From *The War on Bacteria*

(*Krigen mot bakteriene*)

by Erik Martiniussen

Translated from the Norwegian by Alison McCullough

**Introduction**

The room was dark and warm; the hours passed without my noticing. Every now and again my mother would appear, her expression worried, and then I would fall asleep again. In the early hours of the morning a doctor came to the house. I remember him sitting on the edge of the bed. The cold stethoscope against my chest; the way he asked me to take a deep breath in. It was pneumonia.

We got into Dad’s old, red car and drove to the hospital – the wards had high ceilings and big, tall windows. The beds were big and soft, and could be wheeled from one room to another. The nurses served a kind of red cordial – they called it ‘hospital juice’– and I couldn’t get enough of it. The year was 1978. I was three years old.

St Joseph’s Hospital was built in 1924, at a time when patients with lung infections might remain bedridden for years and the only available treatment was light, rest and fresh air. But the doctors now had something far more effective at hand. Antibiotics. Just a few days after taking the small pills – washing them down with the delicious red juice – I was discharged. Healthy.

But things could have turned out very differently. A hundred years ago, one in ten children died before the age of five. Pneumonia, tuberculosis, whooping cough, scarlet fever and measles caused children to drop dead like flies, but today these diseases are almost unheard of. They are diseases we associate with another time, from back when people lived in overcrowded, draughty houses without water or adequate sewage disposal, perhaps even without adequate clothing.

After the war, the arrival of antibiotics revolutionised medical science. Previously deadly infections could now be easily treated with tablets – it was almost too good to be true. The new miracle medicine became enormously popular, and people gulped down antibiotics from morning to night – they were used to treat everything from headaches and upset stomachs to ear infections. Within agriculture, too, antibiotics were a game changer. Pigs and chickens that would previously become ill if they were forced to live in crowded conditions could now be stuffed into cramped cages, without the animals seeming to be harmed by it. With antibiotics, it seemed they could survive almost anything.

Not only did antibiotics eradicate practically all bacterial diseases, they also laid the foundations for modern medical science and surgery – equipped with antibiotics, surgeons could perform increasingly spectacular operations. Heart, liver and lung transplants, artificial limbs and prostheses – all of these surgeries could be successfully performed. Medical science went from strength to strength – and this was all down to antibiotics.

But behind this glittering facade, the bacteria were preparing for a new attack. This should come as no surprise – as early as 1945, Alexander Fleming, the man who discovered penicillin, had warned that bacteria may become resistant: ‘The time may come when penicillin can be bought by anyone in the shops. Then there is the danger that the ignorant man may easily underdose himself and by exposing his microbes to non-lethal quantities of the drug make them resistant.’[[1]](#footnote-1)

Seventy years later, the bacteria are back. And though this fact is rarely discussed, there is no longer a single hospital in Europe that has not experienced infections of resistant bacteria. And thousands of patients are admitted to hospitals across the world every single day.

Should antibiotics cease to work, medical science may be set back by a hundred years. And this is precisely what is happening. One by one, the diseases of the interwar period have returned: tuberculous, blood poisoning, cholera and even the plague are advancing once more – antibiotics are no longer able to defeat them. Across the world, 700,000 people now die of antibiotic-resistant bacteria every year[[2]](#footnote-2); current projections indicate that around ten million people may die of these infections by 2050.[[3]](#footnote-3) In the US alone, multi-resistant bacteria are already responsible for two million infections and 23,000 deaths a year[[4]](#footnote-4) – by comparison, HIV/AIDS causes 6,700 deaths a year in the US.[[5]](#footnote-5) In the EU, it is estimated that 33,000 people die of resistant bacteria each year.[[6]](#footnote-6) The costs of treating patients suffering from these infections are enormous, and the European Commission estimates that the increased health costs and loss of productivity associated with resistant bacteria total €1.5 billion a year.[[7]](#footnote-7)

Antibiotic-resistant bacteria – CRE, MRSA and ESBL – are perhaps the greatest threat to human health since the HIV/AIDS epidemic, and yet the topic is hardly being discussed. At the same time, we are in the process of making the same mistakes as those that were made in the 1980s. When HIV began to spread, the resulting deaths were not registered as HIV deaths. Since the virus destroyed the patient’s immune system, other causes were often registered as the cause of death, and this resulted in medical science losing its most important tool for tracing how the epidemic spread – namely, statistical data. And we are now making the same mistake again. Because even though thousands are dying as result of resistant bacteria, it is almost impossible to find data on these deaths. We are facing an insidious worldwide epidemic, which will destroy our health services from the inside out. But ask how these diseases spread, and there are hardly any clear answers to be found.

While I was working on this book, a friend of mine became seriously ill. Torunn and Erlend were on holiday in the mountains with their three-year-old daughter when it happened. Torunn developed a strange swelling in her throat; she had a fever and felt unwell. But – like many other active parents – Torunn and Erlend thought it was probably something that would pass by itself, and they packed up the car and began their drive home. But the situation worsened. Less than an hour later, Torunn began to sweat, and she fainted. They didn’t know it yet, but Torunn was going into septic shock. If you contract a serious infection, this is a condition that can develop rapidly.

For whose of us who knew Torunn, the news of what happened to her was shocking. Were it not for antibiotics, we would have lost a close friend and neighbour. One of my daughter’s closest friends would have lost her mother. And this is how it used to be – everybody knew someone who had lost someone to an infection. Luckily, Torunn was saved. Our generation has got used to thinking that a number of diseases are no longer so dangerous. But this is about to change.

In bacteriology – the study of bacteria – two paradigms have traditionally existed. One is about killing the bacteria, while the other is about living with them. During the interwar period, these two paradigms existed side by side. Researchers at the Pasteur Institute in Paris were proponents of building up protection against the bacteria through hygiene and vaccination programmes, and by strengthening the immune system – so-called immunology. At the Robert Koch Institute in Berlin, work was more focused on combating the bacteria – something that was achieved through the development of the first antimicrobial agents, called sulphonamides. For simplicity’s sake, we can call the first paradigm the *adaptation paradigm*, and the second the *elimination paradigm* – in a modern mass society, these two paradigms must necessarily supplement each other. We cannot kill all bacteria, but we must of course kill the bacteria that kill us.

But the discovery of penicillin – and later even more effective antibiotics – resulted in a somewhat excessive belief in the elimination paradigm. Antibiotics were so lethally effective that the attitude that humans had now vanquished bacteria spread far beyond the medical profession. As a consequence, fighting bacteria almost became a national sport. Antimicrobial agents were added to everything from toothpastes, soaps and washing detergents to make-up, food, meat production processes and pesticides. No matter where people lived, the aim was to kill any bacteria that might occupy the same area. The good life was a bacteria-free life – with bacteria-free food and bacteria-free homes. And that was that.

But bacteria are cunning. In the years that have passed since antibiotics first became available, they have readied themselves for a new battle. And they are now viciously fighting back, targeting the most vulnerable among us – infants, the sick, the elderly, and those with weakened immune systems. The issue of antibiotic resistance has therefore brought the interwar paradigm debate back to the fore – can we find new antibiotics and win the fight against them once again? Or must we learn to live with them in a new way?

This book will take a closer look at how lethal bacteria can be if we fail to ensure the most basic protection against them. Long before we start to use antibiotics, we must ensure that our children have clean drinking water and our cities modern waste management systems. But at the same time, we live in a two-sided relationship to bacteria. Many of them can make us ill, but many of them can also protect us from diseases. This two-sided relationship between humans and bacteria actually challenges our horizon of understanding.

First and foremost, however, we must stop squandering antibiotics. These miracle medicines must be protected, so that they can continue to perform miracles when we need them most. On this point, there is broad professional agreement.

But I also believe that we have to think bigger. I believe that in the long-term, we must set aside the elimination paradigm and again learn to live with bacteria in a new way. To demonstrate this, this book will explore the search for trace fossils beneath ancient mountains; join archaeologists digging up the dead from deep below London’s busy streets, and follow one of the interwar period’s forgotten bacteriologists in the search for an old recipe for a new miracle medicine. Through these traces from the past, we might just find answers to the question of how we might live with bacteria in the future. The aim is to find a strategy that can pull our modern health service back from the brink – and identify a new way out of the war on bacteria.

Excerpt, pp.148–152

**Chapter 10**

**Bona fide**

“We don’t have time for an interview.” Sabime Kramer, *Interessengemeinschaft der Schweinehalter Deutschlands e.V*

“I don’t think we’ll ever get down to the low level of antibiotic use you have in Sweden and Norway.” Richard Lister, British pig farmer

The US, EU and China are the countries and regions that distribute the most antibiotics for use in meat production. The pork industry uses the most antibiotics, closely followed by chicken manufacturers. More than 250 million pigs are slaughtered in the EU annually. One in four EU pigs is slaughtered in Germany, which is the EU’s largest pork manufacturer. In 2018, the Germans used more than 850 tonnes of antibiotics to produce 60 million pigs. Per kilo of produced meat, the use of antibiotics in Germany is almost double that of the UK. In Spain and Italy, even more antibiotics are used per kilo of meat produced.

As part of my work on this book, I was interested to get in touch with the German pork industry. But not the German Farmer’s Association, *Deutscher Bauernverband*, the German Livestock Association, *Der Bundesverband Rind und Schwein e.V.*, nor the German Pig Farmers’ Association, *Deutschen Schweineproduktion e.V.*, wanted to help me. The German pig farmers’ interest organisation, *Der Bundesverband Rind und Schwein e.V,* informed me that they ‘were unable to find any farmers who had time for an interview.’[[8]](#footnote-8) The pig farmers’ own interest organisation, *Interessengemeinschaft der Schweinehalter Deutschlands e.V. (ISN),* told me simply that they ‘did not have time for an interview.’[[9]](#footnote-9) – despite the fact that I had informed them of my flexibility regarding the time and date.

I spent a huge amount of time on this communication, without it yielding any results. Discouraged, I turned to the British pig farmers via the British Pig Association. In the UK, eleven million pigs are slaughtered annually.[[10]](#footnote-10) This is far fewer than in Germany, and the British pork industry has been through some extremely tough years with extensive rationalisation measures. Yet the British Pig Association was far more accommodating. After my initial telephone conversation with spokeswoman Georgina Crayford, I was invited to Yorkshire, where Richard Lister runs a large pork production operation.

Yorkshire is the centre of British pork production. For a long time, the UK was one of Europe’s largest producers of pork, but this is no longer the case. Although England produces eleven million pigs each year, this figure is far surpassed by France, Germany and Spain.

The pork produced in England is mainly produced for the domestic market – the animals are slaughtered in order to be served to the British as part of their favourite breakfast, bacon and eggs.

As elsewhere in Europe, the meat industry in the UK experienced dramatic developments throughout the 1960s and 1970s. By the 1980s, chicken – which in the 1950s had been regarded as a luxury – had become an everyday staple, and the same development was observed for pork. Between 1960 and 1980, pork production in the UK more than tripled, while the number of pig farms more than halved.[[11]](#footnote-11) The industry was rationalised, and the pigs gathered on enormous farms that produced tens of thousands of swine a year. The country became a net exporter of pork, and British rural communities were changed forever.

The sky is crystal-clear; the weather cold. Richard Lister meets me with his car at Thirsk train station. He’s a pig farmer, head of the British Pig Association, and one of the farmers who survived the rationalisation period of the 1970s. Lister is a little over fifty, with black hair and blue eyes, and wearing a green fleece over his blue sweater. He meets me in a pickup, a Toyota Hilux. Initially, I have the impression that he doesn’t want to look me in the eye – he constantly fiddles with the zip on his green fleece. I’ve arrived straight from London, where people walk around in freshly ironed shirts and smart trousers. Meeting a farmer in his dirty, down-to-earth style comes as a bit of a shock.

Today, very few farms in England focus on raising pigs. The production of pork is concentrated in Yorkshire and East Anglia, and these areas contain over half of the country’s livestock. Ten million pigs are slaughtered in the country each year; 90 per cent of these are raised on a total of 1,600 farms.

Lister himself produces 100,000 pigs a year, and in doing so uses many thousands of kilos of premix antibiotics.

‘I don’t think we’ll ever get down to the low level of antibiotic use you have in Sweden and Norway,’ he says.

In Sweden and Norway, the use of antibiotics in connection with the farming of animals is prohibited. The medicines are used only when a veterinarian has established that the animals have a bacterial disease, and therefore antibiotics are generally only given to individual animals in the form of injections. They are never mixed into feed. But in other countries, like Germany, Italy, Spain and England, thousands of tonnes of our most important medicines are mixed into the feed given to cattle, pigs and poultry. In absolute figures, Spain is the worst offender. The country uses more than 3,000 tonnes of antibiotics in animal feed annually, and in recent years this figure has gone up instead of down – including when calculated per kilo of meat produced. Italy is next, with 1,300 tonnes, and then Germany with 850 tonnes. The total consumption in Britain is 395 tonnes.[[12]](#footnote-12)

The use of antibiotics in the EU is measured in a unit called the Population Correction Unit, or PCU. This unit of measure takes into account the amount of antibiotics used per kilo of meat produced, regardless of whether the antibiotic is used in the production of pork, chicken or beef. This method may result in slightly skewed results, since more antibiotics are used in the production of pork than in the production of beef, for example. A country that produces a lot of beef, but also a lot of pork, may therefore appear more favourably in the statistics than a country that produces little beef, but a lot of pork. In order to be able to compare the countries’ use of antibiotics directly, you must therefore know the PCU values that are used for the individual species in each individual country. But such statistics are not offered by all countries, including Germany – although they are available for many others. In Britain, the use of antibiotics in the production of pork has been significantly reduced, from over 200 mg/PCU per kilo of pork produced in 2015 to 131 mg/PCU in 2017. However, this is still three times the amount of antibiotics used in connection with pork production in Denmark, and almost nine times that used in Sweden, where the consumption is just 15 milligrams of antibiotic per produced kilo of pork.

The extensive use of antibiotics has led to significant resistance problems among livestock. In England, for example, 59 per cent of the E. coli bacteria in pigs are resistant to tetracycline, which has been used extensively to increase the animals’ muscle growth and meat production. In Spain, the situation is even worse. There, 88 per cent of the E. coli indicator bacteria are resistant to tetracycline, data from the European Food Safety Authority shows. By comparison, only 9 per cent of the E. coli in Swedish pigs are tetracycline resistant.

But perhaps most frightening is that this antibiotic resistance is spreading relatively quickly – not only from country to country, but also from antibiotic to antibiotic. When bacteria have become resistant to *one* antibiotic, it seems that it is easier for them to become resistant to others. Tetracycline resistance has existed for a long time. But in the 1990s, it was discovered that the animals’ intestinal flora were also resistant to several types of penicillin and ampicillin, and entire classes of so-called beta-lactam antibiotics – last resort antibiotics that are extremely important in human medicine. Gut bacteria which are resistant to this type of important antibiotic are called ESBL, and in the UK one in five pigs now carries E. coli bacteria with ESBL properties. In Germany, three in ten pigs carry ESBL, while in Spain, which uses large volumes of broad-spectrum antibiotics in pig farming, as many as eight in ten animals carry this resistant bacteria.[[13]](#footnote-13) This is a catastrophically high figure. Not only will infections among livestock be extremely difficult to treat, but should this development continue, the bacteria will also spread to humans. Faced with pneumonia, blood poisoning and other dangerous infections, we will be powerless.

But there is hope – because the extent of the antibiotic resistance can be directly traced back to the use of antibiotics. The countries that use the most antibiotics, such as Spain and Cyprus, have the most antibiotic resistance. Countries that use low levels of antibiotics, such as Sweden and Norway, also have little antibiotic resistance. The level of ESBL in Norwegian and Swedish pigs, for example, is less than one per cent.

After half an hour’s drive, we pull up at one of Richard Lister’s pig farms. It’s huge. We get out of the car, and Richard greets several of the workers. Then I see the large red pig barns, with their curved roofs. There must be around ten or twelve of them – and they’re not entirely what I was expecting. I had imagined large, industrial halls and modern equipment, but the buildings are old. The curved roofs and the large doors give the barns the look of old hangers for light aircraft. A sharp odour hangs above the farm.

In a small, barracks-like building I put on blue overalls and some old brown boots. The building leads out into one of the barns, and when Richard opens the door a rank smell streams towards me. For someone who isn’t used to it, it’s almost unbearable. In the barn are around 450 pigs, divided into ten large stalls. The animals are enormous mountains of flesh – they look nothing like the cute little pigs I used to see on Norwegian farms when I was small. We climb up a steel ladder to get a better view. Inside the stalls, hay is piled up in mounds. Richard says that they only bring in more hay once the pigs have eaten what is there. Now I understand where the smell is coming from – the pigs are walking around in their own excrement. They eat and defecate in the same stall. Contrary to what many people believe, pigs are actually very clean animals. They like to sleep and relax in areas that are clean and tidy. In the Nordic countries, it is therefore a requirement that the animals have clean areas within the stalls; places where they can lie down. But it isn’t like that here. The pigs are trudging around in their own filth.

The next thing I notice is the dust. The barn is so dusty that it’s hard to breathe. There is no active ventilation; instead, fresh air is supposed to come in through some slits in the walls, which in all likelihood it does – but while the air might circulate, little of the dust is transported away. No wonder the pigs are susceptible to lung diseases in here, I think. But in fairness, I have to say that the stalls are large. The ceilings are high, and the pigs have a relatively good amount of space to freely wander around. But I can’t see any individual stalls for housing ill animals. Bringing a pig farm like this up to a modern standard would cost over a million pounds. Richard says that he would like to improve the ventilation and introduce better systems for clearing away excrement, but with the strict rationalisation policy and low meat prices, there is little money for improvements. He’s working on building new barns, but with the current level of investment it will take many decades to replace everything completely. There are no good support schemes available.

We move on to the barn where the sows are suckling their piglets. If it was dusty and dirty in the barn for the adult pigs, it’s even worse where the piglets are housed. I estimate that the barn is around ten metres wide. The sows are standing in narrow stalls on each side of the central aisle, which stretches around 100 metres down the oblong-shaped barn. The barn is old and dilapidated, and there are cobwebs and dust in every nook and cranny. As in most other pig farms in Europe, the pigs stand in metal pens, so-called farrowing crates, while they suckle. These small cages are no larger than two metres in length and fifty centimetres wide. The piglets run around beneath the sows, competing for milk.

It doesn’t look good. The sows can hardly move in their narrow cages. They are unable to take a step forward or back – never mind turn around. The sows’ natural closeness to their piglets is made impossible here – they are unable to build nests, as is their instinct when they birth young; nor can they give the piglets heat or other affection. The practice is forbidden in Norway, Sweden and Switzerland, where the sows must be permitted to walk around freely when suckling their young.

The stalls containing the sows are between four and five square metres in size. Together with the contained sow, each stall contains between ten and fourteen piglets. The piglets have had their tails cut off – this, too, is a common practice in most European countries, to prevent distressed animals biting each other’s tails. In Norway and Sweden, however, cutting off the animals’ tails is prohibited for animal welfare reasons. In one of the stalls some piglets have starved to death, and while this is common and natural – and the reason that the sows birth many young – I never imagined that the dead piglets would be left in the stall. Someone has sprinkled disinfectant powder over them. Another dead piglet lies bloody in the aisle. I point at it and ask what it’s doing there.

‘Someone has probably left it there, so they can clear it up later on,’ Lister explains.

I don’t know what to say. There is no doubt that dead animals spread infections, and the way the animals are packed into the barn and the dirty conditions probably only worsen the situation. But Richard’s farm is in no way one of the worst in the UK – quite the opposite. I see no pigs with pressure sores or infections. And while Richard might not be running a modern, model farm, he is accommodating and honest and makes no attempt to hide anything. From what I’ve read about animal husbandry in other countries, his farm seems to be one of the better ones, rather than one of the worst.

The piglets stay here in the barn for twenty-eight days, before they are taken to a separate barn for piglets. I visit this barn, too, and of the three pig barns I see, this one is the worst. It is long and narrow. I follow Richard into a long, dark corridor, with tens of doors lining one wall. Like the rest of the farm the barn is dusty and dirty, and when Richard opens one of the doors I’m taken aback. Penned in behind the door is a large group of piglets. The room has no windows, and little light enters it. The pigs scream and become agitated when the door is opened, jumping on top of each other. The air is thick with dust, and I’m reluctant to enter the room. I say standing in the doorway. It’s suddenly so clear to me, just how confined the animals are. The room contains no hay for them to play in. Just a cold stall with a rubber mat on the floor. It does not look good.

It wouldn’t surprise me in the slightest if these pigs became ill. Under natural conditions, the sow would have suckled the piglets for several months. Here, they have been taken from their mother after four weeks, and instead given water and dried feed, which their guts are unprepared for. To prevent the animals becoming ill, they are regularly given antibiotics.

‘We add the antibiotics to the drinking water,’ Lister explains.

But I have not been permitted to visit Lister’s farm by chance – Richard Lister is one of the industrialised pig farmers who uses the least antibiotics in the UK. Still, he regularly mixes antibiotics with the adult pigs’ feed and the piglets’ drinking water. The farmer requires no diagnosis from a vet before he can give the animals antibiotics. If he suspects that one or more of the animals in the barn is becoming ill, he can administer antibiotics purely preventatively, as a so-called prophylactic. In Norway, this is strictly forbidden.

‘Here in Norway, we don’t practice prophylactic antibiotic treatments,’ says Harald Oseberg from Tønsberg.

‘If we want to administer antibiotics, we have to call the vet. Then it’s up to him to administer the antibiotics, if he thinks it necessary. He can’t just leave me a bottle of antibiotics here on the farm. If one of our sows is sick, the vet comes out every day to administer the necessary treatment,’ he explains.

Excerpt, pp.175

**The forgotten cure**

‘You will not master nature unless you obey it.’ Sir Francis Bacon.

Four researchers dressed in white are taking water samples from the brown Kura River in Georgia. With meticulous movements, they pour the dirty water into small plastic containers, which they transport to the George Eliava Institute of Bacteriophage, Microbiology and Virology. The air in the old laboratory is muggy and humid. Outside, the temperature is 32°C. The building in which the researchers are working is eighty years old, and the staff struggle to keep the temperature down.

Here at the George Eliava Institute in Tbilisi, the capital of Georgia, researchers believe that they have discovered a cure for antibiotic-resistant bacteria – one that doesn’t involve antibiotics.

‘This isn’t something we *think*, this is something we *know*,’ says research director Mzia Kutateladze.

Can this really be true? A large clump of plaster has fallen from the ceiling in the dark corridor outside. Old fridges are used to store bacterial samples. Broken windows grace the building’s facade; trees and bushes grow on its roof. Might the answer to the mystery that western medical science is struggling with really be found on these dilapidated premises?

The solution involves bacteriophages – tiny viruses that can kill bacteria. They are all around us, and live in an eternal symbiosis with the bacteria. They have been used to cure infectious diseases in countries such as the former Soviet Union and Poland since as far back as the 1920s, but the development of antibiotics meant that bacteriophages were set aside, and the cure almost forgotten. But now that we are facing the age of antibiotic resistance, interest in bacteriophages has gradually begun to increase.

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In the winter of 1919, a serious outbreak of dysentery took the lives of several hundred people in France. At the Pasteur Institute in Paris, self-taught bacteriologist Félix d’Herelle worked around the clock in an attempt to find a cure. Under his microscope, he had isolated the bacteria that caused the outbreak. What interested him were the blank patches on the petri dish where the sticky bacterial mass didn’t seem to be able to get a foothold. He studied them more closely under the microscope, but could see nothing but dead bacteria.

[Chapter continues]

Excerpt, pp. 186–189

‘In its heyday during the 1970s and 1980s, the George Eliava Institute produced between two and three tonnes of bacteriophagic medicine every day,’ says Zemphira Alavidze, one of the heads of the laboratories at the institute. She’s an amiable woman in her seventies, and has worked at the institute for a generation. In the old laboratory halls, they still produce bacteriophages that are used as medicines in Georgia to this day. A cluster of lab technicians are working on isolating bacteriophages when I visit. In a separate room are several boxes containing capsules of medicine; each tiny capsule contains a clear fluid and as many as a billion bacteriophages.

In the 1970s, when the institute was at its largest, the staff here produced bacteriophages for all kinds of infections – no research institute in the world had a greater collection of bacteriophages. Soviet scientists reported significant breakthroughs, but their scientific literature was never read in the West.

Then, in 1991, the Soviet Union broke down, taking the George Eliava Institute’s entire distribution network with it. The borders between the former Soviet states were closed, and in Georgia civil war broke out. Armed men ran through the streets. The production premises fell into decline, and the equipment was sold. Just a small group of dedicated researchers remained.

Mzia Kutateladze, the current director of research at the institute, clearly remembers the breakdown of the 1990s.

‘They were very hard times,’ she says.

Continual power failures destroyed parts of the unique collection of bacteria and bacteriophages; at the same time, Tbilisi was in the grip of a violent rebellion. In the main street, the regime’s proponents and opponents barricaded themselves behind upturned buses and cars, shooting at each other from tanks and with machine guns. The remaining researchers decided to do what they could to save the collection of bacteriophages.

‘I lived in the same part of the city as Eduard Shevardnadze, the appointed president, at the time – it was perhaps the only district where the electricity supply was stable,’ says Kutateladze. She decided to take some of the most important bacterial samples home with her; the other researchers did the same. In doing so, they saved what was left of the unique collection.

Today, the George Eliava Institute is in the process of returning to its former glory.[[14]](#footnote-14) In the laboratories, I meet the dedicated researchers working with their test tubes of bacterial samples. They wear gloves and protective suits to prevent bacteria from one culture contaminating another. Drops of concentrated bacteriophages are dripped into the test tubes to test for virulence.

One of the researchers collaborating with the George Eliava Institute is Professor Elisabeth Kutter at Evergreen State College in Washington. I speak to her over the phone.

‘The first time I visited them was as far back as 1990,’ says Kutter. ‘I was very sceptical, but I’ve visited them several times since then. The scientific standard of what they’re doing is very high. They have a huge amount of knowledge and ensure great precision in their work. They work with clinical preparations, in close collaboration with the hospitals in Tbilisi, where patients are treated with bacteriophages. They work back and forth. At their clinic, they make diagnoses and define which bacteria need to be treated. Then they check these against the bacteriophages they have in their bank, to see whether any of them can be used. They often make special preparations, tailor-made for each individual patient,’ she says.

‘The bacteriophages are specific in the type of bacteria they attack,’ explains research director Mzia Kutateladze. ‘When a patient has a bacterial infection, we have to find out exactly which bacteria is causing it. Our task is then to find the right bacteriophage to treat exactly this patient,’ she says. Kutateladze has worked with bacteriophages for the past thirty years, and has no doubt that they can also be used to cure infectious diseases caused by antibiotic-resistant bacteria.

‘This isn’t something we *think*, it’s something we *know*. We have already used bacteriophages to treat patients for many decades,’ she says. One of the medicines the institute has developed can be used to treat E. coli, salmonella and shigella.

Sometimes, patients from Western Europe and the US come to Georgia seeking treatment for extremely difficult infections – these are patients who have tried everything else. One such patient is Alfred Gertler, a Canadian musician who suffered a severe injury to his foot while on holiday in Costa Rica.

‘I was desperate,’ he says over the telephone from Canada. Areas of his heel were crushed, and part of the bone was sticking out of his foot. Back home in Canada, he was put on an intensive antibiotic treatment. For a year and a half, he walked around with a bag attached to his leg, which administered daily intravenous doses.

‘I had a high fever and was in intense pain. There was yellow staphylococcus in the wound, and it wouldn’t heal. Instead, my foot swelled up, puss running out of it. It was starting to turn into blood poisoning,’ says Gertler.

Gertler’s doctor had said that the foot would have to be amputated, but Gertler wasn’t ready to give up. In a *New York Times* article, he read about the institute in Georgia that treated infections using bacteriophages. Gertler got himself on the next available flight to Tbilisi.

‘I’d never heard of bacteriophages, and knew almost as little about Georgia, but I decided to take a chance,’ he says. ‘It was a peculiar experience. The hospital I arrived at had neither lighting nor electricity – they hardly had running water,’ he says.

But they did have a cure. At the state hospital in Tbilisi, doctors opened up Gertler’s foot and treated the infection with salves and gauzes impregnated with bacteriophages. Three days later, the infection was gone. Gertler could hardly believe his eyes.

‘It was like a miracle. The treatment was pain-free and had no side effects. I would never have imagined that I would find a cure in Georgia,’ says Gertler.

In Georgia, I meet the surgeon who treated Alfred Gertler. He has no doubt that bacteriophages work.

‘The bacteriophages work extremely well. They are cheap, there are no risk factors associated with them, and they have no side effects,’ says Guram Gvasalia.

‘We are seeing an increasing number of patients from Western Europe and the US, but many of these cases are difficult to treat. The level of Western medical science is very high, and so it goes without saying that it isn’t easy to cure patients that doctors in the West have given up on. But we have a number of cases in which we have succeeded,’ says Gvasalia.

Might bacteriophages be the thing that saves us from antibiotic-resistant bacteria?

‘There are many people out there who are suffering. I just hope that this cure will be made available to more of them,’ says Alfred Gertler.

So why isn’t this treatment more widely used?

‘These are products that are extremely difficult to commercialise,’ says Elizabeth Kutter by way of explanation. ‘Antibiotics are broad-spectrum, and kill all kinds of bacteria. But with bacteriophages, you need dedicated phages for each individual bacterium. A central institution needs to be established in order to study bacteria and produce bacteriophages,’ she says.

But the George Eliava Institute doesn’t have the necessary funds to initiate research on this kind of scale.

‘This kind of research costs millions of dollars. We simply don’t have that kind of money,’ says Mzia Kutateladze. The introduction of new medicines requires complex studies with large control groups. So far, nobody has been willing to finance them.

After the crisis of the 1990s, things are now looking up for the George Eliava Institute. With funding from the EU and US, they have modernised some of their old laboratories. New equipment has been obtained, and the bank of bacteriophages has been secured.

‘Bacteriophages have existed for three billion years. They’re everywhere – including in our bodies. We eat them every day. They coexist with us,’ says Mzia Kutateladze. She sees no reason why bacteriophages shouldn’t also be used in the rest of the world.

Yet Georgia is the exception that proves the rule. Because in the EU and the US, such treatments are simply prohibited. Only in extreme cases are bacteriophages offered as an alternative treatment in the EU, and only at one institute – located in Poland.

1. Fleming, Alexander, 11 December 1945: *The Nobel Lecture* [↑](#footnote-ref-1)
2. The Guardian, 08.10.2017 [↑](#footnote-ref-2)
3. O´Neil, Jim et al. (2016). [↑](#footnote-ref-3)
4. CDC (2013). [↑](#footnote-ref-4)
5. U.S. Statistics (2018). [↑](#footnote-ref-5)
6. ECDC (2018) [↑](#footnote-ref-6)
7. European Commission (2017) [↑](#footnote-ref-7)
8. Email from Klemens Schulz, *Zentralverband der Deutschen Schweineproduktion e.V.*, 16.06.2017. [↑](#footnote-ref-8)
9. Email from Sabine Kramer, *ISN*, 28.08.2017. [↑](#footnote-ref-9)
10. EUROSTAT (19.09.2017). [↑](#footnote-ref-10)
11. Harrison, B. (2009). [↑](#footnote-ref-11)
12. Pig Progress (6.11.2017). [↑](#footnote-ref-12)
13. EFSA, 2017. [↑](#footnote-ref-13)
14. The interviews at the George Eliava Institute were undertaken in connection with a research trip made by the author in 2013. The article was published in *DN Lørdag*, 31.08.2013. [↑](#footnote-ref-14)