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Lessons from History: Parallels between the COVID-19 Pandemic and Poliomyelitis

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Introduction

There are notable resemblances in the epidemiology and social and scientific responses of the Poliomyelitis (polio) epidemics of the 1900s and the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) pandemic. Polio is no longer a public health concern, but it was a serious and debilitating illness that initially struck infants (hence its title "infantile paralysis") and later affected adolescents and young adults more strongly; the latter were almost five times more likely to die from polio than young children [1]. This review will discuss lessons learned from polio such as social distancing, early treatments, and vaccine developments in both diseases as well as the role of collaboration.

Social Responses

Social distancing and quarantines are not new concepts; during polio's multiple epidemics, individuals remained separated from one another in order to mitigate the spread of polio. For example, during the 1945 outbreak, Trenton instituted a quarantine that prohibited children under the age of 16 from attending church or going to parks, playgrounds, and other mass gatherings [2]. Likewise, the Centers for Disease Control and Prevention (CDC) recommend to "keep a safe distance to slow the spread" of COVID-19; self-isolation has been crucial to the global response to the virus [3]. Unlike the 1900s, the 21st century has seen a more connected world with frequent global travel. As a result, multiple regions of the world have instituted travel guidelines. The United States temporarily implemented travel restrictions for nationals of China, Iran, Brazil, and multiple European countries [4]. Similarly, smaller regions such as New York, New Jersey, and Connecticut required that travelers from states with high incidences of COVID-19 self-quarantine for two weeks [5]. While widespread travel guidelines were less common during polio, restrictions did exist; the Bahamas prohibited the travel of children from Florida and Cuba in 1946 [6].

Reopening schools and universities remains a heavily debated topic today, just as it was in the 1900s. In order to prevent the spread of polio during the 1916 epidemic, the start of the school year was delayed; for example, New York schools reopened on September 25, two weeks later than initially planned. The Health Department worked with schools so that a doctor and nurse was present in every building to evaluate students' conditions. Children who had been to regions outside of New York with a high incidence of paralytic polio were required to either provide a health certificate verifying that they had not been exposed to polio or quarantine for two weeks prior to returning to school. Despite these strict measures, however, some parents remained doubtful. A New York Times article read, "THOUSANDS WON'T ATTEND," later elaborating, "While it is expected that many parents will keep their children away from the schools for the next week or two through fear of the disease, yet this number is not expected to be large, in proportion to the number enrolled...not over 10 percent." Arnold Gross was one such skeptical parent; he delivered a petition, on the behalf of the Parents' Association, to the President of the Board of Education objecting to the reopening of schools and declared that he did not intend to let his children return when schools opened [7]. In 1949, George Saunders wrote a Letter to the Editor of the New York Times questioning the reopening of schools, saying, "The National Foundation for Infantile Paralysis and other groups, as well as family physicians, have advised parents to keep their children out of crowds and away from new acquaintances during the present polio epidemic. Why, in the face of this, does the Board of Health advise the Board of Education to open the city schools on September 12th as scheduled?… Why not consider the children first and keep the schools closed until the element of danger has unquestionably passed?" [8]. While online education was not available like it is today, some students did learn *via* radio [9].

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Similar concerns and discussions have resurfaced with regard to opening educational institutions. Schools and universities across the country switched to distance learning in spring 2020 as the number of cases increased, and the pros and cons of opening schools and colleges for the 2020 to 21 academic years are being debated. Proponents of reopening schools cite students' health and educational opportunities. Twenty million students depend on receiving a school meal, and the economic and racial disparities are more apparent as many families struggle to gain high-speed internet and home computer access. Other consequences of distanced learning include student safety; 20% of reports in child abuse are made by school officials, by one estimate [10]. Christopher Morphew of the Johns Hopkins School of Education highlighted the number of unknowns in remote learning and how several students are unable to flourish in this environment [11]. Remote learning has also resulted in financial losses for private schools and universities [12]. Equally vocal are proponents of prioritizing student and teacher safety. It is likely that parents and educators would rather err on the side of caution; an Axios-Ipsos poll in July found that 71% of parents believed that sending children back to school was a moderate-to-large risk while a May 2020 poll found that 20% of teachers did not want to return in the Fall [13,14]. The Florida Education Association, the largest teacher's union in the state, has sued Gov. DeSantis to stop him from reopening schools in the fall [15]. Regardless, schools that do open will have to make accommodations similar to those from the era of polio such as social distancing in the classroom and meticulous disinfection efforts [16]. Unlike the polio era, however, schools of the 21st century are able to embrace online learning and hybrid models combining remote and on-campus instruction so that students' education is not hindered. The ultimate strategy will likely consider fatality and hospital admission rates, the success of mitigation efforts, and the availability of treatments and, eventually, vaccinations.

Initial Treatments

Like COVID-19, the 1916 epidemic posed significant challenges to hospital systems, especially that of New York City. Physicians scrambled to treat patients with multiple treatments, including tetanus and diphtheria antitoxins, serum injection, and lumbar puncture; however, these methods were found to be ineffective and were ultimately dismissed [17,18]. Likewise, COVID-19 overwhelmed the Empire City's hospitals in April 2020; The Federal Government, fearing shortage of beds and equipment, positioned the U.S. Navy Ship Comfort outside Manhattan to provide medical assistance and to alleviate stress on local health centers [19]. Like polio treatments, coronavirus therapeutics has evolved over the course of the disease. Remdesivir has been demonstrated to shorten recovery time, and dexamethasone seems to lower the 28-day mortality rate among patients receiving respiratory support [20,21]. The malaria drug hydroxychloroquine was initially given an Emergency Use Authorization (EUA) by the Federal Drug Administration (FDA) which was revoked, as the medication's efficacy was not demonstrated in clinical trials [22].

Data collection has advanced significantly since the polio era; information can be accessed more easily for epidemiological purposes. In 1916, data records were incomplete and did not distinguish the disease's severity (paralytic or non-paralytic) or the treatments used [23]. In 2020, technological advancements, such as high-speed internet and specialized statistical models have led data's instant circulation for field use; for instance, the Johns Hopkins University Coronavirus tracker, the Centers for Disease Control and Prevention (CDC), and COVID-NET, have allowed for the number of confirmed cases, fatalities, and hospital admissions to be recorded and accessible to any health organization across the globe [24].

Regardless, limitations of inadequate and inconsistent testing are still prevalent; the CDC released an analysis in July stating that the number of infected persons was likely anywhere from 2 to 24 times the number of confirmed cases, depending on the region [25]. Adequate testing with instant results remains a formidable challenge in containing the coronavirus [26].

Vaccine Development

In the late 1800s and early 1900s, the United States did not have any major research institutes like the publicly-funded French Pasteur Institute or the German government-financed labs of Robert Koch and Paul Ehrlich. In 1902, John Rockefeller established the Rockefeller Institute in New York City. Simon Flexner was the Foundation's First Director and while he made some important contributions to polio research, his work on only the Macaca Mulatta Monkey (which does not contract polio via assisted feeding) and his disdain for clinical work misguided him and others [27]. Unlike the early 1900s, the united state, with multiple Tier 1 research universities, has a robust biomedical basis and is well-equipped to enhance our understanding of the novel coronavirus.

An organized effort to cure polio would later appear after Franklin D. Roosevelt was struck with the ailment; in 1938, he formed the National Foundation for Infantile Paralysis, with Basil O'Connor as the director. The Foundation succeeded in fundraising, helping patients, and funding research [27]. On his radio show, celebrity Eddie Cantor launched "The March of Dimes," a new fundraising initiative in which donors would mail dimes to the White House; other personalities soon followed suit. The result was 2,680,000 dimes and many more checks and bills. A similar fundraiser was not repeated, but the fundraising sect of the National Foundation was named the March of Dimes and the idea of collecting dimes to raise money remained [27,28]. While no one universal fundraising effort is present during the coronavirus, many global projects, including the World Health Organization (WHO) COVID-19 Solidarity Fund, are raising money for personal protective equipment, trials, and other needed supplies [29].

As unsuccessful polio research continued, Basil O'Connor appointed Harry Weaver for a new position of Director of Research at the National Foundation. Weaver struggled to organize the studies being performed, citing scientists' strong desire of being entirely independent in their projects as well as their inclination to learn more about polio rather than solve the issue quickly. Jonas Salk, however, seemed to share the sense of determination and necessity that Weaver so deeply valued [27]. The current scientific community does seem to share Weaver's rare-at-the-time sense of urgency; as of July 22nd, 2020, 27 vaccinations were in the human trial stage across the globe and many showed promising results from Phase 1 trials [30]. These monumental developments might make the anti-SARS-CoV-2 vaccine the quickest inoculation ever developed [31].

After Jonas Salk developed his inactivated inoculation, the Salk Vaccine Trials of 1954 the largest field trial at that point in time–commenced. Elementary-school children, who would receive consent forms for their parents in school, were the only subjects, and volunteers helped carry out the initiative. Two studies took place; a randomized placebo-control study and an observed-control

study [32]. Volunteers for various coronavirus vaccine trials are as important today; the COVID-19 Prevention Network has set up a website where individuals can sign up to participate [33]. Because there is no efficient treatment option for the coronavirus, a pandemic vaccine development model has been created that shortens the amount of time required to complete various stages. As a result, Controlled Human Infection Models (CHIMs) have been proposed for studies instead of field trials like Salk's. In such a model, healthy subjects are infected with a microorganism to study vaccines or therapies. They lessen variability regarding exposure to the disease that is common among field trials, so fewer participants are needed [34].

While Jonas Salk's vaccine was a killed-virus vaccine, an mRNA vaccine containing the SARS-CoV-2 spike glycoprotein may be developed to combat COVID-19. Such a vaccine is under development by Moderna which, in a Phase 1 trial, was successful in that all participants developed an anti-SARS-CoV-2 response [35]. A vaccination in development by the University of Oxford and AstraZeneca has also been demonstrated to produce neutralizing antibody responses without any serious adverse effects [36].

Even after the Salk vaccine trials of 1954, polio continued to be an unsolved problem for the nation. Some children who were administered the vaccine developed in the Cutter Laboratories of Berkeley, CA developed polio; as a result, the government temporarily terminated the approval of new manufacturers that were undergoing a safety assessment. Fewer than expected inoculations were available in 1955 [37]. The incident likely led to the current federal regulation of vaccines [38]. The Cutter event suggests that even if a treatment is demonstrated to be safe and effective, issues among particular manufacturers can be problematic; individual companies must be reviewed carefully.

While Salk's vaccine was widely available, administering it properly to the Populus remained a challenge. By June 1959, 450 people were affected by polio, up from 333 in the same time span the previous year. Of those with the disease, more than half were paralyzed and more than half did not receive the complete series of the Salk inoculation [39]. The next year, a New York Times article read: "The Health Department estimates that only 66 percent of children under 5 have received one or more doses of Salk vaccine. This is insufficient. The elimination of polio as a threat hinges upon the realization by responsible adults that there is no public health without the public's cooperation" [40]. Lack of public cooperation is also present during COVID-19. Despite multiple medical professionals' advice on wearing masks, many Americans fail to do so. When a vaccine becomes available, it may not be distributed effectively. Parallels regarding the importance of public cooperation are readily available during COVID-19; if social distancing, mask-wearing, and, when available, vaccinations are not embraced, setbacks like those of the polio era may recur. A Washington Post-NBC News poll found that only 7 of every 10 Americans would get vaccinated [41]. Fauci has indicated that this "general anti-science" sentiment among some that could hinder the nation from reaching herd immunity, especially if the vaccine's efficacy is not particularly strong [42]. The saga of polio inoculation development from Salk's killed-virus vaccine to Albert Sabin's live-virus one may be repeated as various vaccines are developed until one of the highest efficacy and lowest adverse effects is found [43,44].

The COVID-19 pandemic has already had many similarities with the polio epidemic in social responses and treatments; hopefully, the coronavirus can be conquered just as polio was by a vaccination. This will require extensive collaboration, pooling of resources, and innovative thinking as well as global partnership, like that of the Global Polio Eradication Initiative, which consisted of multiple partnerships to provide inoculations and ultimately limit disease transmission [45]. The crucial next steps are best stated by Fauci and Dr. H. Clifford Lane in their New England Journal of Medicine editorial titled "Research in the Context of a Pandemic": "Despite the decreases in death and complications that are likely to result from appropriate treatment of patients with Remdesivir and dexamethasone, far too many people with COVID-19 will die. It is our responsibility in the global medical research community to rapidly design, implement, and complete studies of the most promising therapeutic agents and vaccines against this disease…Such efforts will benefit from national and global coordination and public–private partnerships, including Accelerating COVID-19 Therapeutic Interventions and Vaccines (ACTIV) in the United States, the ACCORD (Accelerating COVID-19 Research and Development) platform in the United Kingdom, and the SOLIDARITY effort by the World Health Organization.

Scientifically robust and ethically sound clinical research remains the quickest and most efficient pathway to effective treatment and prevention strategies for patients with COVID-19" [46].

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