



## Averting biological dangers

A man buys castor beans online and manufactures ricin. Then he orders material for a cluster bomb. When a special commando unit arrests him in Cologne in summer 2018, the RKI's task force is at the ready. In protective clothing they and their colleagues from the Bundeskriminalamt – the Federal Criminal Police Office – scour the flat, collect samples and take them to Berlin for analysis.

*'It is the responsibility of public health protection to be prepared for events involving highly pathogenic agents.'*

Professor Dr Lars Schaade, Vice President of RKI

The term "dirty dozen" refers to a group of pathogens and poisons that, at least in theory, could be used for terrorist attacks. They include anthrax bacteria, the plague and tularaemia, the smallpox and Ebola viruses, the bacterial poison, botulinum toxin, and also the plant poison, ricin.



Castor beans

If there is the suspicion of a bioterror attack RKI experts support the security services. The institute is the German centre for the detection, assessment and handling of biological threats. Scientists collate information on highly-pathogenic agents and toxins, draw up recommendations for protective measures, and offer courses for the emergency services. Employing a whole raft of measures, they are able to identify pathogens quickly and efficiently and thus avoid false alarms.

RKI does not, however, only focus on attacks, because all pathogens that can be used for attacks occur in nature and can trigger spontaneous outbreaks. Scientists therefore investigate diseases like anthrax, botulinum and Ebola in order to understand them better.

Highly pathogenic viruses like Ebola are studied in the institute's high-security laboratory, or BSL-4 laboratory, for short. The laboratory is hermetically sealed off from the rest of the building and staff working there wear full-body protective suits with their own air supply. After work, several minutes are spent in a special shower where they are decontaminated.



RKI's BSL-4 laboratory

## Identifying health trends and preventive measures

What do children in this country weigh? How does social status influence well-being? What is the state of adult psychological health – in short, how are people in Germany doing? RKI has the answers: nationwide federal health reporting and health monitoring are signature activities at the institute. RKI epidemiologists study health trends and risks. Their findings help form the basis for decision-making by government and other actors on issues like preventative measures and the targeted development of healthcare.

*'RKI is data-driven. With our innovative research data management, we can record and evaluate health trends even better.'*

Professor Dr Lothar H. Wieler, President of RKI

Most people in Germany are in good health or very good health and it is pleasing to note that they reach a greater age. The result of this, however, is that chronic illnesses like cardiovascular diseases, cancer and diabetes mellitus are on the increase. Scientists want to elucidate the risk factors relating to these diseases and thus create the preconditions for healthy ageing.

Almost half a million people per year are diagnosed with a malignant tumour. RKI's Centre for Cancer Registry Data bundles the data from the whole of Germany, assembles an overall picture

and identifies developments that urgently need to be investigated. Moreover, at RKI, National Diabetes Surveillance is being established to map the burden of the disease and the care quality experienced by roughly seven million adults with diabetes in Germany.



Examination during RKI health monitoring

The publications on health reporting are largely based on the data from RKI's own health monitoring. For this purpose, many thousands of children, adolescents and adults in the whole of Germany are regularly examined and interviewed. Amongst other things, RKI teams test physical fitness, register mental health, allergies, nutritional and lifestyle habits as well as analyse blood and urine samples.

## The Robert Koch Institute

- 1891** Founding of the "Königlich Preußische Institut für Infektionskrankheiten" (Royal Prussian Institute for Infectious Diseases) with Robert Koch as Director. He heads the institute until 1904
- 1905** Robert Koch receives the Nobel Prize in Medicine for his discovery of the tuberculosis pathogen in 1882
- 1933** During the Third Reich the institute is substantially involved in the National Socialist politics of violence
- 1952** RKI becomes part of the new Federal Health Office
- 1978** A new laboratory building at the Nordufer site becomes operational – one of the most modern in Europe
- 1982** Following the first cases of AIDS in Germany, an AIDS case registry is established at RKI
- 1994** The Federal Health Office is dissolved; RKI is charged with a second major topic: non-communicable diseases
- 2001** The new Protection against Infection Act (IfSG) reinforces RKI's portfolio
- 2003** Launch of the longitudinal study of child and adolescent health, KiGGS
- 2008** The Bundestag resolves to develop the institute into a modern Public Health Institute
- 2014** RKI helps to contain the largest ever Ebola outbreak in West Africa
- 2015** A new laboratory building housing a BSL-4 laboratory is opened at the Seestraße site
- 2019** RKI establishes its Centre for International Health Protection

The Robert Koch Institute (RKI) monitors public health. It is the Federal Government's central institution in the field of biomedicine: its core mission includes the detection, prevention and combatting of infectious diseases as well as the improvement of the health situation in Germany. The focus is on research: approximately half of the roughly 1,200 members of staff are scientists. RKI advises the specialist public and government and functions as an important interface in relations with international actors, such as the European Centre for Disease Prevention and Control (ECDC) and the World Health Organisation (WHO). It is also very active in training scientists and has a broadly-based portfolio of educational opportunities.

[www.rki.de/en](http://www.rki.de/en)

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Nordufer site, Berlin-Wedding



THE INSTITUTE FOR PUBLIC HEALTH

The Robert Koch Institute

ROBERT KOCH-INSTITUT

## Fighting infectious diseases

The virus strikes in winter, usually at the very start of the New Year. It surges through Germany, year after year, sweeping along millions of people in its wake: the flu (influenza). The influenza experts at the Robert Koch Institute have been monitoring the course of flu epidemics for years. They prepare weekly situation reports for Germany, investigate which flu viruses are in circulation and check the efficacy of the flu vaccine.

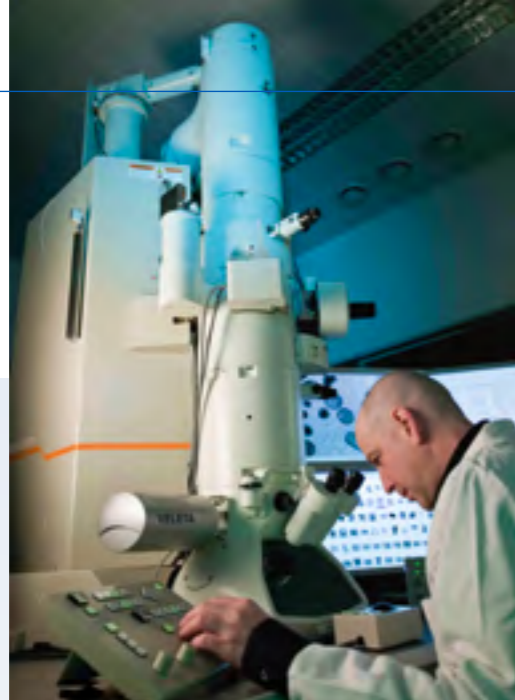
*'From viruses in body cells to obesity in the population – RKI investigates disease on all levels.'*

Professor Dr Lothar H. Wieler, President of RKI

In order to quickly identify trends and outbreaks, nationwide infection monitoring – also known as surveillance – is essential. Data on notifiable diseases like HIV, tuberculosis, tick-borne encephalitis and EHEC from the whole of the country are pooled and evaluated at the institute. RKI hosts



EHEC bacteria



Electron microscopy

National Reference Centres and Consultant Laboratories specialising in various pathogens: scientists investigate how viruses, bacteria, fungi, prions and parasites are transmitted and how they can be diagnosed and rendered harmless. And when an infectious disease does break out somewhere in the world, RKI infection epidemiologists assess the actual risk to Germany and decide what measures should be taken – if necessary, they help to fight the outbreak on the spot.

RKI also continually evaluates the efficacy of vaccinations such as those against rotavirus and the human papilloma virus (HPV). These studies help the Standing Committee on Vaccination (STIKO), an independent expert commission, to adapt its vaccination recommendations on an annual basis. RKI scientists also monitor vaccination coverage in Germany where young people, for example, are often insufficiently protected against measles, leading to repeated measles epidemics.

## Analysing data streams

Traffic movements, commodity flows, genome analysis, climate and geo-information: in the digital age, masses of data are generated every day which, when properly evaluated, can help to identify health hazards more quickly and precisely. RKI scientists want to open this treasure trove of data – with the aid of digital epidemiology. Artificial intelligence, data science, bioinformatics algorithms and mathematical modelling are some of the methods for tomorrow's health protection.

*'Artificial intelligence opens up completely new paths in epidemiology.'*

Professor Dr Lothar H. Wieler, President of RKI

Take the example of genome analysis: nowadays, modern sequencers can unravel the entire genome of a bacterium in no time – often several million building blocks of DNA. One single experiment easily produces huge volumes of data. Using special computer algorithms RKI bioinformaticians can filter out the crucial information, such as which bacterial strain is responsible for an outbreak and whether it is resistant to antibiotics.

With these new methods it is even possible to predict epidemic dynamics. The international flight network, for example, covers thousands of airports, and several billion passengers travel around the world every year. Air network data reveal the routes which spread infectious diseases like influenza across the globe – and at what



The global flight network

speed. At local level, the same is true for commuter movements in buses and trains. In order to assess the trends better, scientists can also link several different data sources, such as air network data with data on pathogen genomes and information from social media. At the same time, the institute's own research data management ensures that the diverse research data are well structured and connected so that they can be used sustainably by scientists worldwide.

## Global health protection

A village in Guinea in December 2013: Whilst playing, a two-year-old comes into contact with a bat. A few days later, the child dies, as do his sister, his mother and his grandmother. This was almost certainly the start of the worst Ebola epidemic ever, as scientists at RKI have deduced from their studies. In 2014/15, more than 39,000 people in West Africa contracted the disease.



Examining a bat in Guinea

Whether we are looking at Ebola viruses, flu pathogens or multi-resistant germs, never has it been easier for pathogens to spread than in our mobile, interconnected world of today. In order to recognise and address health hazards in good time, a robust health system is indispensable. The Robert Koch Institute cooperates with partners all over the world to reinforce local systems and thus pull together to improve the health of everyone.

*'RKI is an international hub of health protection.'*

Professor Dr Lothar H. Wieler, President of RKI

In the high-risk regions of Africa, RKI teams search for unknown pathogens in the animal kingdom that could be a danger to humans. RKI staff help to fight disease outbreaks – including the Ebola epidemic in West Africa and the plague outbreak on Madagascar in 2017. They also help partner countries to build modern laboratories and train colleagues on the spot – in diagnosing



Ebola virus

Dengue virus in Sri Lanka, for example. Furthermore, the institute keeps an eye on non-communicable diseases – obesity and cancer have long since ceased to be the prerogative of rich industrialised countries.

In its role as the German point of contact for global health protection, RKI is also an important collaborative partner for ECDC and WHO in areas such as measles surveillance, international outbreak control, and advice on new biological hazards.

## Avoiding hospital-acquired infections and antibiotic resistance

Every year in Germany, some 400,000 to 600,000 patients are thought to catch infections whilst in hospital – usually surgical site infections after operations, urinary tract infections and pneumonia. Approximately 10,000 to 15,000 of them die.

More stringent hygienic measures, such as improved hand hygiene in all patient contact, could



Traces of bacteria on a hand

avoid some of these infections. The RKI-based Commission for Hospital Hygiene and Infection Prevention (KRINKO) draws up recommendations deriving from studies which present the most up-to-date medical knowledge. The institute also prepares a list of disinfectants and disinfection methods that are used for officially prescribed measures.

Some infections are very difficult to treat: ever more frequently, pathogens like Klebsiellae or certain E.coli bacteria are proving to be unaffected by conventional antibiotics. RKI experts study these bacteria and collect nationwide data on

where the resistant pathogens occur, how their spectrum of resistance mutates, and how many antibiotics are used in Germany's hospitals: improper use of drugs promotes the development of resistance.

The ways in which the pathogens spread can be traced in their DNA. It has long been known that antibiotic-resistant bacteria are not only passed from person to person but also between hospitals and old people's homes or by travellers. Methicillin-resistant Staphylococcus aureus (MRSA) is an example of antibiotic-resistant bacteria that also occur in animals such as pigs and fattening poultry. RKI therefore advocates a one health approach: human, animal and environmental health are closely connected – the problem of antibiotic resistance can only be solved if everybody works together.

