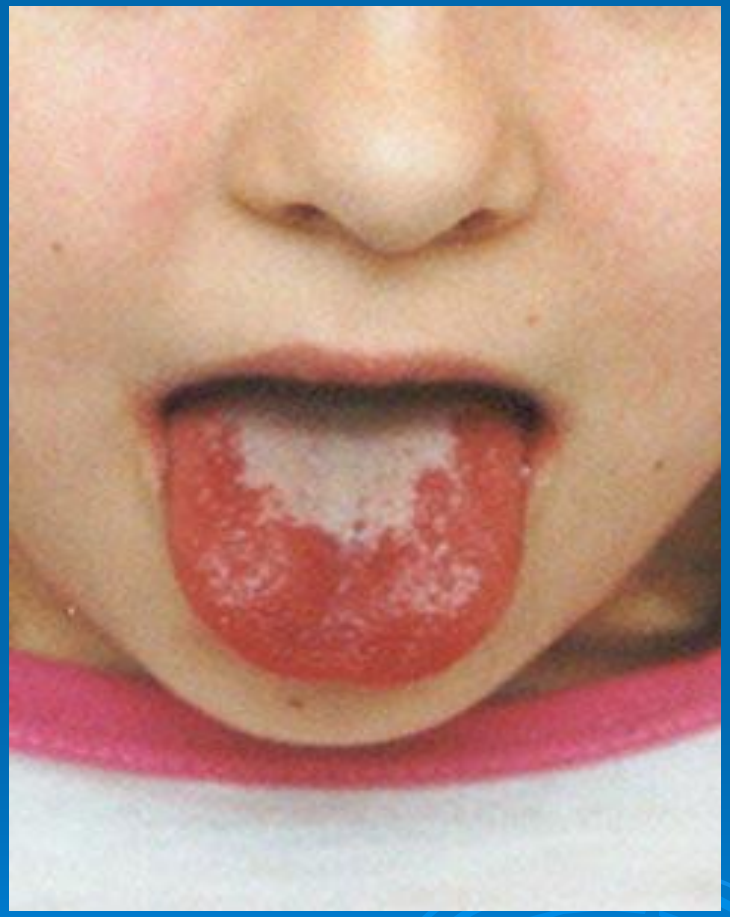
Septic pulmonary emboli. Multiple nodular pulmonary infiltrates secondary to a dialysis catheter-associated infection. The patient presented with high fevers, cough and pleuritic chest pain. *Staphylococcus aureus* was isolated from multiple blood specimens.



Staphylococcus aureus

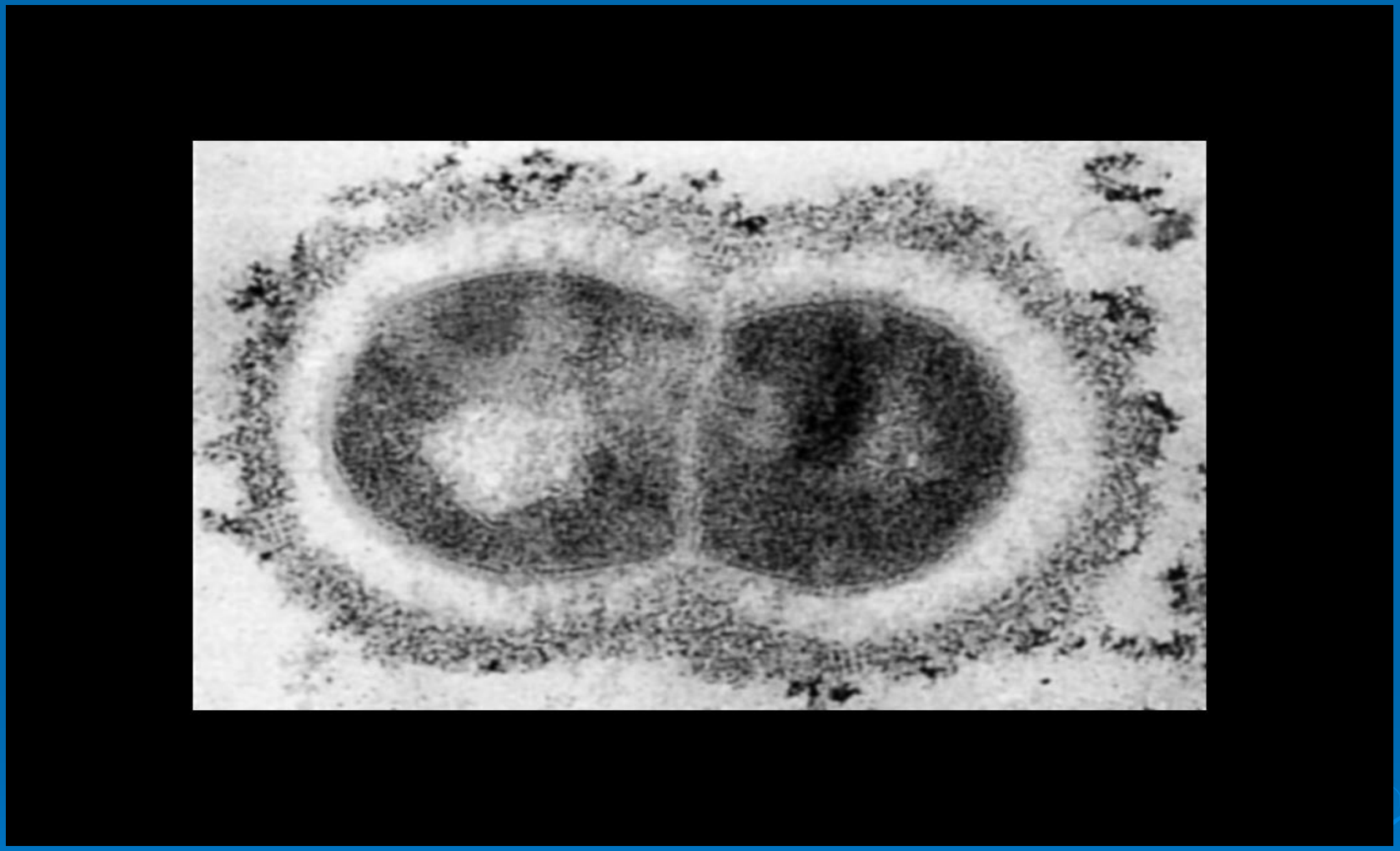


Scarlatina (scarlet fever)



- Necrotizing fasciitis caused by **group A strepococci**. There is only moderate erythema but at surgery there was extensive soft tissue damage.

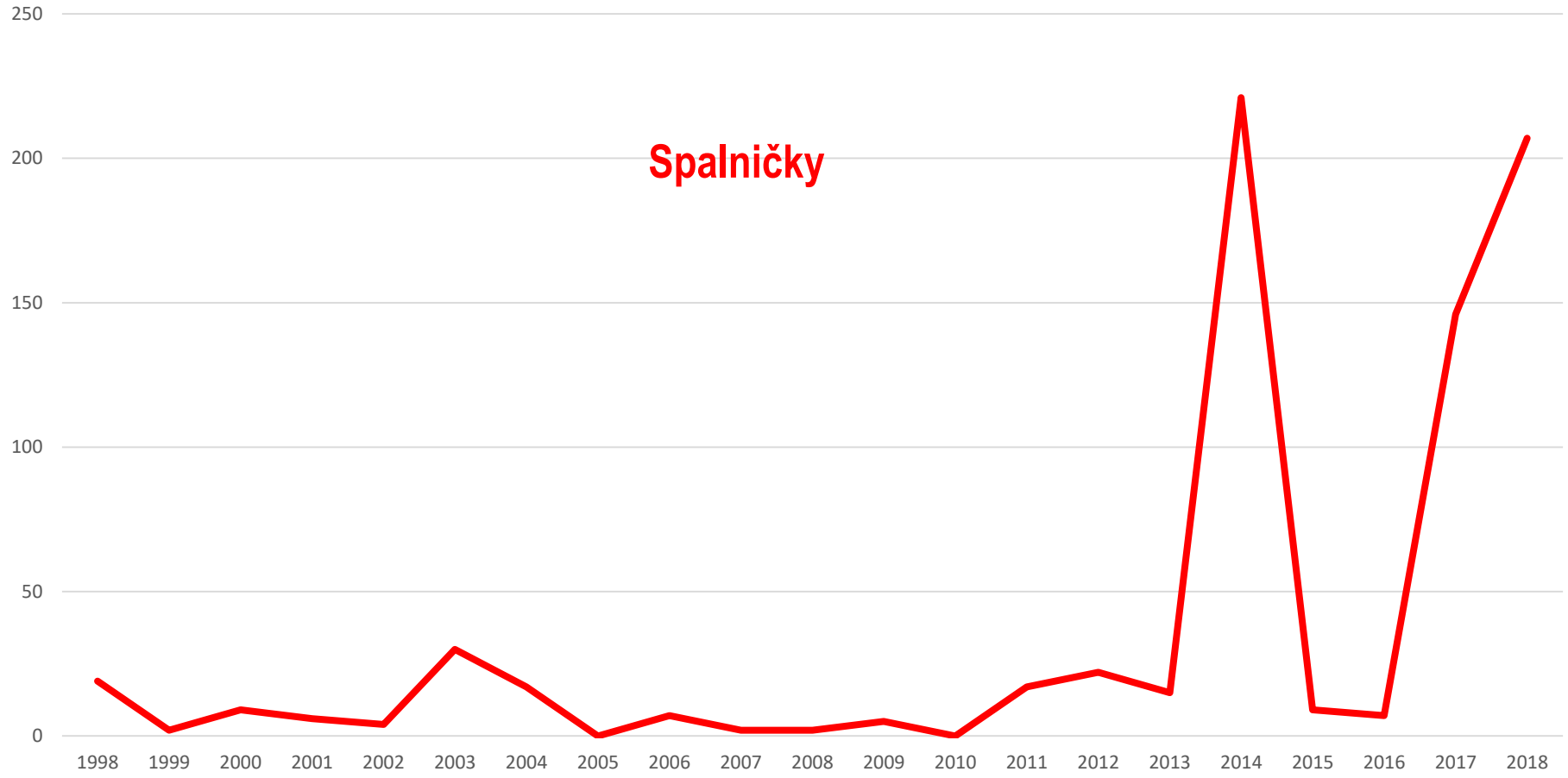
- β-Hemolytic streptococci group A on a blood agar plate. Note the clear b-hemolytic zone.



- Electron microscopy of group A streptococcus. The fuzzy M protein layer can be seen protruding from the cell wall..

Typical rash of meningococcal septicemia. Fine erythematous macules and petechiae are present in some areas.

Morbilli (Measles). A disseminated erythematous rash can be seen over the trunk and arms.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Rubella. A pink macular rash can be seen on the forearm.

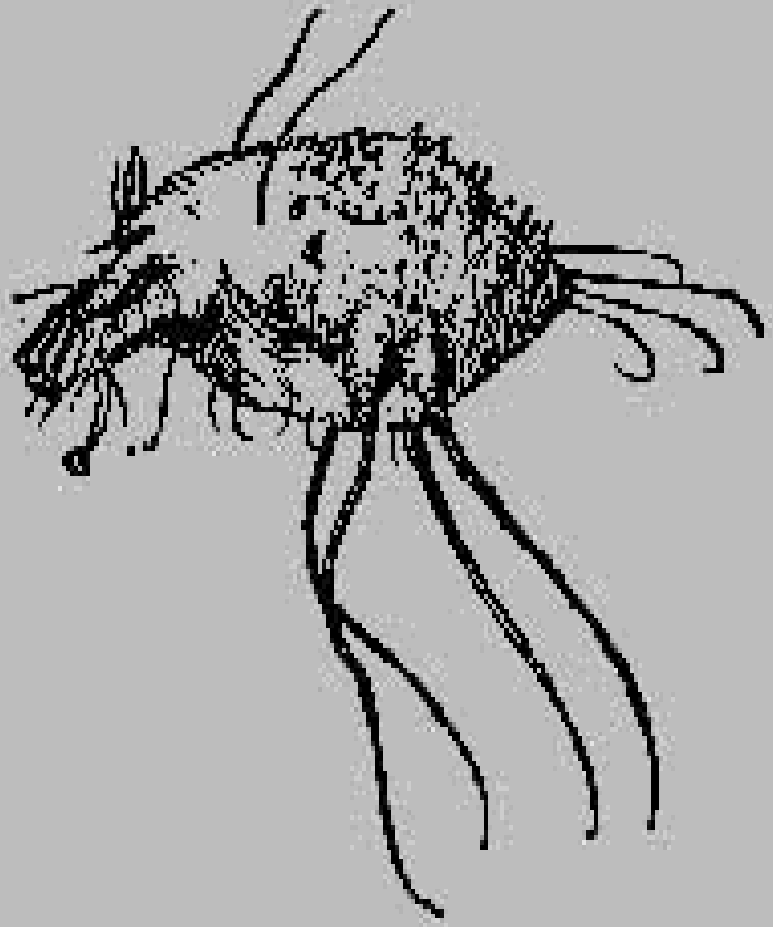
Rubella

Parotitis epidemica (mumps)

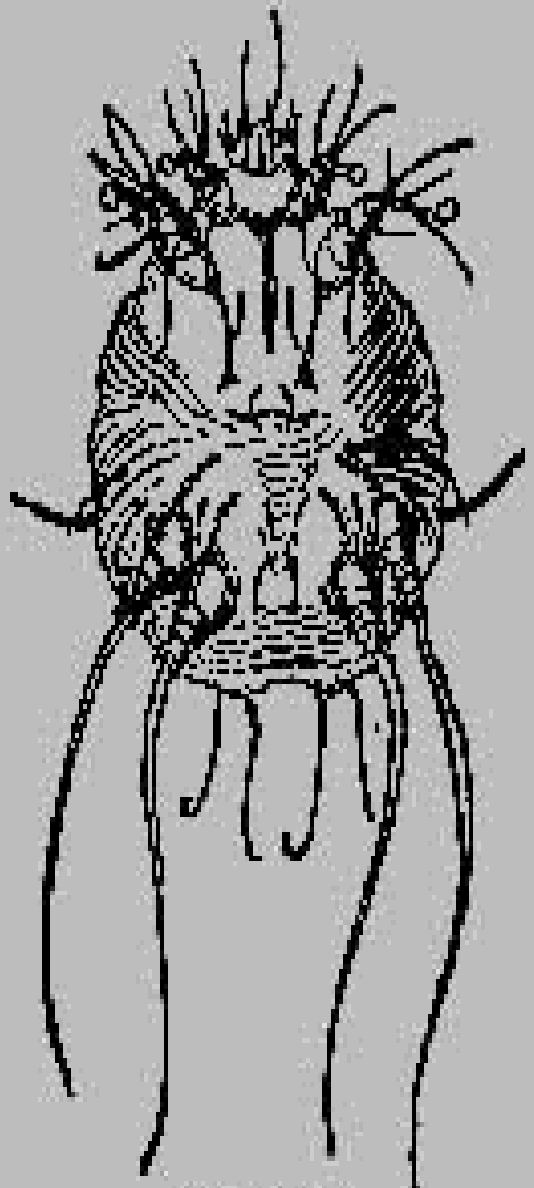
Scabie

Crusted or Norwegian scabies in a patient who has AIDS.

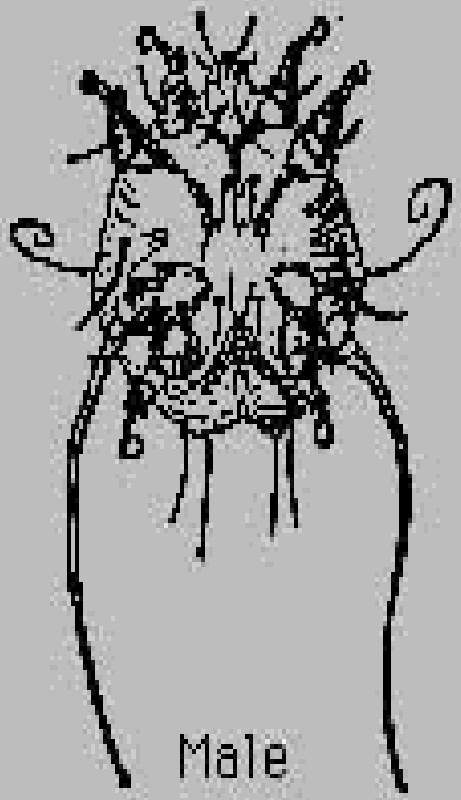
Sarcoptes scabiei



lateral



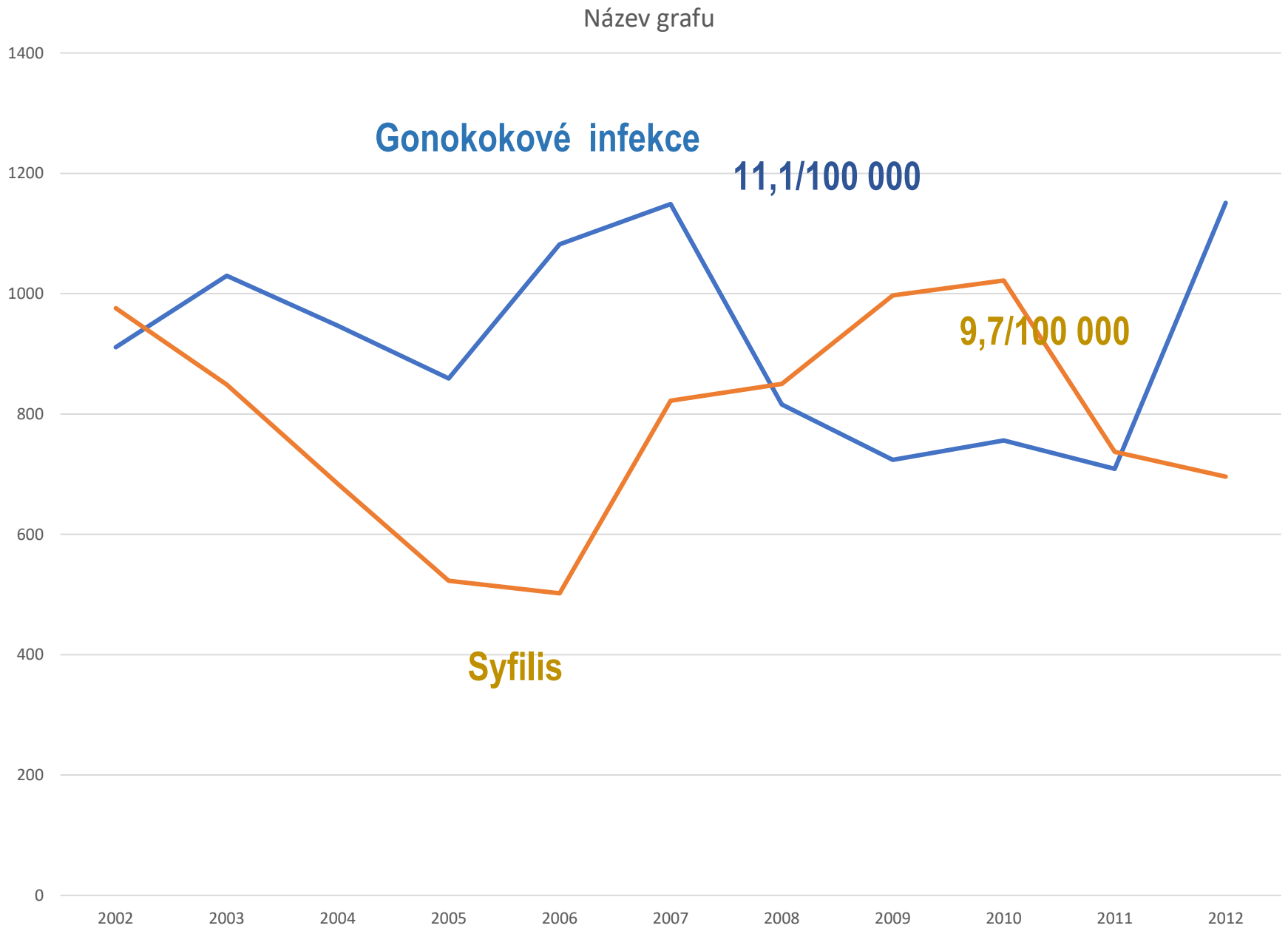
Female



Male

0.4 mm in length

Gonococcal urethritis.


Název grafu
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Gonokokové infekce
11,1/100 000
9,7/100 000
Syfilis
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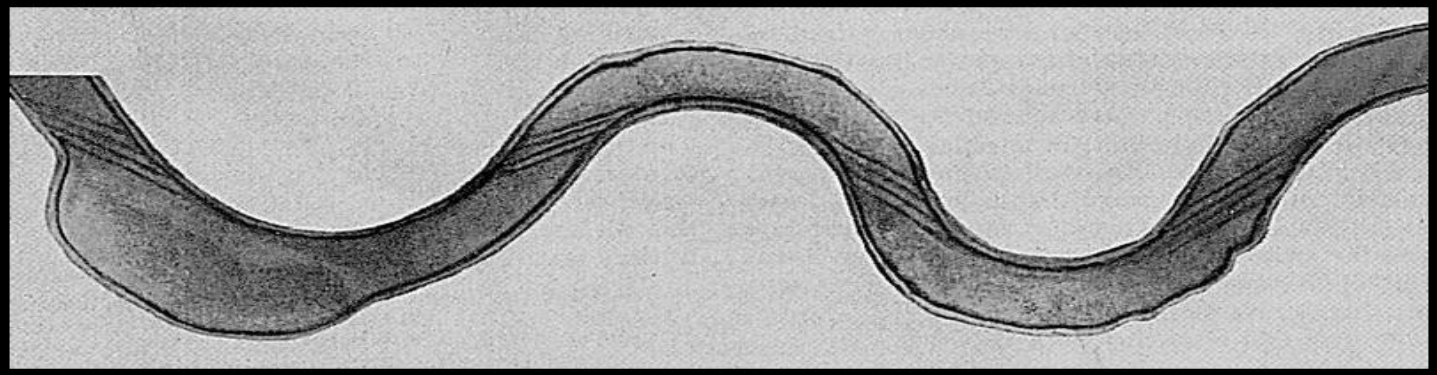
Secondary syphilis with typical skin rash.

Helical structure of *Treponema pallidum* with the periplasmic flagella.



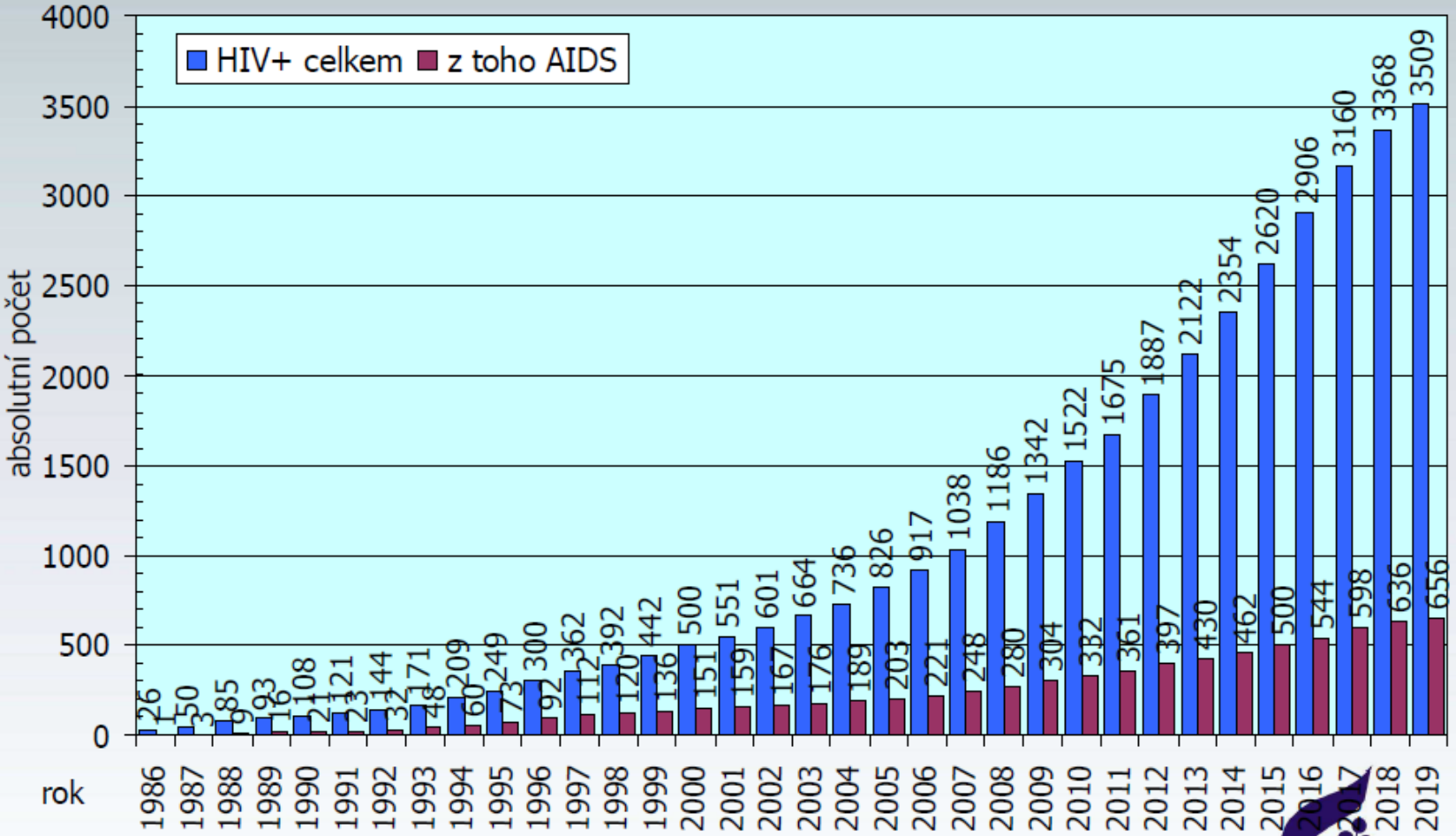
Primoinfection HIV

HIV / AIDS V ČESKÉ REPUBLICE

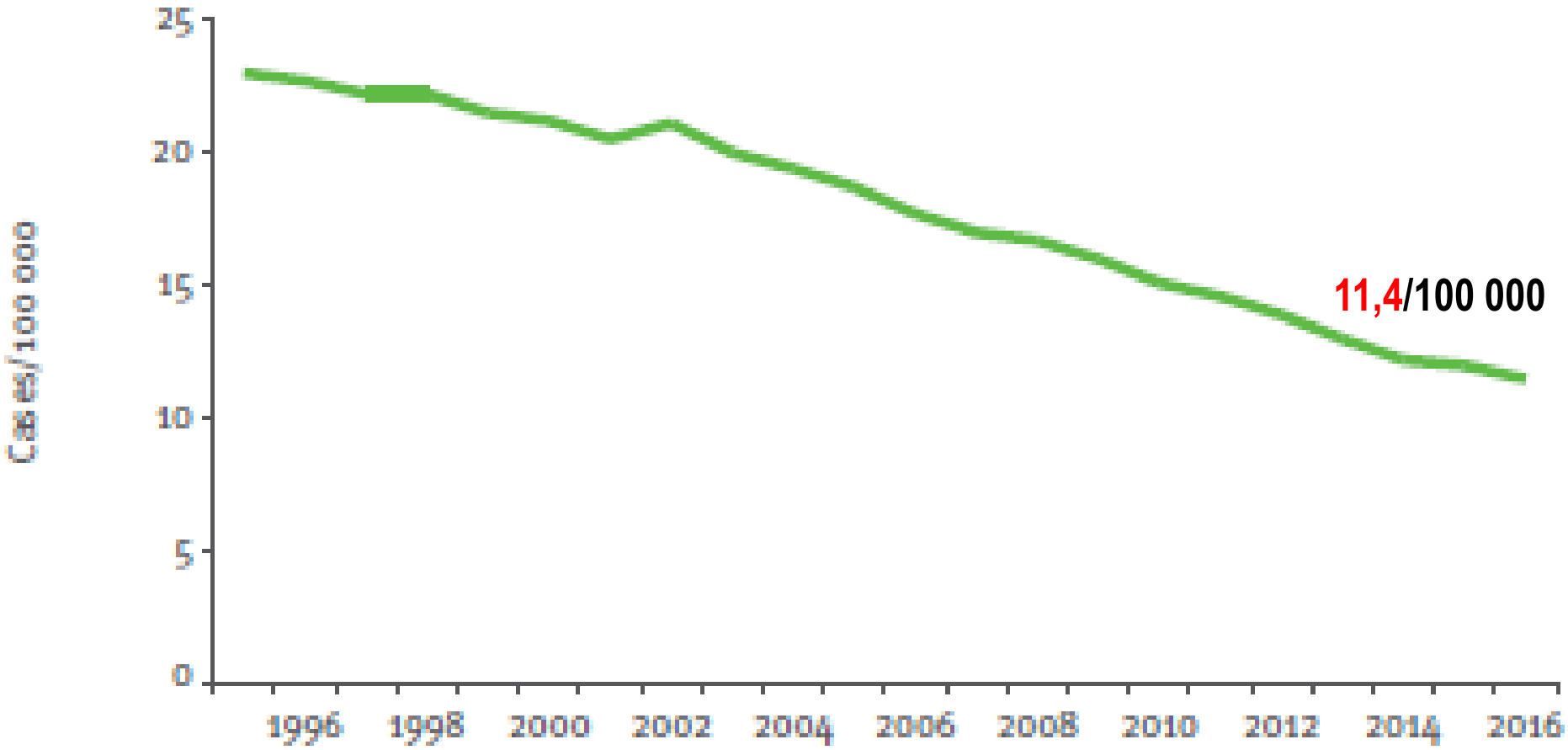
(občané ČR a cizinci s dlouhodobým pobytem)

Kumulativní údaje za období

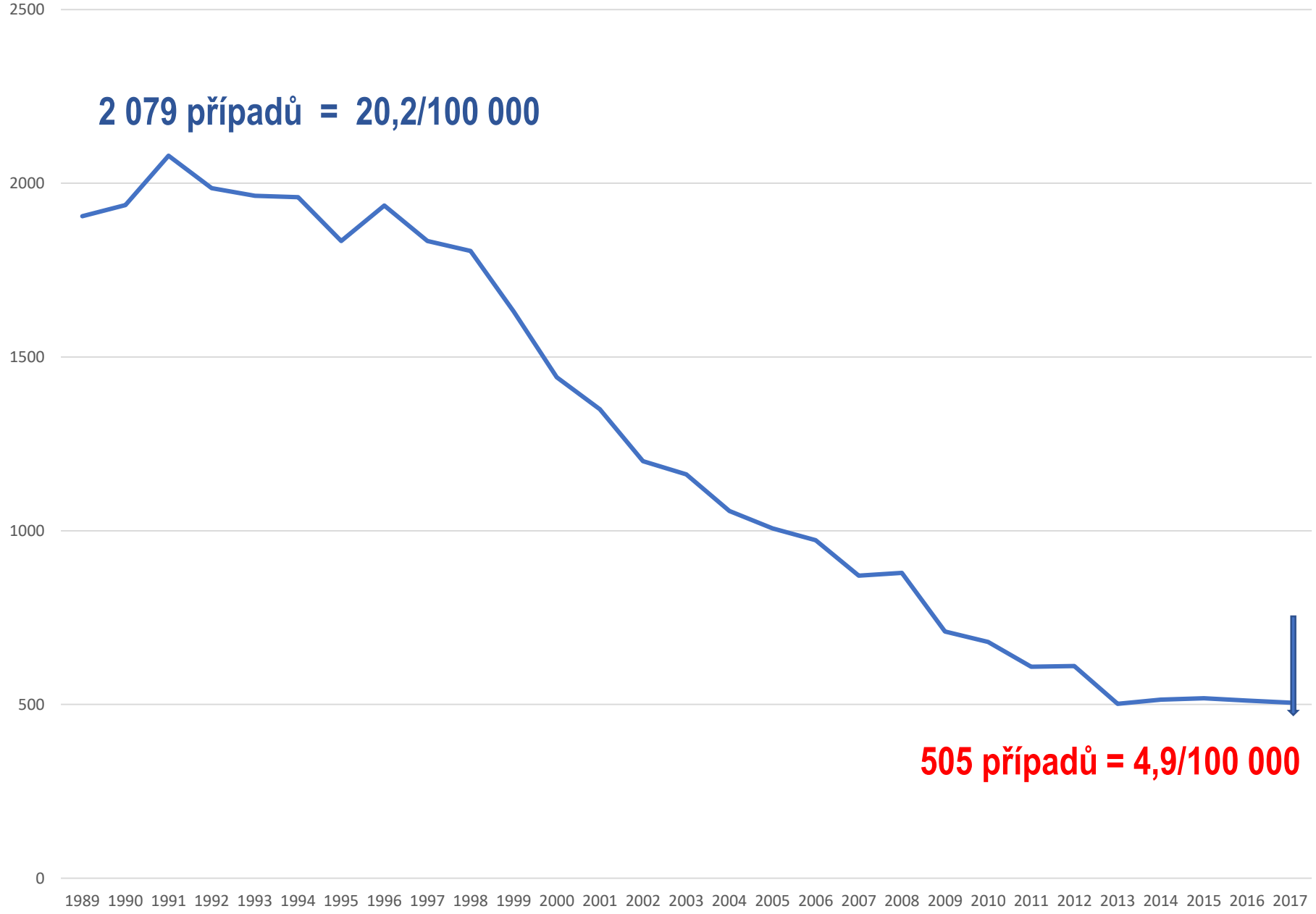
1.1.1986 - 31.7.2019



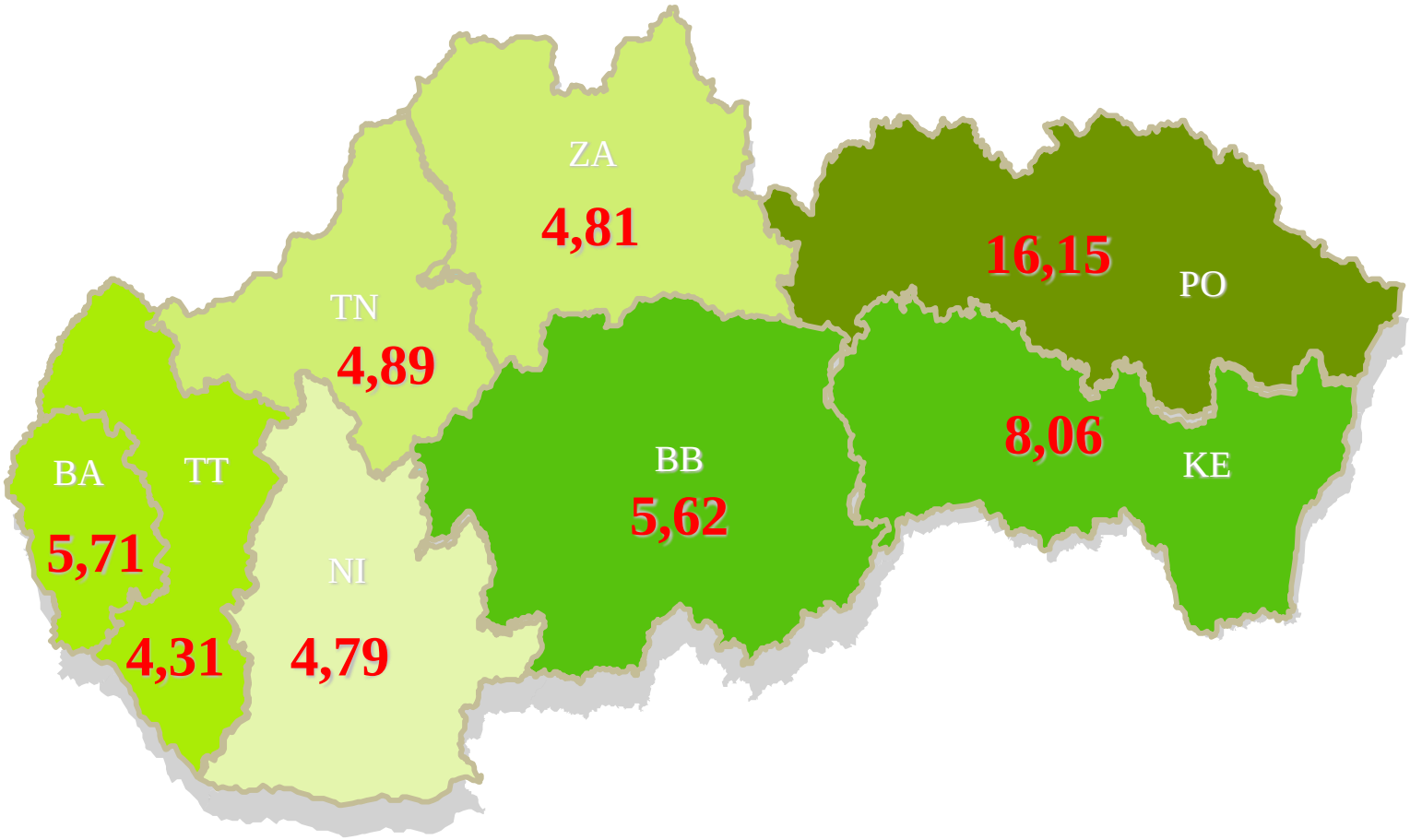
TB notification rates per 100 000 population by year of reporting, EU/EEA, 1995-2016



Tuberkulóza



TBC – in Slovakia - 2013
number of cases/100 000 residents



Source: Doc. MUDr. Ivan Solovič, CSc.

Poliomyelitis

Morbid changes occur
mainly in the gray matter of the spinal cord.

<u>The infectious agent:</u>
There are three types of polioviruses
-1, 2 and 3.

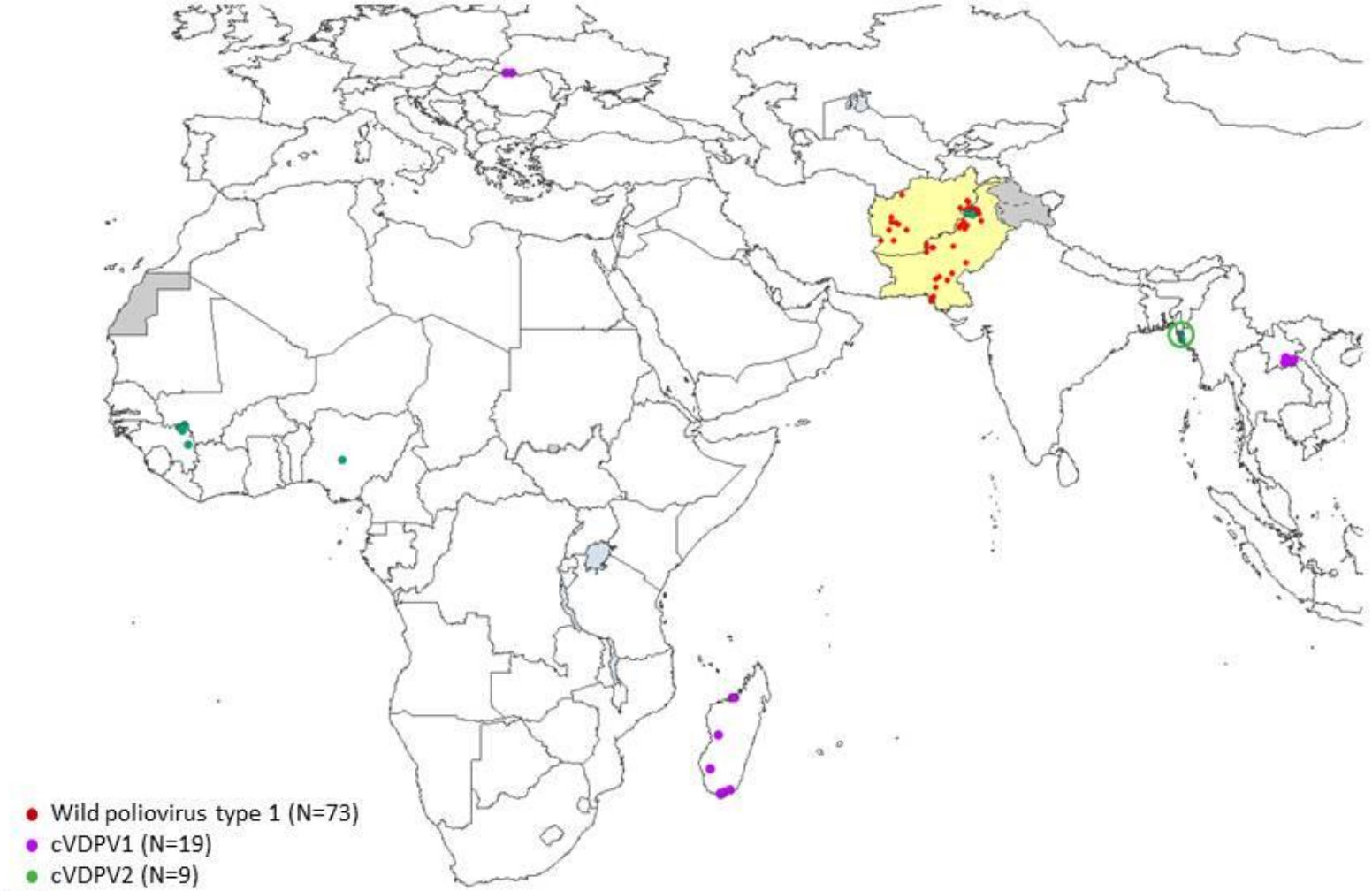
Virus excretion: 1 week from the nasopharynx,
6 weeks of stool.

<u>80% of cases are asymptomatic.</u>

- Polio Viruses, which are endemic or epidemic areas
- spreading in a population,we are known as **wild polioviruses**.

- Among them were for the purpose of preparing live vaccines repeated passaging the virus in cell cultures resulting strain called **vaccinal.**

Wild Poliovirus & cVDPV Cases[1], 2015
01 January – 31 December



[1]Excludes viruses detected from environmental surveillance.

Data in WHO HQ as of 02 February 2016

Polio this week as of 02 October 2019

- September's Polio News is now available with the latest polio numbers and news updates.

- Summary of new viruses (AFP cases and ES positives) this week:
- Pakistan— **three WPV1 cases** and 13 WPV1-positive environmental samples;
- the Democratic Republic of the Congo— one circulating vaccine-derived poliovirus type 2 (cVDPV2) case;
- Ghana— one cVDPV2 case and five positive environmental samples;
- Philippines— one cVDPV2 case, one cVDPV2 and 5 cVDPV1 positive environmental samples.

Polio eradication

In 1988, the forty-first World Health Assembly adopted a resolution for the worldwide eradication of polio, the Global Polio Eradication Initiative (GPEI). Since then, the number of cases has fallen by over 99% from an estimated 350 000 to 416 reported cases in 2013.

In 2014, only three countries in the world remained polio-endemic: Nigeria, Pakistan and Afghanistan.

In 2015 to date, two countries have together reported 37 cases: Pakistan (29 cases) and Afghanistan (eight cases), all due to wild poliovirus type 1.

The last natural circulation of WPV2 was in India in 1999 and the last WPV3 case was detected in Nigeria in November 2012.

- Since then, WPV1 has been the only circulating wild type virus.

The last case of endemic paralytic polio in the WHO European Region (i.e. with the source of the infection originating in the Region) was reported in Turkey in November 1998,

and the Region was declared polio-free in June 2002.

The most recent outbreaks linked to importations into the WHO European Region occurred in 2010 in Tajikistan and in 2013–2014 in Israel where WPV1 was circulating in the environment without causing clinical cases .

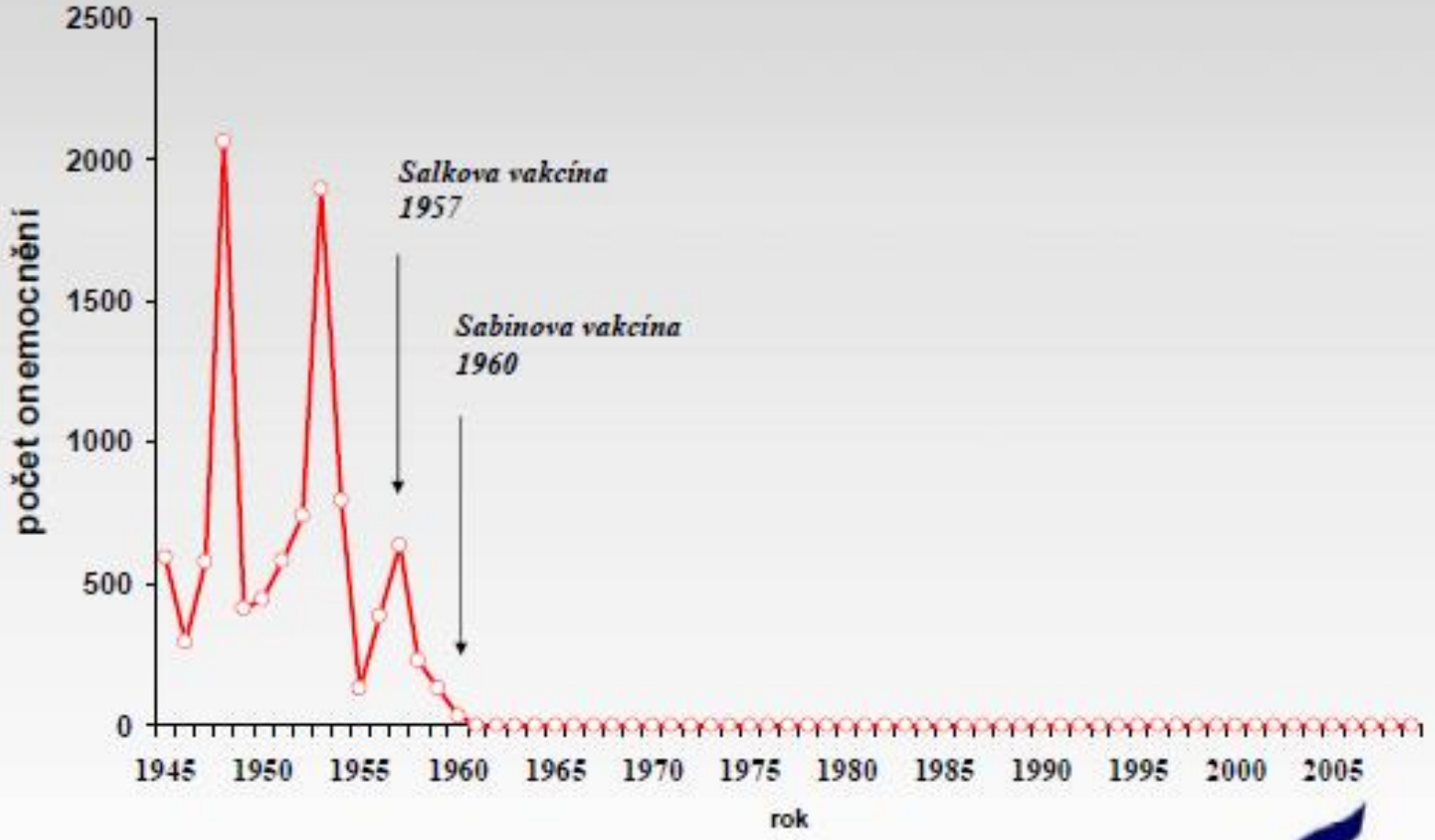
The most recent polio outbreaks in what today constitutes EU/EEA were in the Netherlands in 1992, in a religious community opposed to vaccination,

and in 2001, when three polio cases were reported among Roma children in Bulgaria .

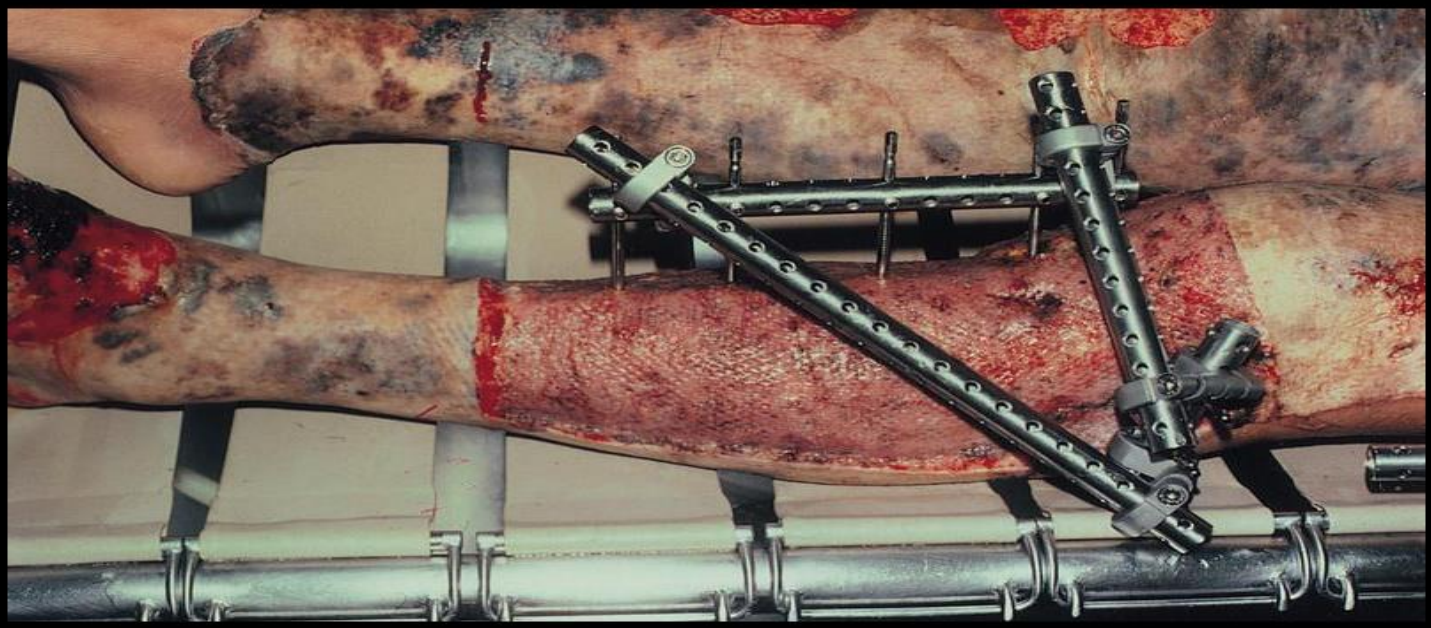
On 5 May 2014, WHO declared the international spread of wild poliovirus in 2014 a Public Health Emergency of International Concern (PHEIC) following the confirmed circulation of wild poliovirus in several countries and the documented exportation of wild poliovirus to other countries.

The Polio Eradication and Endgame Strategic Plan 2013–2018 sets out the actions required for a polio-free world by 2018 and beyond.

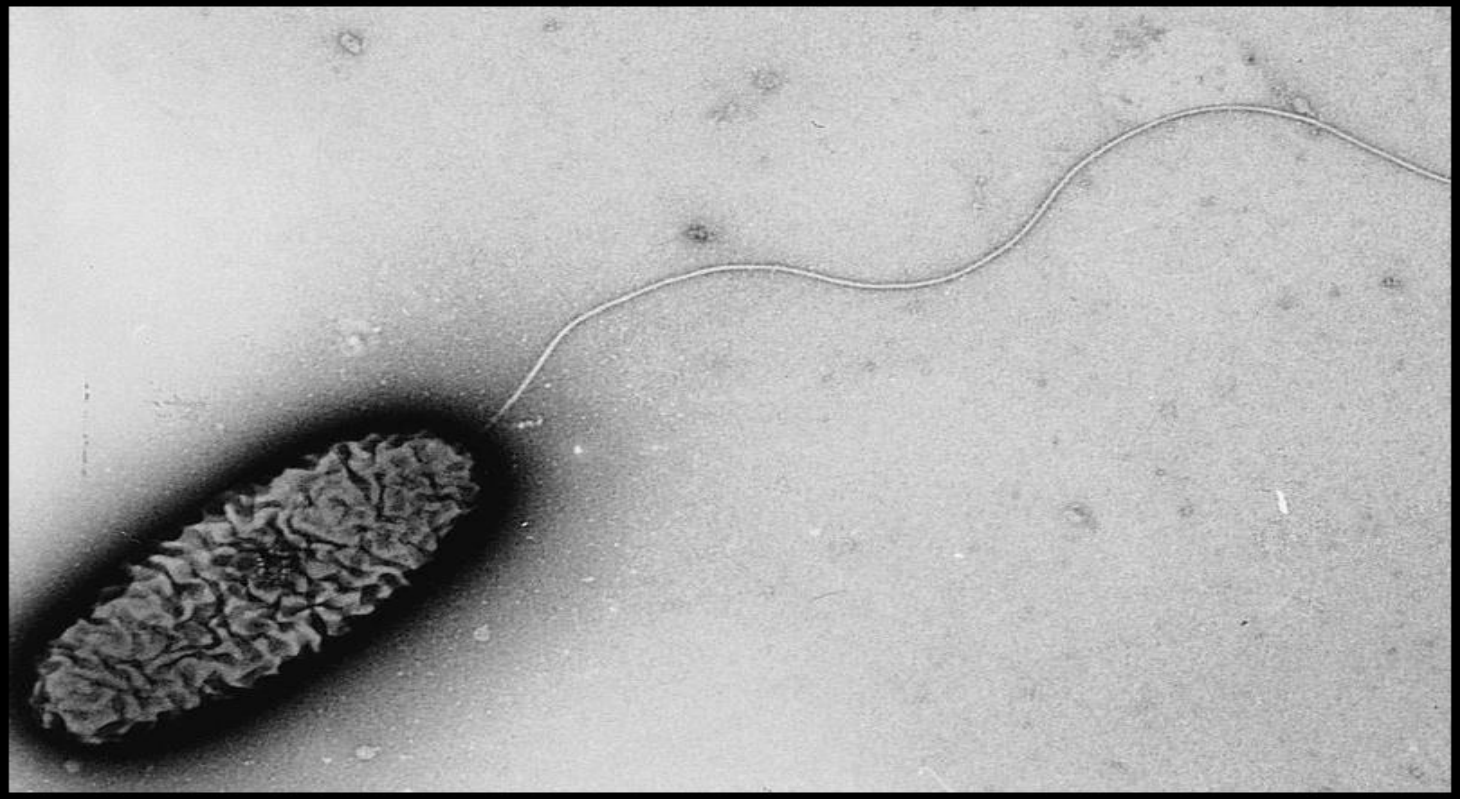
Polio (A80), Česká republika, hlášená onemocnění 1945-2009



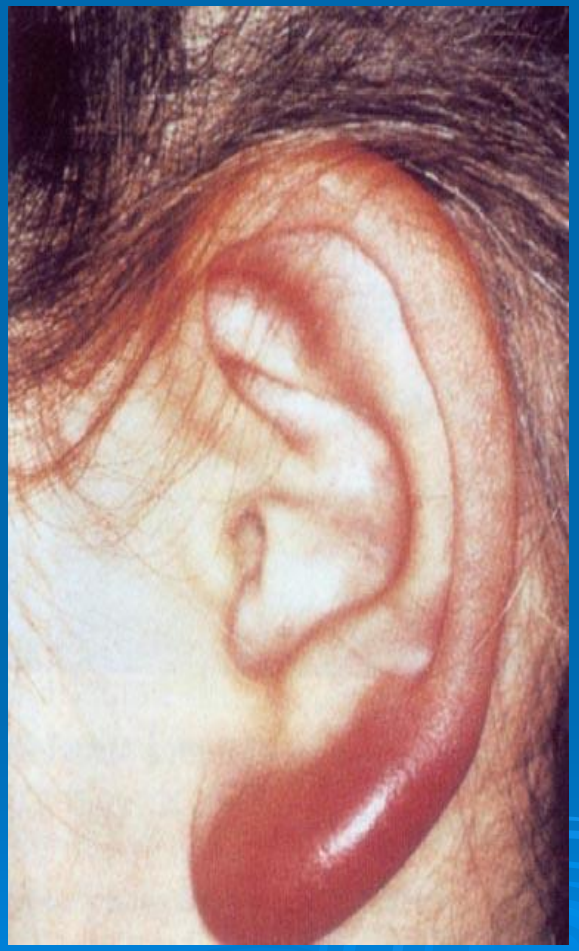
Burned leg that has been superinfected with *Pseudomonas aeruginosa*.



Pseudomonas aeruginosa monotrichous polar flagellum seen on electron microscopy.



Lyme boreliosis (LB)



LB - Typical erythema migrans rash.

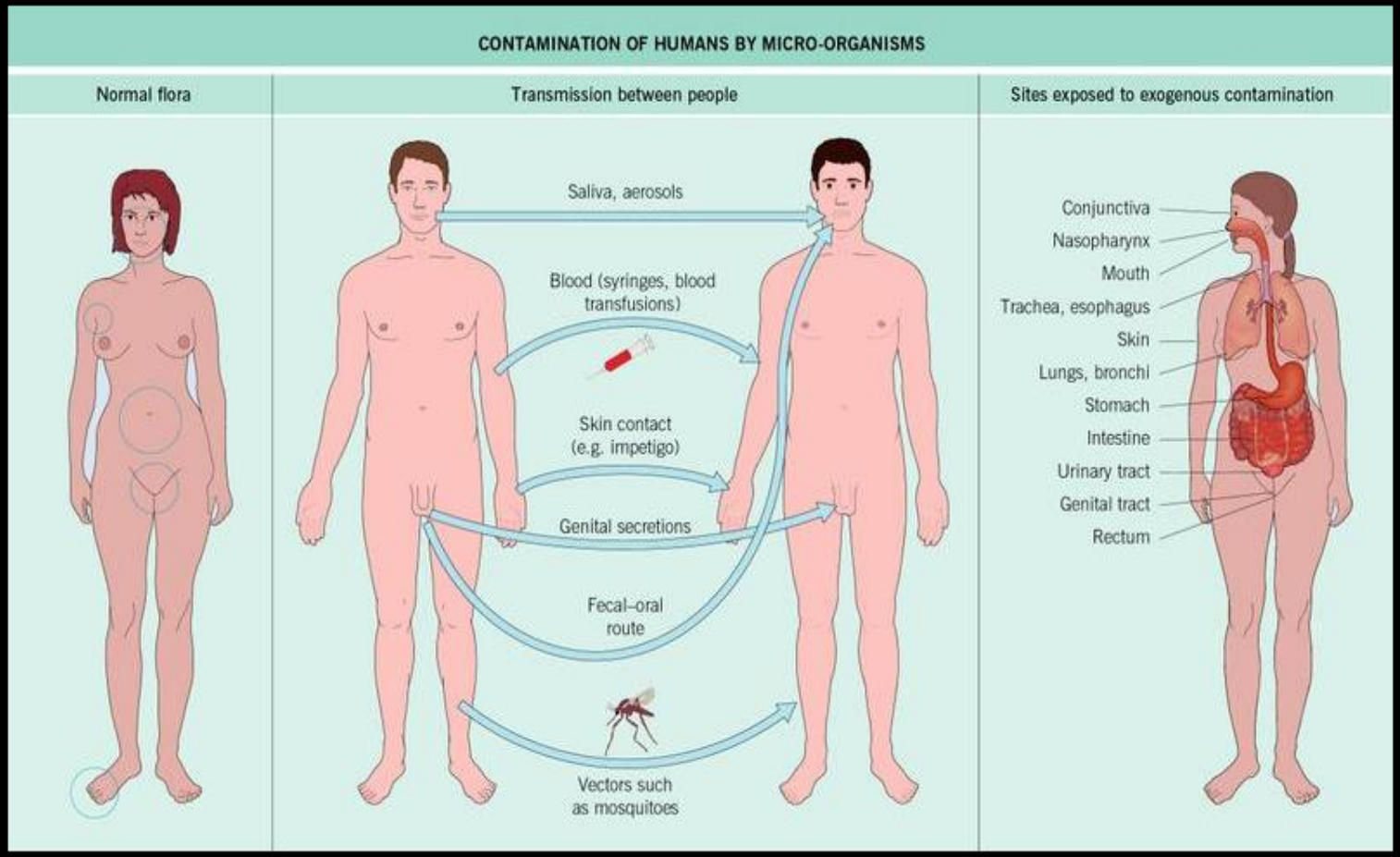
Giemsa stain of blood with *Borellia burgdorferi*.

Tick - Ixodes ricinus

Colonisation and contamination of humans by micro-organisms.

Many parts of the body are colonized by normal flora, which can be the source of endogenous infection. Large numbers of micro-organisms are found in moist areas of the skin (e.g. the groin, between the toes), the upper respiratory tract, the digestive tract (e.g. the mouth, the nasopharynx), the ileum and large intestine, the anterior parts of the urethra and the vagina.

Other routes are interhuman transmission of infections and exposure to exogenous contamination.


CONTAMINATION OF HUMANS BY MICRO-ORGANISMS
Normal flora
Transmission between people
Saliva, aerosols
Blood (syringes, blood transfusions)
Skin contact (e.g. impetigo)
Genital secretions
Fecal–oral route
Vectors such as mosquitoes
Sites exposed to exogenous contamination
Conjunctiva
Nasopharynx
Mouth
Trachea, esophagus
Skin
Lungs, bronchi
Stomach
Intestine
Urinary tract
Genital tract
Rectum

Infectious diseases result from the interaction of agent, host, and environment.

More specifically - spreding of infections occurs when:

the agent leaves its **1. reservoirs or host (source)** trough a portal of exit,

is conveyed **2. by some mode of transmissin**

and enters trough an appropriate portal of entry to infect

3. a susceptible host.

THE CAUSATIVE AGENT OF INFECTION

(viruses, Chlamydia, rickettsia, mycoplasma, spirochete, bacteria, prions, fungi, protozoa helminthes)

1. the **presence of rezervoir (source)** of infection

2. the way of **transmission**

3. the **susceptibility** of the population or its individual member to the organism concerned

THE INFECTION

= 1. **source of infection**

1. the presence of source of infection

is the site or sites in which a disease agent normally lives and reproduces.

May be classified as:

- human - at the ende incubation period,
  if is ill,
  reconvalescent,
  carriers – healthy,
  chronic diseases
- animals - at the ende incubation period,
  if is ill,
  carriers – healthy,
  reconvalescent, chronic

2. the metod of transmission

A/ direct contact

touching, kissing or sexual intercourse (Staphylococcus spp., Gonococcus spp.,HIV …),

- vertical transmission – from mother to fetus (VHB, VHC, HIV, listeria, rubella, cytomegalovirus…)

B/ indirect contact

- inhalation of droplets containing the infectious agents (TBC, measles, influenza…)
- ingestion of food or water that is contaminated (salmonella, giardia, Norwalk virus, VHA….)
- biological transmission by insects (malaria, borellia….)

Organisms vary in their capacity to survive in the free state and to withstand adverse environmental conditions, for example:

* heat, cold, dryness.

Sporo-forming organisms, such as tetanus bacilli which can survive for years in a dormant state, have a major advantage over an organisms like the gonococcus which survive for only a very short time outside the human host.

Routes of transmission

- Air
- Food, Drink or Water
- Direct or indirect contact
  - * Transplacental
- Insects (Artropods)

Main portals of entry

- Respiratory tract
- Gastro-intestinal tract
- Genito-urinary tract
- Direct break through skin

  * surgical and wounds
- Direct into blood via needles/catheters

3. the susceptibility of the population or its individual member to the organism concerned, and the characteristic of the organism itself.

Host factors :

Non specific immunity

- Barrier action (natural barrier)
  - External barrier:
    - skin , mucosa
    - Secretion of skin and mucosa
    - Accessory organ
  - Internal barrier: placenta, blood-brain barrier
- Phagocytosis
- Humoral action :
  - Complement, Lysozyme, Fibronection, Cytokines.

Specific immunity

- Humoral immunity
  - Immunoglobulin: IgG, IgM, IgE, IgA, IgD
- Cell mediated immunity

THE CAUSATIVE AGENT OF INFECTION (bacteria, viruses, fungi, prions, protozoa)

1. the **presence of rezervoir (source)** of infection

man, animal → at the ende of incubation period
→ acute stage
→ cariers

2. the way of **transmission** **A/ direct contact**

touching, kissing or sexual intercourse (Staphylococcus spp., Gonococcus spp.,HIV …),
- vertical transmission – from mother to fetus (VHB, VHC, HIV, listeria, rubella, cytomegalovirus…)

B/ indirect contact
- inhalation of droplets containing the infectious agents (TBC, measles, influenza…)
- ingestion of food or water that is contaminated (salmonella, giardia, Norwalk virus, VHA….)
- biological transmission by insects (malaria, borellia….)

3. the **susceptibility** of the population or its individual members to the organism concerned

Host factors : age, nutrition, genetics
immunity – natural (nonspecific, specific),
- acquired (after vaccination)

THE INFECTION

= 1. source of infection

.....

THE CAUSATIVE AGENT OF INFECTION

(viruses, Chlamydia, rickettsia, mycoplasma, spirochete, bacteria, prions, fungi, protozoa helminthes)

1. the **presence of rezervoir (source)** of infection

2. the way of **transmission**

3. the **susceptibility** of the population or its individual member to the organism concerned

THE INFECTION

= 1. **source of infection**

. . . .

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ANTI - EPIDEMIC MEASURES

1. the **presence of rezervoir (source)** of infection

X **ISOLATION**

2. the way of **transmission**

X **HAND WASHING, LINEN WASHING, CLEANING, GOOD PREPARING OF FOOD, SAFE WATER……., DISINFECTION, STERILIZATION**

3. the **susceptibility** of the population or its individual member to the organism concerned

X **VACCINATION**

REDUCING THE INCIDENCE,
ELIMINATION,
ERADICATION

INFECTION
= 1. source of infection

Remembering an Old Disease

- Smallpox

Face lesions on boy with smallpox.

Public Health Images Library (PHIL) ID # 3.
Source: CDC/Cheryl Tyron

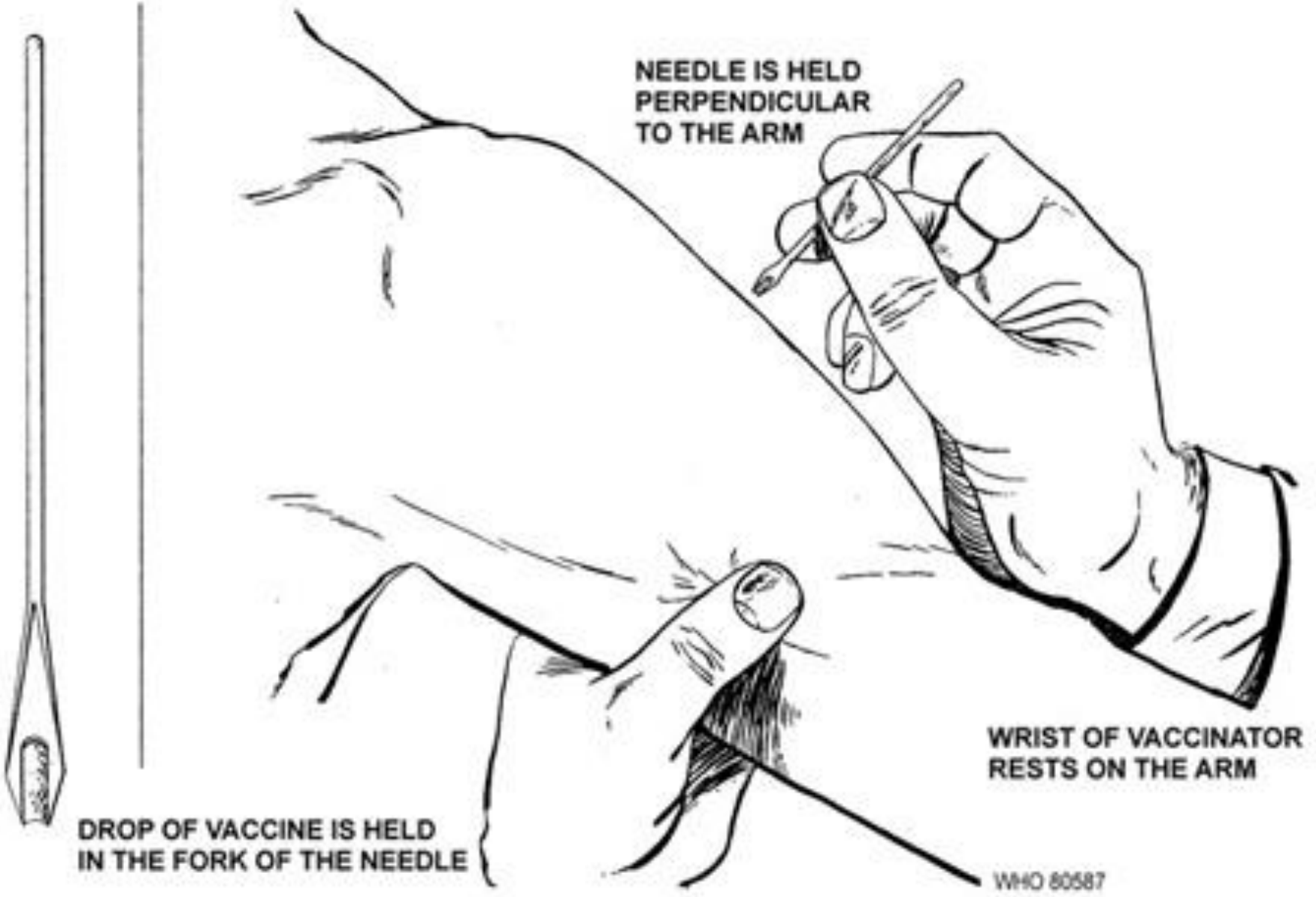
Smallpox recognition card, c.1973, courtesy Dr. Damodar Bhonsule, Panjim, Goa, India.

Smallpox lesions on skin of trunk.
Picture taken in Bangladesh, 1973.

Public Health Images Library (PHIL) ID # 284. Source: CDC/James Hicks

Rural vaccinator in United Provinces, British India, c.1930, private collection of Dr. Sanjoy Bhattacharya

MULTIPUNCTURE VACCINATION BY BIFURCATED NEEDLE



Variola virus, which causes smallpox, was once the scourge of the world.

This virus passes from person to person through the air.

A smallpox infection results in fever, severe aches and pains, scarring sores that cover the body, blindness in many cases, and, often, death. There is no effective treatment.

Although vaccination and outbreak control eliminated smallpox in the United States by 1949, the disease still struck an estimated 50 million people worldwide each year during the 1950s.

In 1967, the World Health Organization (WHO) launched a massive vaccination campaign to rid the world of smallpox —and succeeded.

The last natural case of smallpox occurred in Somalia in 1977.

Ali Maow Maalin, cook twenty-three of the hospitals in the Somali Merce.
He contracted when he showed the path of the ambulance chauffeur who drove two sick children to camp insulation.

In 1978 was ill photographer Medical School in Birmingham, England. She was killed by a virus that escaped from a neighboring lab.

Mr. John Wickett, of the World Health Organization, with the last person to have contracted – and survived – naturally occurring smallpox in Somalia.

(1977),

Eradication of smallpox
Czech experts

A key figure in the global eradication program smallpox was prof. MUDr. Karel Raska, MD., who drove in the sixties division

Communicative Diseases of the WHO

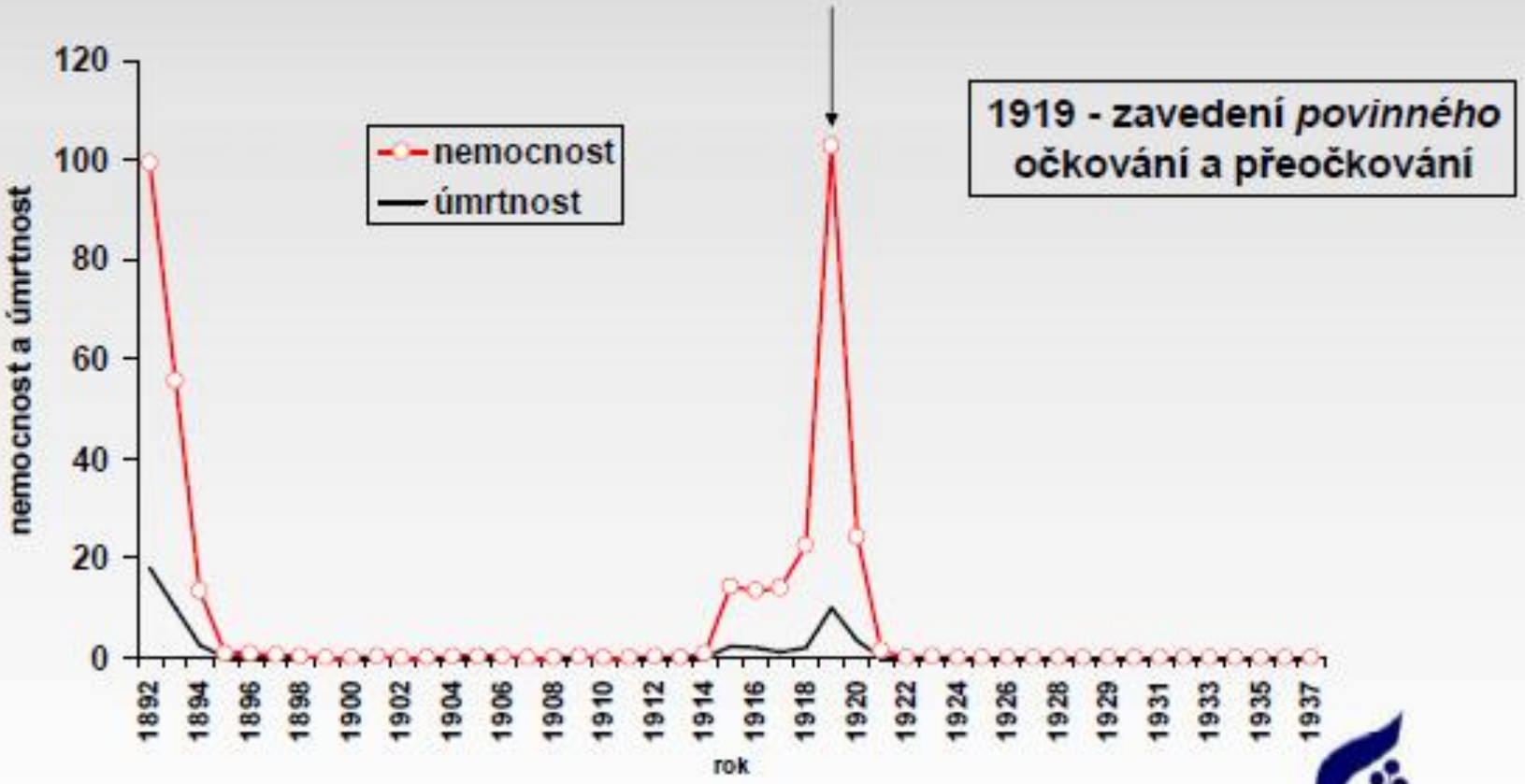
Secretariat in Geneva.

He promoted the establishment of a new, independent units "Eradication of smallpox"and ensure its initial financial and material support, not only in Geneva, but also in regional offices of WHO.

With its support of the program also attended the 20 Czechoslovak health professionals (14 Czechs and Slovaks 6), mainly epidemiologists.

They participated in both the preparation methodology and procedures, thus working directly in infested areas.

Variola, České země, 1892-1937, nemocnost a úmrtnost na 100 000 obyvatel



Smallpox eradication was
officially announced
at the 33rd General Assembly WHO

8. May 1980.

Tuesday, March 8, 2011; 9:41 AM

Milestones in the eradication of smallpox

1789 Edward Jenner invents a smallpox vaccine.

1966 The World Health Organization (WHO) launches a massive global campaign to eradicate smallpox.

1972 Smallpox vaccinations are discontinued in the United States.

1975 and 1977 The last cases of the two known variants of smallpox occur in the world, in Bangladesh and Somalia.

1978 Two people are sickened in a lab accident in England; one dies.

1980 The WHO declares smallpox eradicated.

1991 Smallpox virus DNA is mapped.

1999 The WHO sets this deadline, by which remaining lab stocks of the virus are to be destroyed. The deadline will be postponed again and again.

2003 Millions of doses of vaccine are produced to hedge against a biological attack.

2011 WHO's decision-making body will meet in May to again vote on whether to kill the remaining live viruses.

If the epidemiology is know, we can interfere with transmission:

„BREAKING THE CHAIN OF INFECTION“

Different infections have different epidemiologies and thus require different methods of control

In the practical part it is preoccupied with

preventive measures
repressive measures
related to infectious diseases

The 14 steps of an epidemic investigation

1. Confirm the existence of an epidemic.
2. Verify the diagnosis.
3. Develop a case definition.
4. Develop a case report form.
5. Count the cases (i.e., an approximate analysis).
6. Orient the data (i.e., time, place, and person).
7. Analyze the data (e.g., agent, transmission, and host).
8. Develop a hypothesis.
9. Test the hypothesis.
10. Plan and implement control and prevention measures.
11. Evaluate the implemented measures.
12. Establish or improve the public health surveillance.
13. Write a report.
14. Plan and conduct additional studies.