



NEW CHAPTER
ON
COVID-19

PATIENT ZERO

SOLVING THE MYSTERIES OF
DEADLY EPIDEMICS

MARILEE PETERS

UPDATED EDITION

PATIENT ZERO

SOLVING THE MYSTERIES OF
DEADLY EPIDEMICS FROM
PLAGUE TO COVID-19

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INTRODUCTION

DISEASE DETECTIVES ON THE CASE

“So, tell me, where were you on the night of the murder?”

In movies or TV, when a detective asks this question, they narrow their eyes and lean in close to the suspect, to see how they’ll respond.

The audience pays attention, too. We know that question is a sign that the detective is close to cracking the case.

Sure enough, the suspect starts squirming. Sweat breaks out on their forehead. Their eyes dart around in panic as they search their memory – or try to come up with a good excuse. Unless they have an air-tight alibi, the detective announces, “Case closed!” A few scenes later, we watch as a cell door slams shut, putting the criminal behind bars. As the credits roll, the detective heads off into the night, to solve the next case and keep the public safe.

Now, take that detective out of their trench coat and fedora and

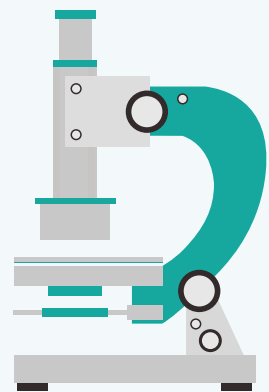


put them in a lab coat. Instead of a gun, give them a microscope and a computer. This time, the assignment isn't to track down an escaped convict with a grudge, or a deranged psychopath masquerading as a friendly neighbor, or any of the usual suspects. The murderer they're trying to identify is—a microbe.

This is a disease detective. Otherwise known as epidemiologists, these scientists are trained to solve medical mysteries and find the evidence needed to prevent the spread of disease and improve the public's health. Like police detectives, epidemiologists make a beeline for the "scene of the crime" when a disease first strikes, to search for clues that reveal how the outbreak started, how it is transmitted, what puts people at risk of getting sick, and how to stop or slow its spread.

Just like the hardboiled detectives in old movies, they talk to the victims, track down witnesses, ask lots of questions, sniff out facts that may have been overlooked, and then assemble their case. In addition to these tried-and-true detective techniques, they also take advantage of the latest technologies and use their scientific skills and know-how to understand how diseases spread and to protect our health.

The investigation into an outbreak starts with the first patient who shows up at their doctors' office or local hospital with an illness. While epidemiologists call this first patient the "index case," in the media and popular culture this person is often referred to as "patient zero". (Spoiler alert: to find out how patient zero became a popular term for the first known case in an outbreak, flip to chapter 7). Starting from this first case, epidemiologists trace the infection's spread. They look for clues that help them understand the factors that contribute to the transmission of the disease.



TOOLS OF THE TRADE: THINK LIKE A MICROBE

Epidemiologists are up against tiny but powerful enemies: the microbes that make us sick. Although they are microscopic, they vastly outnumber us (there are as many *species* of microbes as there are stars in the galaxy!). Fighting this invisible army depends on understanding it.

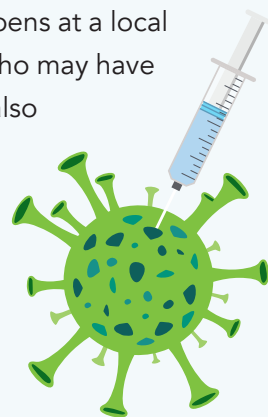
To start with, not all microbes are bad guys. Microbes live all around us, and in us. Some make us sick, but many others – like the ones that live in our guts and help us digest our food – are important for our health.

Viruses are incredibly tiny microbes that can only survive inside the cells of other living things. A virus invades a host cell and takes it over, using the cell's energy to multiply itself and then releasing new viral particles that go on to infect more cells. Most viruses cause diseases in the host organism and have evolved ways of spreading to new hosts through the disease.

For example, influenza viruses make us cough and sneeze. Each time we do, we spread viruses in clouds of droplets, giving them a chance to find new homes in other humans. The cholera virus gives its unlucky hosts diarrhea, and the virus spreads to others when their waste finds its way into drinking water supplies. Sometimes – as with malaria and yellow fever – a virus will be in the host's bloodstream, and when a mosquito takes a bite of blood from one host and then bites another, the virus comes along for the ride, and now two people are infected. For an epidemiologist, knowing how a microbe spreads is key to understanding and stopping an outbreak of disease.

This means tracking down, one by one, everyone the infected person came into contact with. It takes patience and determination—and it also doesn't hurt to have charm and sense of humor when you're asking people to try to remember everyone they might have coughed on recently!

Lots of the detective work of epidemiology happens at a local level, by knocking on doors and talking to people who may have been exposed to the disease. But epidemiologists also need to coordinate their disease-fighting efforts with other scientists, and with governments and public health agencies nationally and internationally. Today, a disease outbreak can spread around the world in just days, or even hours. To be prepared for that kind of global threat, modern epidemiology requires teamwork, cooperation, and endless tracking of information about health



concerns from all nations. At public health agencies like the World Health Organization (WHO), the Centers for Disease Control (CDC) in the United States, and the Public Health Agency (PHA) in Canada, epidemiologists are constantly scanning new reports from all around the world of unusual diseases, or new outbreaks of known diseases. They know that any one of them could be the next “Big One.”

In December 2019, doctors in Wuhan, China started seeing an increase in the numbers of patients with pneumonia. When they realized they might have an outbreak of a new disease on their hands, they notified the WHO, an agency of the United Nations that looks after international public health. Those pneumonia patients were the earliest victims of a virus that had jumped from an animal host to humans, triggering an epidemic that led to a global pandemic: COVID-19. “The Big One” had arrived.

COVID-19 turned 2020 into the year of the epidemiologist.

Epidemiologists held news conferences, gave interviews, recorded podcasts, appeared in YouTube videos and made animated visuals mapping the spread of the infection.

But epidemiology isn't all bright lights and glamour. The scientists who unraveled the medical mysteries behind the diseases covered in this book faced a terrifying prospect: they were tracking down infected patients, working in communities where disease was rampant and deadly, and risking their lives. They needed to be courageous, and very determined— all too often, no one believed their crazy theories. They were ignored, laughed at, sometimes even fired from their jobs. But they kept searching for answers, putting together the puzzle pieces of these epidemics. Millions of people owe their lives to the work of these early epidemiologists. Thanks to their willingness to do the dangerous work of tracking diseases to their source, we now know how to prevent or cure some of history's most deadly diseases.



A CORONAVIRUS CHEAT SHEET

Beginning early in 2020 we started hearing the messages on TV, on social media, in our schools and our communities: “Save lives, #flattenthecurve”, “We’ll get through this together by staying apart”, “#socialdistancing”. The messages and hashtags are all public health advice drawn from epidemiological science. Here’s a primer on some of the most-used terms.

Contact tracing: methods that public health officials use to track the spread of the virus. Infected people are asked about their recent activities and to list others they have interacted with. Those people are contacted and told to stay home and to get care if they develop symptoms.

Flattening the curve: slowing the spread of the virus so that fewer people need to seek treatment at the same time, by following practices such as social distancing, self-quarantine, hand-washing, etc.

PPE: Personal protective equipment such as gloves and masks, along with more specialized gear worn by health care workers, such as face shields, gowns, foot covers.

Self-isolation: people who are infected with COVID-19 are required to stay at home and away from those who are not sick while they have active symptoms of the disease.

Self-quarantine: staying at home, apart from others, for a period (usually 14 days) to see if illness develops. In some places, people are required to self-quarantine if they have been exposed to the coronavirus, or if they have returned from an area with widespread transmission of the disease.

Shelter-in-place: used as a synonym for quarantine, this means to stay home, only going out to shop for essentials or to exercise.

Social distancing: maintaining a physical distance from others that is greater than usual, and avoiding busy public places. Also sometimes called physical distancing, this reduces the chance of becoming infected.

GET OUT YOUR EPI-DICTIONARY

Listening to the news about COVID-19 or any other emerging disease, you might start to wonder if epidemiologists have their own language. For instance, what's the difference between an *endemic disease* and an *epidemic*? What's worse, an *outbreak* or an *epidemic*? When does an *epidemic* become a *pandemic*?

Endemic disease: These are the diseases that are always around, the ones doctors expect to see year after year in particular areas of the world. Malaria is rarely seen in North America, but it is endemic to certain parts of Africa, where it occurs regularly.

Outbreak: When a relatively small number of people get sick with the same disease at around the same time it's called an outbreak. An outbreak of disease could be triggered by a single event, like some undercooked hamburgers that send everyone at a family reunion to the hospital. Or an outbreak can happen when an endemic disease from one place turns up unexpectedly somewhere else. For instance, in 2019 someone with dengue fever visited Hawaii and was bitten by mosquitoes. Those mosquitoes transmitted the disease to other people in Hawaii, causing an outbreak.

Epidemic: An epidemic is an outbreak, multiplied. New cases are actively spreading, and the numbers of cases are higher than what is normally expected. When doctors start reporting an unusual number of patients with the same symptoms, public health authorities may declare that there is an epidemic underway. They'll alert the media so that people can take precautions against the disease.

Pandemic: If the epidemic can't be contained, it may become a pandemic: a global epidemic that infects a large number of people over a very wide area, in different countries and regions of the globe. The World Health Organization considers that when an epidemic is reported in three or more countries, it's officially a pandemic. One way to remember the difference between an epidemic and a pandemic is the "p"—a pandemic is an epidemic with a passport.

CHAPTER 1

A DEADLY YEAR

THE GREAT PLAGUE OF LONDON, 1665

The rat looked dead. Goodwoman Phillips nudged it with her toe to be sure. It didn't move.

She bent down, pinched its tail between her thumb and forefinger, and lifted the rat up so it dangled limply before her face. "Come into my kitchen and die on my clean floor, will you?" she said menacingly to the little corpse. "We'll see about that, you dirty beast." Goodwoman noticed with disgust that fleas were still jumping in the rat's coarse black fur—it hadn't been dead for long. Probably frozen to death: the winter of 1665 was the coldest she could remember.

She opened the door and swung the rat by its tail, flinging it as far from the house as she could. It landed with a thud in the gutter. Good riddance, thought Goodwoman Phillips. She wiped her hands on her skirt before heading inside to make breakfast.

She thought no more about the rat that day. She was a busy woman, with a husband and sons to feed. For a poor family like hers, living outside the walls of London in the rough-and-tumble parish of St. Giles in the Fields, food was often hard to come by. Worse, with this winter's dreadful cold, they needed more fuel than usual for the fire. Goodwoman feared that the extra expense would mean Christmas, not even a week away, would be a lean and dismal holiday this year.



Goodwoman Phillips was right to worry about Christmas. There would be no celebrating in her home. As that dark December day wore on, her head began aching, and pain grew in her back, arms and legs until she could hardly stand. Then fever and chills set in. By evening she was forced to take to her bed. She lay in a daze, trying not to moan.

SIGNS IN THE SKY

Day by day, Goodwoman Phillips got sicker. Her sons sat by her bedside in the evening, trying to distract her with the latest news from London. The whole city was buzzing with rumors about the comet that had been seen flaring across the heavens every clear night since November.

Many believed that the comet was a sign from God to England's king, Charles II, who had been on the throne for just four years. People remembered an old superstition that the crowning of a new

king would be followed by plague. "These Blazing Stars Threaten the World with Famine, Plague, & Wars. To Princes, Death; to Kingdoms, many Crises; to all Estates, inevitable Losses!" was the dismal forecast of one popular astrologer.

As a fresh wave of fever shook Goodwoman Phillips, her sons crept away, leaving her to rest. Soon she was tossing in a restless, feverish sleep.

HOUSE CALL

When Goodwoman Phillips opened her eyes next, it was light in the room. A tall man in a long coat was unpacking a leather satchel and laying out items along the wooden bench under the window. A cup, a cloth, a knife. Goodwoman realized at once who this man was, and why he was there. A doctor!

"I'll not be bled." She tried for a firm, clear tone, but even to her own ears her voice was low and faltering. The doctor turned and looked at her calmly.

"Goody Phillips, your husband and sons have consulted me about your case. Bleeding will balance the humors within your body. It is for the best."

The doctor came closer. She could see the knife glinting in his hand. Then it was done, a smooth, quick cut on her arm. Blood dripped into the cup he held up. Her head thudded and the room seemed to lift and tilt, then spin.

"Fainted," said the doctor. "Not uncommon for one so far gone with fever. Let's hope this bloodletting was done in time."

Goodwoman Phillips didn't wake again. On Christmas Eve of 1664, she died, the first victim in an epidemic of plague that was to kill nearly one in five Londoners over the coming year.



IT'S NOT FUNNY, IT'S HUMORAL

From ancient times until the 19th century, when a doctor told you your humors were out of balance, he didn't mean that there was something wrong with your funny bone. Humoral theory was one of the key principles in Western medicine.

According to this theory, first proposed by the doctors of ancient Greece, the human body contained four humors, or fluids: black bile (also known as melancholy), yellow or red bile, blood, and phlegm. Your health depended on maintaining the right humoral balance, or mix of fluids, inside your body. Curing disease was a matter of putting the humors back in balance. This is where the idea of bleeding patients came from.

"GOD HAVE MERCY UPON US!"

A neighbor woman came that afternoon to wash the body and prepare it for burial. When the neighbor removed Goodwoman Phillips's nightdress, she gasped: large red rings had appeared on the dead woman's chest and back. Under her right arm was an ominous purple swelling.

"A buboe! Plague tokens!" whimpered the shaken woman. "Plain as my hand, these are the signs. This is a plague house. Oh, God have mercy on us!" She turned and fled down the stairs and out of the house.

Before long, there was a knocking at the door of the Phillipses' tiny house. The searcher had arrived. It was the searcher's duty to visit every house where a death occurred in St. Giles in the Fields, to examine the deceased and to report back to the parish clerk, who

recorded the cause of death in the parish register.

All 119 London parishes kept registers of births and deaths, bulky volumes filled with line after line describing deaths from old age, accidents, and illnesses of every kind. Yet of all the ways to die in 1664, none was more feared than plague, for plague could spread through a neighborhood like fire. In a matter of weeks, plague could engulf a whole city, even a whole country.

The searcher for St. Giles in the Field was a shrunken, wrinkled old woman. She was desperately poor and spent every cent she had on ale at the inn. It was well known that she'd gladly take a coin or two should a family wish to have the cause of death changed in the report she delivered to the parish clerk. For a small tip, a suicide could become an "accident." Even plague could be registered as a simple fever. But the Phillips family had no money to offer her. Her sons had spent everything they had to bring the doctor in to bleed their mother.

The searcher peered down drunkenly at the body, then reeled away in alarm at the sight of the swollen lumps called buboes, proof that Goodwoman Phillips had died of the disease we now know as bubonic plague. She staggered off, returning later with men from the parish office who began boarding up the doors and windows. The dead woman's family would not be allowed to leave their house for weeks, in case they spread plague to others.

Inside the darkened house, Goodman Phillips and his sons listened as nail after nail was pounded into the boards blocking their windows. Finally, the pounding was replaced by the softer sound of brushes. A huge red cross was painted on their door, and the words "God Have Mercy Upon Us". Those signs let everyone in the neighborhood know that this house was cursed



with the plague.

That Christmas Eve, all was silent in the Phillips house. Goodwoman's husband and sons could only wait and wonder: which of them would be next?

Outside, their neighbors crossed the street to avoid walking past the boarded-up house, fearing that if they came too close, they would be contaminated with "plague seeds."

THE FEAR BUILDS

A little more than a week after the death of Goodwoman Phillips, soon after New Year's, John Graunt stepped to the door of his London shop and tossed a coin to one of the ragged boys shivering in the frosty January air outside.

"Run and fetch me a copy of the Bills of Mortality. The first bill of the year was printed this morning, and I'm anxious to see it. You may find me in a generous mood to repay you for your speed." As he watched the boy disappear up the cobbled road, John considered, how surprising it was that the Bills of Mortality, a page of statistics listing the week's births and deaths in each London parish, should have become so popular with readers. Each week in the coffeehouses and the taverns, conversation was sure to turn to the latest news in the bills—especially if there were any unusual deaths.

John Graunt always found the Bills of Mortality fascinating, but he'd heard that there was something he would find particularly interesting in this week's edition. And when the errand boy ran back with the page fluttering in his hands, it didn't take long for John to spot it: "Death by Plague — 1."

London hadn't had an epidemic of plague for nearly



twenty years. And plague usually struck in the hot months of summer, not in the midst of the coldest winter that anyone could remember. But all the same, John decided to keep a close eye on the bills over the next few months.

For the rest of that cold, dark winter, while all of London was watching the sky, John was scanning the lists of deaths, reading the signs there that told him an epidemic of plague was coming again.

LOOKING FOR ANSWERS

John Graunt was the owner of a popular haberdashery—a store selling cloth, from the coarsest cottons to the finest silks and velvets, as well as buttons, thread, and ribbons in every color of the rainbow. But running a successful business wasn't enough to keep John's active mind occupied. He really wanted to make a name for himself as a scientist or a scholar. He'd always been fascinated with the weekly Bills of Mortality, and by the late 1650s he had saved several years' worth of the weekly statistics. John realized that those dusty stacks held a treasure trove of information.

As a businessman, he knew the value of having information about his customers. He needed to know approximately how many births to expect each year, so that he could stock the right amount of delicate linen for christening robes. And by knowing how many deaths there might be in a year, he could have enough cloth for mourning clothes on hand. At the time, there was no source for this kind of data. John, like other shopkeepers, was forced to depend on his intuition and experience when ordering his stock. Yet since 1592 the weekly Bills of Mortality had been tracking these numbers, and more. By reading through all the bills and adding up the deaths and the births, John realized he would be able to work out annual averages, and perhaps find useful patterns.

He began to wonder what other uses there might be for information about birth and death rates in his city. Comparing the numbers of deaths and their causes from one year to another might reveal patterns not only in how many people were dying, but also why.

John Graunt decided that he had found the perfect subject for a scientific study.

WHAT ABOUT DYING OF CURIOSITY?

Plague wasn't the only thing killing Londoners during the 17th century. The Bills of Mortality were full of unusual ways to die. Some that you are not likely to see in an obituary today include: "Stoppage in the Stomach," "Twisting of the Guts," "Eaten by Lice," and the mysterious "Horseshoe head."

SUCCESS AT LAST

John Graunt collected all the Bills of Mortality from the past sixty years and studied them, looking for the secrets that they held about London life. In 1662 he published his findings in a short book with a long title: *Natural and political observations, mentioned in a following Index, and made upon the Bills of Mortality: With reference to the Government, Religion, Trade, Growth, Air, Diseases and the several changes of the said City.*



BLAST FROM THE PAST

Many people have heard of the Black Death – the pandemic of plague in the Middle Ages that killed almost a third of the people in Europe. But the world has suffered through not just one but three plague pandemics.

The first is known as the Plague of Justinian. Named after the Roman emperor Justinian I, the disease first broke out in Constantinople (modern-day Istanbul, Turkey) in 541 CE. It swept through the city, killing up to 5,000 people a day, before going on to spread across Spain, Italy, Africa and the Middle East. Over the next three years, it killed as many as 50 million people.

Afterwards, plague outbreaks continued but didn't reach pandemic levels again until 1347, when traders and invading armies carried the disease into Europe. Whole villages were wiped out by the Black Death, crops went unharvested, and trade stopped. Some historians think one third of the population died in the pandemic. It took 200 years for the population to recover.

The next great pandemic of plague started in 1855 and lasted one hundred years. Rats hiding in steamships carried the disease across the world, causing outbreaks in port cities on every continent. Over 15 million people died.

Will there be a fourth pandemic of plague? Its possible, but unlikely. Plague can now be treated with antibiotics, and thanks to modern hygiene many cities are cleaner, with fewer rats.