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The first thing you see when you walk in the door of Raphaele and Michael Horwin's modest San Diego apartment are photos of their son Alexander. Arranged neatly on bookcases or hung on beige walls, the photos are everywhere, his image set into a gold frame, a pewter frame with flowers, wooden frames, even plastic desk frames. Here is Alexander as an infant, with huge, round brown eyes and dark curly hair, lips parted in a wide, world-embracing smile with two teeth peeking out of the top and two on the bottom. Here he is at age two, in a denim jacket embroidered with colorful fish, holding a stuffed yellow duck. In photo after photo he gazes happily, intelligently, handsomely into the camera.

But move to the rear bedroom of the apartment, and the mood changes; a strange silence falls over the room. There are photos of young Alexander on the wall, and there is a shelf with five stuffed bears sitting on it, but otherwise this is not a child's room. Rather, the room is filled with computer equipment, whiteboards covered with lists, and scientific books and journals. Instead of a child's clothing, the closet is jammed with plastic file folder boxes. In this bedroom-turned-office other photos are kept, ones that are not on display. In these, Alexander is tranquil, but not happy. In one, he is lying on a hospital bed in the University of California at Los Angeles Medical Center pediatric intensive care unit. From the center of his spine to his armpit, a blistering red wound spreads across the upper part of his back—a second-degree burn from a chemical drip that “accidentally spilled” onto his body during treatment at the hospital. In another, he is bald, with sunken eyes staring quietly from a stroller.

Alexander had been “a strong, happy, intelligent little boy,” says his father Michael. As a toddler, he loved visiting the ocean tidal pools near the family's Marina del Rey home and exploring the tiny, mysterious marine creatures. He enjoyed being pushed by his mother on the boardwalk while she roller-bladed behind him. By the time he was two, he could already speak English and French.

Then something went very wrong.

On August 10, 1998, two months after his second birthday, Alexander received a

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diagnosis of brain cancer. Called medulloblastoma, it was one of the more common pediatric brain cancers, accounting for about one-sixth of all childhood brain tumors diagnosed in the United States.

Alexander had two operations—sixteen hours of surgery in all—that successfully removed the entire tumor. But his parents were told that the tumor would return unless he had further treatment—with chemotherapy. “Even after two brain operations, Alexander was still a vibrant, ruddy, strong, energetic child,” Michael Horwin recalls. “That changed as the chemotherapy repeatedly filled his body with toxic chemicals. Alexander began to die inside.” First there were relentless stomach pains and horrendous projectile vomiting. Then Alexander’s curly hair fell out. Next his dark skin turned ghostly pale. “He got sick with fevers and spent weeks in the hospital,” Horwin says. “We felt as if we were actively engaged in the slow torture and destruction of our own child.”

On January 31, 1999, following three rounds of chemotherapy, Alexander Horwin died. The fact that the chemotherapy appeared to have harmed rather than helped him made his parents’ grief unbearable. They felt compelled to find out what had gone wrong.

The Horwins decided to investigate why their otherwise healthy son should have suddenly developed a brain tumor. They looked at environmental exposures but came up empty-handed. They hadn’t been exposed to high levels of pesticides; they didn’t live near a nuclear power plant; they ate healthy foods. Alexander had been in the ninety-fifth percentile for height and weight for his age group. There was no cancer history on either side of their families. Both of their paternal grandmothers had lived to almost ninety years of age.

Next, the Horwins reviewed Alexander’s medical file in the months prior to his diagnosis. Like most children, he had received numerous vaccinations in the first two years of his life. There was nothing unusual about that. Vaccines are one of modern medicine’s most important innovations. Not only do they prevent early childhood disease, they are a critical public health tool, having rid the world of scourges like smallpox, and having reduced the number of deaths from childhood illnesses like measles dramatically. Still, could something about the many vaccines Alexander had received have hurt him? The Horwins dug deeper and began to uncover information about vaccines that their pediatrician had never told them. Sometimes, they learned, vaccines contain trace amounts of toxic chemicals: residue from the manufacturing process, or preservatives designed to extend their shelf life. Sometimes they can be contaminated with living organisms, bacteria and viruses that have escaped from the animal tissues that are used during the manufacture of many vaccines.

One of the vaccines Alexander had received was the polio vaccine—mandatory in every state of the union and typically administered four times during the first sixteen months of a baby’s life. When the Horwins researched the polio vaccine, they found, to their amazement, that during the 1950s and early 1960s, the vaccine had been widely contaminated with a virus. Millions upon millions of doses administered in the United States and other countries had been tainted—not just by any virus, but by a monkey virus that had gotten into the vaccine during the manufacturing process. Worse still, this strange virus appeared to cause several different types of cancer, including brain cancer, when injected into laboratory animals.

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Supposedly, the polio vaccine had been rid of this virus long ago. But what if it hadn't been? Was it possible, the Horwins wondered, that this same cancer-causing virus somehow had gotten into a dose of polio vaccine that had been given to their son?

The Horwins' quest took them to the research laboratories of Michele Carbone, a molecular pathologist at Loyola University Medical School, just outside Chicago. Carbone was a medical doctor with a Ph.D. in anatomic pathology; he was also a leading expert in the simian virus that had contaminated the polio vaccine. He had detected in a type of human lung tumor called malignant mesothelioma in 1994 while working at that National Institutes of Health (NIH). He wasn't the first investigator to link the virus to cancers, but he was, without a doubt, the most tenacious. In the years since his discovery, he had dedicated his entire laboratory to investigating how it caused human cells to become cancerous.

When the Horwins contacted him in the fall of 1999, Carbone's initial inclination was to refuse them. Because the tests were expensive and time consuming, normally, he tested only those tumor samples that were part of a larger research effort or that had come to him through the Loyola health system. But Carbone found himself moved by the grief of Alexander's mother, Raphaele. He decided, at his own expense, to run a series of sophisticated molecular tests on Alexander's tumor biopsy and the blood from his umbilical cord at birth.

A few weeks later, he informed the Horwins of the results Alexander's brain tumor contained the simian virus. His cord blood did not. Somehow, their child had been exposed to the virus after birth. Michael and Raphaele had themselves tested. Neither of them showed any signs of the virus. That meant the virus in their son's tumor hadn't come from either one of them. The evidence seemed unbelievable, but the results were conclusive. Taken together, it seemed to the Horwins, the tests said one thing: a strange virus from another species had caused the death of their otherwise healthy son, and its source was a medical intervention that was supposed to protect him from harm—the polio vaccine.

How does a monkey virus get into the brain of a human being? At first blush, the answer seems bizarre—straight out of the script of a 1950s sci-fi thriller. But it is true. For nine years, from 1954-1963, almost every dose of polio vaccine produced in the world was contaminated with a cancer-causing simian virus. In one of the biggest blunders in medical history, nearly half the American population—about one hundred million people—and millions more in Canada and Europe, were administered this widely contaminated vaccine. When scientists discovered the virus in 1960, they named it SV40—an innocent-sounding, almost antiseptic appellation, except that SV stands for simian virus and 40 designates that it was the fortieth such virus discovered. Like HIV, which causes AIDS, SV40 crossed into humans from monkeys and had its own dramatic consequences. Exactly how HIV leapt from monkeys to human beings is as yet unknown; there is no debate, however, about the primary source of SV40: The virus came from the monkey kidneys on which the polio vaccine was produced. At the time, scientists developing the polio vaccine and other vaccines knew that the monkey kidneys they were using were often contaminated with unwanted simian viruses, but it was assumed they were inconsequential. SV40 proved them wrong.

After it was discovered in 1960, researchers inoculated laboratory animals with the

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simian virus in experiments conducted during 1961 and 1962. They were astonished—and scared—when their experiments showed that the polio vaccine contaminant readily caused an array of cancers. For a while, there was panic within public health circles as scientists debated what to do, but almost no one outside of a small coterie of health officials and researchers knew what had happened. Determined not to alarm the public, federal health officials kept the news about the SV40 contamination of the polio vaccine under wraps. They refused to recall millions of contaminated doses that had already been released for use; and when one government researcher dared to speak out about the contamination, they punished her. Then, in 1963, federal scientists surveyed the American population and concluded that they could find no evidence the virus was causing cancer in people who had received contaminated vaccine. Based on this one epidemiological study, most of the scientific world concluded the virus had little effect in humans. Meanwhile, vaccine production methods had changed and procedures had been instituted that supposedly made it impossible for SV40 to ever contaminate the vaccine again. Between the one epidemiological study and the switch to what was assumed to be a clean vaccine, SV40 was quickly forgotten and a false sense of security replaced the previous panic. For the next thirty years, almost everyone ignored SV40. The virus's relationship to human disease was almost totally unexplored.

Ignoring SV40 for so long was a mistake, according to Carbone and other cancer experts. “There is no doubt that SV40 is a human carcinogen,” says Carbone, who has studied the virus closely for more than ten years. “SV40 is definitely something you don't want in your body.” Yet that is exactly where the virus is showing up. Since the mid-1990's, SV40 has been found not only in the type of brain cancer that afflicted Alexander Horwin, and the mesotheliomas studied by Carbone and other researchers, but also in a variety of other brain tumors and bone cancers, as well as leukemias and lymphomas.

Many of these tumors have increased in incidence dramatically since the 1950s and early 1960s—the period when the polio vaccine was contaminated with SV40. Malignant mesothelioma, for instance, was virtually unheard of prior to 1955; today it afflicts and kills about 2,500 Americans each year and many more people in Europe. Brain and central nervous system tumors increased in incidence by more than 30 percent in just one twenty-year period from the mid-1970s to the mid-1990s. Bone tumors are also on the rise. Non-Hodgkin's lymphoma, and disease that killed Jacqueline Kennedy Onassis and Jordan's King Hussein, has also skyrocketed in incidence, increasing by 3 percent annually since the 1970s. It now strikes 54,000 new victims each year. Another 30,000 Americans are afflicted every year with acute or chronic leukemia.

More disturbing still, scientists are now finding SV40 not just in tumors from adults but in the tumors of children like Alexander Horwin—children too young to have been exposed to contaminated vaccine back in the 1950s and 1960s. These findings raise some disturbing questions: Has the simian virus established a permanent foothold in human beings and begun to spread? Or is it possible, as Alexander's parents assert, that polio vaccine continued at times to be contaminated, even after 1963? One thing is clear: The vast majority of baby boomers—almost all of whom received polio vaccine in the late 1950s and early 1960s—have potentially

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been exposed to the virus. And if what happened to Alexander Horwin is any indication, some of their children have been exposed as well.

This book tells the story of how SV40 came to contaminate millions upon millions of doses of the polio vaccine forty years ago and cause disease today. It follows a group of determined cancer researchers, who, led by Carbone, have revived interest in the long forgotten virus. In the process, they have made important new discoveries about how the virus works and about how cancer is caused in general. But such groundbreaking research has not been welcomed in all corners. Because SV40 was a contaminant in a government-sponsored vaccine. Within federal health circles there has been strenuous opposition to the proposition that the virus is a human carcinogen. At times, as this book recounts, that has included pressure on independent scientists to conform to the government point of view and even efforts to cut off their research funds. How—and why—scientific research can be shaped by such external forces lies at the heart of this story, and this book concerns itself as much with the people who practice science as it does with the science itself. For, as the history of SV40 shows, science is not always the disinterested pursuit of pure knowledge we may imagine it to be. It is a venture that, however noble, still can be influenced by the prejudices and predilections of its practitioners—sometimes for better, sometimes for worse.

Much of this account unfolds within the past ten years, the period during which research by Carbone and others exploded the long-standing assumption that the monkey virus was harmless to humans. But to really understand the story of SV40, one must begin many decades ago during a unique chapter in American history, a time when the entire nation was fixated on polio. Today, it is difficult to imagine the anguish that accompanied epidemics of poliomyelitis, a disease that ravaged the United States and much of the Western world during the first half of the twentieth century. For four decades, beginning with the epidemic of 1916, polio swept through the country every summer, leaving thousands of dead and maimed individuals in its wake, particularly children. Polio haunted America, especially its parents, and defeating it became a national obsession. It was against this backdrop that the story of SV40 begins.