

POLIOMYELITIS IN LANCASTER COUNTY WITH EMPHASIS ON THE IRON LUNG

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“When I wake, I am breathing out of proportion to myself. My whole body is a lung; I am floating above a doorway or a grave.”

Stanley Plumly, *The Iron Lung*

ABSTRACT

Lancaster County felt the full force of the Polio epidemic of the 1950s. The pervasive fear and uncertainty about transmission of the disease led to closure of public gathering places during the summer months in an attempt to curb its spread. Patients with paralytic polio that affected innervation of the respiratory muscles (around 1% of those infected) were placed in an Iron Lung; one is currently on display at the Edward Hand Medical Heritage Foundation.

The creation of the March of Dimes by President Franklin D. Roosevelt and the introduction of the Salk and Sabin vaccines dramatically improved the nation's response to polio. Although polio has now been eradicated in the United States, it is still endemic in three countries. Complete eradication is more likely due to increased efforts to vaccinate every child through the Global Polio Eradication Initiative.

This paper also includes comments from Dr. Henry Wentz, who worked in the polio unit at LGH, from Dr. John Randall, an Infectious Disease Specialist for Lancaster in the 1970s during the polio outbreak among the Amish community, and from a polio survivor from Lancaster.

INTRODUCTION

The excerpt from Stanley Plumly's poem *The Iron Lung* cited above clearly depicts the anxiety that was associated with polio's uncertain prognosis.¹ It also links polio to the Iron Lung which enclosed the torso in a metal cylinder, and maintained respiration by alternating positive and negative pressure. While providing breath and life to thousands with paralytic polio, the Iron Lung came to symbolize the dread that polio induced in the American public. Many factors fed this fear including a limited knowledge of the virus, the helplessness which doctors and nurses felt during treatment, the lack of a cure, and the nondiscriminatory nature of polio. Although many effective vaccines are

now available, polio has not been globally eradicated because some still resist being vaccinated.

HISTORY OF POLIO

Charles Caverly reported the first clinical description of an outbreak of polio in the United States in 1894. The outbreak occurred in Vermont with a recorded 132 cases. In 1908 Karl Landsteiner and Erwin Popper demonstrated that the disease was viral and could be transmitted to monkeys by a filterable virus from human spinal cord homogenates. The poliovirus is a member of the Enterovirus genus which lives in the human gastrointestinal tract. There are three wild types distinguished by their capsid proteins. Type 1 is the most virulent and unfortunately, the most common. Type 2 was eradicated in 1999 while type 3 is still in circulation.

A major epidemic occurred in 1916, with over 9,000 cases in New York City alone and 27,000 nationwide with 6,000 deaths. The severity of the threat that polio posed is indicated by some of the extreme measures that were taken: travel between infected cities was often restricted, and the *Los Angeles Times* reported that inspectors stationed themselves along the Delaware River in order to “bar all children under 16 years of age who attempted to cross into Pennsylvania without certificates of health.”²

A huge part of the fear of polio was its contagiousness. After a person contacts infected feces, the virus enters the mouth, multiplies in the throat and intestinal tract, and enters the bloodstream. From there it travels to the central nervous system where it ultimately destroys motor neuron cells responsible for voluntary and involuntary muscle movement.³ The virus is then “shed into the environment” via excrement and spread to other hosts.⁴ For these reasons, and the fact that polio was a summer disease striking most forcefully from July to October, many places of public gathering such as swimming pools and movie theaters were closed to prevent the spread of the virus.⁵ Kathleen Navarre recounts living with polio during the 1950s.

During the epidemic years polio was “a public event that brought fear, compassion, and prejudice all at once.” Friends ostracized the siblings of polio patients and oftentimes, the “emotional confusion was nearly as crippling as the physical disease.”⁶

CLINICAL SYNDROMES

95% of natural polio infections are completely asymptomatic yet the virus is still contagious, so people can contract and spread the poliovirus unknowingly. The mildest form with symptoms is abortive polio, which occurs in 5% of cases and is recognized by symptoms of fever, fatigue, headache, sore throat, nausea, and diarrhea. Non-paralytic polio includes these cases plus those with mild neurological symptoms such as stiffness in the neck. Finally, the least common but most feared type is paralytic polio, occurring in only 0.1% of all infections. This form also begins with fever, fatigue, and headache, but it progresses to loss of muscle movement and function.⁷ If the virus spreads to the brainstem with bulbar involvement, the chance of recovery is severely decreased. The helplessness that doctors and nurses felt for their patients was immense. Due to the limited methods of establishing a diagnosis, primarily only clinical judgment and spinal fluid analysis, several of those given a polio diagnosis probably had Echo virus or Coxsackie virus, both of which are Enteroviruses, have symptoms that can mimic polio, and disappear without treatment.⁸

POLIO IN LANCASTER COUNTY

Doctors' helplessness fostered the fear in the community and frustrated physicians' natural urge to provide comfort to their patients. Unable to stop the progression of the virus, the caring physician would sit helplessly at the bedside as the patient lost movement of the extremities and function of the respiratory system. Dr. Henry Wentz, now in his nineties, remembers this feeling all too well. A family physician in Strasburg, Pennsylvania, Wentz spent the summer months during epidemic years in the seasonal polio unit of Lancaster General Hospital (LGH).⁹ This unit with private and semi-private rooms and four-bedroom wards was installed during the 1940s with Dr. William Saul as director. Dr. Edgar Meiser took charge in 1946. It was designated as the polio unit for Lancaster and Lebanon Counties by the Pennsylvania Department of Health. Those with upper respiratory or gastrointestinal symptoms were admitted to the unit for observation and diagnosis. The peak incidence occurred in 1954 when 118 patients were admitted to LGH with polio symptoms, 80 of which were confirmed. Of these

80, 38 were non-paralytic, 28 were paralytic, and 14 had bulbar involvement.¹⁰

Although there was no cure or vaccine during the 1940s and early 1950s, physicians employed several treatments to combat the effects of polio and to affect its course. The antibodies in human gamma globulin could reduce, but not eliminate, the risk of paralysis.¹¹ An Australian nurse named Sister Kenny developed an additional remedy in 1940 named the Kenny Treatment. This consisted of placing flannel hot packs on a patient's back, neck, and extremities to relieve muscle spasms and pain. With this technique, the management of polio patients was altered from strict immobilization to muscle mobilization and re-training. Although this treatment was not scientifically proven, Sister Kenny received an endorsement from the AMA in 1941 for her methods. Lancaster County sent Edna Schreiber, a nurse, to the Mayo Clinic to learn this muscle re-education technique.¹² It was remarkable that LGH recognized the potential value of this therapy, which was controversial because it was not only unconventional but had been developed by a woman.

Alice Royer of West Lampeter Township contracted a mild case of polio in June 1942. One minute she was sitting on the floor with friends and minutes later, when she tried to get up, she could not put weight on her left foot. “It was just that sudden.” At four years old, she was the first polio case in the area during the 1942 epidemic, which Royer describes as one of “the most fearsome experiences [Lancaster] county had.” Doctors at LGH diagnosed Royer with polio and would have admitted her had her mother not needed cataract surgery at the same time. Royer's father chose to forgo the conventional medical treatment of hospitalization with braces and splints and opted the more radical Kenny Treatment. Three times a day, Royer's father massaged her leg muscles in scorching hot water. A period of “physical therapy” followed consisting of walking repeatedly around the kitchen table so her muscles could relearn how to put the foot flat on the floor. These treatments were painful, yet successful, as Royer made a full recovery.¹³

THE IRON LUNG

Once a critical piece of equipment in the fight against polio, the iron lung is now a medical artifact. Dr. Philip Drinker and Dr. Louis Shaw of Harvard University developed a machine that provided artificial respiration for patients with respiratory paralysis by demonstrating that external changes in positive and negative pressure could provide sufficient tidal volume for gas exchange. Drinker

reported his successes in the article titled “The New Apparatus for the Prolonged Administration of Artificial Respiration: A Fatal Case of Poliomyelitis.”¹⁴ The Drinker Respirator was built for prolonged use, could accommodate a large size range of patients including children and adults, and could regulate rates of respiration.¹⁵

The iron lung on display at the Edward Hand Medical Heritage Foundation in Lancaster, PA can be seen in Figure 1.

The iron lung pictured is the Emerson Respirator, a less expensive version of Drinker’s. A plate behind the head mirror designates it as model number “SR,” serial number 50, and patent number 2060706. This patent dates to March 23, 1936, but there are other

Fig.1. Iron lung with mannequin inside. This model was used by Lancaster General Hospital.



patent numbers under which this respirator is manufactured. On January 6, 1941, John H. Emerson filed patent number 2240838. Emerson’s artificial respirator was an improvement in that it allowed patients’ “arms to be raised and elbows to be bent while confined in the respirator.” Since patients were often in the iron lung for weeks or months, this change prevented permanent contractures of the arm muscles and tendons.¹⁶

There is a larger metal plaque on the side with printed operating instructions. There are directions on emergency hand operation; making electrical connections; inserting the sponge rubber collar; putting a patient inside the machine; changing respiration rate and depth; adjusting for positive pressure; tilting the respirator; using accessories such as the respiration dome, the alarm, the aspirator, and the mirror

and book rest; and finally, caring for the machine and its rubber parts. This list is broad and extensive, most likely due to the novelty of the instrument and the critical importance of operating it correctly.

Highlighting just one operation, placing the patient inside required several steps. Nurses pulled the tray out through the head of the machine and opened a hole in the neck collar by pulling the rubber to the sides and securing it with pins. The patient was placed supine on a mattress with his head through the hole created. Hand wheels adjusted the heights of the head rest and bed. The medical staff placed cotton around the neck, pushed the bed inside the respirator, and released the pins on the collar so that it sealed off

the outside environment. Nurses could remove patients from the respirator for short periods of time in order to change bedpans. However, if the patient could not survive even a short time outside of the machine, nurses managed bathing and nursing care through arm ports on each side of the respirator.

A gold placard on the machine indicates that it was donated to LGH for public use by the Lancaster City and County Auto Trade Association in June of 1952. A bright orange LGH Safety Check sticker near the back of the machine is dated April 23, 1987, which means that it was maintained at the hospital until at least then.

The iron lung reduced some of the helplessness which the doctors felt, but it was not always welcomed by patients who often fought being placed inside it. At LGH Dr. Meiser used sedatives such as morphine to reduce anxiety and fear. LGH bought its first iron lung in 1938 for \$1,350 and, at its peak, the hospital had five iron lungs in operation. Once the acute phase of paralytic polio was over, the medical team faced a difficult task of weaning, which lasted weeks and required a high level of care. Patients were taken out of the machine for increasing intervals of time to achieve muscle re-education.¹⁷

Other patients were not as fortunate, and many had to live with respiratory assistance for the remainder of their lives. Dr. Wentz recalls the experience of one female patient in particular, whom he calls Marie. She was placed in an iron lung at LGH for paralytic polio, and when no improvement occurred she was transferred to a respiratory assistance program in Baltimore, Maryland.

There were many actors involved in the move including a large van, doctors and nurses, police escorts, and workers from Pennsylvania Power and Light Company to operate the electrical equipment.¹⁸ This case stands out in that it highlights the toll that polio took on the entire community and shows how the Lancaster community came together to help polio patients.

THE MARCH OF DIMES

Although better known for its crippling effects on children, poliomyelitis did not discriminate; men, women, and children, young and old were susceptible to the virus. Franklin D. Roosevelt contracted polio in 1921 at the age of 39, crippling his legs.* He later established the National Foundation for Infantile Paralysis, but the funds raised at the President's Birthday Balls were insufficient and he appealed to the public for support. The Foundation received thousands of dollars to fund polio research and the name of the organization was changed to the March of Dimes. These fund raising efforts were so successful that the March of Dimes was able to pay for the treatment of polio patients and for many iron lungs, in addition to polio research.¹⁹

SALK AND SABIN VACCINES

A breakthrough finally came when March of Dimes grant recipient Dr. Jonas Salk at the University of Pittsburgh created the Inactivated Polio Vaccine (IPV) by using formaldehyde to inactivate the poliovirus by stopping its reproduction. Given intramuscularly, IPV provides protection by inducing production of antibodies to all three types of poliovirus. In April of 1954 one of the largest field trials of its kind was conducted to test the efficacy of the vaccine. This was a double-blind study involving over 1.5 million "polio pioneers," all children. One year later, Salk's vaccine was approved as "safe, effective, and potent" and was immediately delivered to the American people.²⁰ His vaccine is most commonly used in the United States and European countries today.

As Salk was discovering his "miracle" vaccine, Dr. Albert Sabin was working to develop a live, attenuated viral vaccine that would provide better long term immunity than a killed virus vaccine. His oral polio vaccine (OPV), developed in 1962, became preferred for the global fight against the virus because after the

OPV is taken, the weakened virus is flushed from the body via excrement and spread to the environment, effectively inducing immunity in others in the community.²¹ This herd or community immunity is significantly less expensive to achieve. During that same year of 1962, Dr. Meiser headed a local program to deliver thousands of oral vaccines to children and adults in Lancaster County.²²

Once these vaccines were developed and in full use, the polio unit at LGH was "phased out," as there were no more polio patients to admit. The introduction of vaccines also reduced the use of the iron lung dramatically.²³ Technological advances such as improved tracheostomy procedures and portable respirators also led to the decline of iron lung use. Though nearly obsolete today, the historical importance of this machine is enormous. Several iron lungs are still in operation in the United States; in 2004, there were 39, and today this number has dwindled to an estimated six to eight.

THE ERADICATION OF POLIO

Wild polio was eradicated in the United States in 1979. The last cases occurred in Amish communities in four different states. Of the seventeen people infected with type 1 polio, eight were from Pennsylvania, and a majority of these were unvaccinated Amish in Lancaster County. The outbreak spread from the Netherlands, to Canada, to Pennsylvania due to the movements of this religious group.²⁴ This outbreak led to a three day mass immunization program in Lancaster County during June 1979. Twenty-one free clinics were set up to deliver OPV drops, and additional private clinics were set up at the farms of the Old Order Amish due to their reluctance to seek immunization on their own. Health officials were confident that if 60-70% of the target population were reached with the oral Sabin vaccine, the problem would "be licked" in regard to the general population.²⁵ In the end, these efforts were extremely successful as these were the last cases of naturally occurring polio in the United States.

Dr. John Randall worked as an Infectious Disease Specialist with the Family Medicine Residency Program at LGH during the 1970s. He recalls the challenge of overcoming the religious objections of the Amish to vaccination. Randall and his team had to go to the estimated

* In 2003, an article in the *Journal of Medical Biography* suggested that FDR's illness might have been Guillain-Barre Syndrome, rather than polio. Perception is reality, as the saying goes, so whether or not FDR had polio, he and everyone else thought he did, and that perception led to the March of Dimes. (Goldman, AS et. al. What was the cause of Franklin Delano Roosevelt's paralytic illness? *J Med. Biog.* 2003; 11: 232-240)

82 parishes in the region to get authorization from the bishops in order to conduct mass immunizations. The collaboration of the Pennsylvania Department of Health and the United States Centers for Disease Control, together with up-to-date epidemiological reports, were essential in containing this final epidemic.²⁶

Religious objections to immunization are just one of the reasons that people forego vaccination. Other objections are societal. There is an unfounded fear of a lack of safety with the OPV. Many parents believe that three doses of OPV are not necessary, and will do more harm than good. There is also distrust of government and—in many countries—political opposition to Western influence. Religious groups in Africa and the Middle East feel that polio is brought about by God and that only he can eliminate its presence. In Afghanistan, social norms play a huge role in whether a child receives the vaccine. Women seldom leave their homes unattended and male vaccination teams are not allowed to enter these homes. These “missed opportunities” hinder the progress towards global eradication.²⁷

Although polio has been eradicated in many countries, there are still ten affected by the virus including Afghanistan, Cameroon, Equatorial Guinea, Ethiopia, Iraq, Israel, Nigeria, Pakistan, Somalia, and Syria. Polio is endemic, meaning that transmission has never ceased, in only three countries: Pakistan, Afghanistan, and Nigeria. In 2014 alone, there were 350 global cases with 297, 28, and 6 cases of wild poliovirus type 1 in each respective endemic country. The remaining seven countries are each recognized as being re-infected with wild poliovirus serotype 1. Although the level of fear has been strongly reduced since the 1940s and 50s, there is still widespread alarm such that on May 5, 2014, Margaret Chan, Director-General of the World Health Organization, declared the “international spread of wild poliovirus a public health emergency of international concern.”²⁸ Putting polio back on the public’s radar might further the efforts of global eradication, but it will take full cooperation from all sides in order to achieve this goal.

This declaration of a public health emergency should not take away from the tremendous strides that have been made against polio. Since 1988, when the Global Polio Eradication Initiative (GPEI) began, the number of polio cases has decreased by 99%, from a staggering 350,000 cases to 149 cases as of September 2014. The GPEI is a public-private partnership launched by the World Health Assembly. It is

led by a multitude of organizations including national governments, the World Health Organization, Rotary International, the United States Centers for Disease Control, and UNICEF. A key supporter of the GPEI is the Bill & Melinda Gates Foundation, which provides technical and financial resources to eradicate polio including the investments needed for polio vaccine research and targeted vaccination campaigns. In 1994, 2000, 2002, and 2014 the WHO regions of the Americas, Western Pacific, European, and Southeast Asia respectively were confirmed polio-free. Furthermore, the GPEI has established the Polio Eradication and Endgame Strategic Plan, a long-term strategy to “deliver a polio-free world by 2018.”²⁹ Part of this strategy includes the withdrawal of OPV and introduction of IPV as the preferred vaccination method due to the risk of OPV-induced iatrogenic polio, uncommon as it is (1 case per 2.5 million doses). Despite the major successes of these international campaigns, there are many uncertainties about the future of polio.

POST POLIO SYNDROME

Unfortunately for those who contracted the virus and survived, there is roughly a twenty-five percent chance of experiencing post-polio syndrome, which can appear decades after the initial poliovirus infection. Symptoms include pain, fatigue, and new weakness that seems proportional to the severity of the residual disability after the original infection. Space precludes a detailed discussion here. Briefly, the cause of PPS is uncertain, but the new weakness appears related to the degeneration of individual nerve terminals in the motor units. It would appear that in an effort to compensate for the loss of motor neurons at the original attack, surviving cells sprout new nerve-end terminals and connect with other muscle fibers. These new connections may result in recovery of movement and gradual gain in power in the affected limbs, but years of high use of these recovered but overly extended motor units stresses the motor neurons, which over time lose the ability to maintain the increased work demands.³⁰

CONCLUSION

Poliomyelitis was a feared infection in the 20th century, as there were many unanswered questions about transmission of the virus and how to stop it from spreading. Most of these questions have been answered due to the efforts of researchers, public health officials,

physicians and nurses, and patients who became knowledgeable about the disease. Polio had a large impact on the Lancaster community, evident in an entire unit being dedicated to its treatment at LGH. The team of doctors and nurses including Dr. Henry Wentz and Dr. Edgar Meiser worked tirelessly to help their patients in any way they could, but their tools were limited. Once vaccines were developed, Lancaster residents were quickly immunized, but because of the Amish population's resistance

to being immunized, Lancaster experienced several of the last cases of wild polio in the United States. Now in the twenty-first century, the fear associated with the poliovirus has been greatly reduced. Along with this development is the hope that the disease which once crippled even the President of the United States will be globally eradicated by the year 2018. Until that time, to prevent polio's resurgence we must continue to urge full immunization for all.

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