Lost in Transmission

What do the following have in common: a cold-shouldered Swedish virologist; a fly-encrusted monkey in a cage; 5,000 snuffy American schoolchildren and 70,000 dead cats in New York City? Answer: they were all victims of bizarre ideas about how polio was spread.

Viruses can enter the human body in many different ways: with food or drink, during sex, through the bite of a dog or a scratch in the skin, or by hitching a lift on a contaminated needle or – as a sad sign of our times – on a spicule of bone from a suicide bomber. During the first third of the twentieth century, the route by which the poliovirus breaks into the human central nervous system was one of the hottest controversies in polio research. This degenerated into a standoff which pitted American science against the rest of the world, and would have left one of the mandarins of polio research looking foolish, if any of his countrymen had had the guts to stand up to him. As a result, tens of thousands of healthy people were exposed to discomfort and risk – and progress towards developing an effective polio vaccine was held up for decades.

To set the scene, we need to trace the journey of the poliovirus through the human body.

Now wash your hands

Like other enteroviruses, the poliovirus inhabits the intestine. It is usually spread by what is delicately termed the ‘faecal-oral’ route, mostly with the assistance of fingers, water or food. It can also be transmitted in droplets by sneezing and coughing, as the nose and throat are colonised in the early stages of invasion.

Human communities have always provided rich opportunities for oral-oral transmission. Patronising comments were made in 1945 about the Inuit of Hudson Bay who lived on top of their own excreta, but even societies that pride themselves on their sanitation are not above reproach; in present-day Britain, credit cards and banknotes are often heavily contaminated with colonic bacteria. Conversely, basic hygiene can limit the spread of intestinal microbes, including the poliovirus. In 1954, a polio epidemic was in full swing in Western Australia, but the
incidence fell off markedly when the Queen arrived on a state visit. The Royal presence was probably catalytic rather than causative, as children were only allowed to join the crowds that greeted Her Majesty if they had thoroughly washed their hands after using the toilet.\textsuperscript{5}

The poliovirus can survive in detergents, disinfectants, alcohol and swimming pool-strength chlorine, all at concentrations that kill most bacteria.\textsuperscript{6} Powerful chemicals, such as the formalin used to prepare the Salk polio vaccine, are needed to inactivate it so that it can no longer replicate. Unlike bacteria such as cholera, viruses cannot multiply in cell-free media (even when enriched by sewage), but the poliovirus remains viable in water and milk for several days. However, it has weaknesses. It is quickly killed by drying and by the heat of the tropical sun – conditions that do not trouble some other viruses. The smallpox virus could survive in dust for years, and managed to infect mill workers in Bolton several months after dried scabs fell into bales of raw cotton in Madras.\textsuperscript{7}

The poliovirus is particularly pervasive and spreads rapidly through families and social networks – and even the pristine household of a professor of virology.\textsuperscript{8} In practical terms, if one of your close contacts has polio, you are virtually guaranteed to pick up the virus. However, if you are immune to that particular strain (from having met it previously or from vaccination), then the virus will be beaten back by antibodies secreted into the gut cavity before it can invade the intestinal wall. Even if unprotected by immunity, your chances of becoming paralysed or dying are remote, as explained in Chapter 1.

Once past the teeth, the poliovirus heads south and homes in on the epithelial cells that line the throat, stomach and intestines. Viruses are not truly ‘alive’, as they cannot replicate without locking into the life-support systems inside intact cells. The poliovirus slips into its target cells and tricks them into shutting down all their normal activities and channelling all their resources into making replicas of it. The whole process is astonishingly quick: within a few hours of entering a cell, a single poliovirus can produce 10,000 progeny.\textsuperscript{9} Electron micrographs show the new virus particles lining up under the membrane of the doomed cell, like massed paratroopers preparing to jump.\textsuperscript{10} By now, the cell is stuffed with virus and fit to bust – which it soon does, spilling out what is left of its guts and the thousands of polioviruses, ready to enter and infect the next wave of target cells.

The polioviruses march down through the lining of the gut and are carried in the tissue fluid (lymph) to the nearby lymph nodes. These contain immune cells which monitor incoming material, identifying bacterial or viral ‘antigens’ (key parts of proteins) as ‘foreign’ and then producing antibodies which will kill the invaders. The immune response may be swift enough to confine the infection to the gut mucosa. Otherwise,