

**Pandemic Preparedness: A Literature Review Assessing COVID-19's Impact on Mass
Vaccination Efforts**

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Abstract

Mass vaccination initiatives have been a driving force in combating preventable diseases around the world and more specifically, the United States. With the emergence of vaccines for conditions such as polio, Americans have flocked to their healthcare providers in hopes of receiving protection from debilitating and detrimental diseases. However, the practice of conducting mass vaccination initiatives has been reserved in recent times to flu vaccine clinics where individuals were not rushing to receive their dose. With the emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2 or COVID-19), private and public health institutions were forced to assess their practices related to vaccinating large numbers and ensuring they could do so in an effective and timely manner. The importance of mass vaccination initiatives to public health is a simple but valuable one: if we are to achieve any sort of success in countering a pandemic and benefiting the greater good, our methods of doing so must be refined to the fullest extent and continuously evaluated. This essay will first review the history of vaccinations and their rollout process to the general public. This will lead to a discussion of the methods undertaken to identify and evaluate the existing peer-reviewed literature available surrounding mass vaccination efforts and how they may have changed throughout history and how the COVID19 pandemic changed them. Personal anecdotes and examples will also be utilized to identify the impact these mass vaccination efforts have had on public health throughout the pandemic.

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Preface

This essay was made possible by those who have supported me in my endeavors, especially my family, friends, and colleagues at Allegheny General Hospital, who have been my home from home over the past two. To you, I owe my greatest thanks for this and much more.

1.0 Introduction

The utilization of vaccines dates hundreds of years ago, as researchers at the time were looking to eradicate smallpox from those who were afflicted. Since then, humanity has made leaps and bounds in the field of vaccine research to the point where once deadly diseases are now essentially eradicated.¹ Therefore, one may say that vaccines are among, if not the single most, the greatest forms of infectious disease control ever created. The process of infection control does not simply stop with the invention of a new modern marvel, but rather the focus shifts to getting this preventative measure into the arms of those in the population. Since the invention of Edward Jenner's smallpox vaccine (his method of inoculating others with materials found on lesions on milkmaids), the implementation of mass, and mandatory, vaccination has increased as individuals and governments alike began to identify the positive's associated with increasing the number of those vaccinated.¹

Regarding mass vaccinations, it becomes a matter of getting the vaccine into as many individuals within the shortest amount of time possible. This practice is primarily valuable during instances when a city or country is facing a pandemic-inducing pathogen, much like COVID-19. Practices have been developed over time by the US government in addition to public health departments across the country in order to assist in coordinating mass medication administration programs. Some programs are dedicated to the administration of oral or intravenous medications, while others are dedicated to the administration of vaccinations.² Additionally, the World Health Organization (WHO) has established their own practice of conducting mass vaccination events in underdeveloped countries to provide protection to infectious diseases that run rampant in certain countries.³ In the early decades of the 1800s, European countries such as the United Kingdom,

Sweden, and Denmark saw a marked decrease in the number of people who were becoming afflicted with smallpox. These same countries became some of the first to initiate mandatory vaccination requirements to reduce the spread of disease. This practice would spread to other countries by way of legislation and rules surrounding enrollment into schools during childhood.⁴

As countries employed more mass vaccination projects, they began to see a decrease in the occurrence of smallpox, including in those who were unvaccinated. This was a surprising discovery to be made but was noteworthy because it showed that mass vaccination initiatives played a vital role in ensuring that both the vaccinated and unvaccinated could benefit from such projects.⁴

Throughout the 20th century, there were multiple instances where mass vaccination efforts were utilized to control outbreaks of certain diseases, including: smallpox, polio, yellow fever, and measles, amongst others. Although these instances proved to be effective, their translation into the modern day would certainly be called into question with the emergence of COVID-19. While there have been instances of other infectious disease appearing on American soil without a known preventative piece or treatment, they never escalated to the large-scale infection rates that COVID-19 caused.⁵

While public health organizations certainly have experience with conducting mass vaccination events, the private sector had to also play a large role in order to assist the efforts if there was any hope in effectively fighting this disease.⁶ Across the country, large healthcare organizations such as UPMC, AHN, Cleveland Clinic, and many more, were able to leverage their resources, primarily staff, to assist in conducting vaccination events.⁷ The US government planned a goal of 100 million vaccines in 100 days at the start of 2021. States had about two weeks to prepare to vaccinate those aged 65 and older, so the burden upon public health organizations was

immense in addition to retail pharmacies. The support that large health-systems could provide with their resources has proven to be valuable as the need for booster doses continues and may continue moving forward.

This paper will review and assess historical and current literature related to the creation, implementation, and optimization of mass vaccination efforts in addition to the potential impact COVID-19 had on such practices. Most mass vaccination efforts in recent years have dealt with the influenza vaccine and its administration in nursing homes or community pharmacies. However, with the implementation of *Operation Warp speed*, a sense of urgency was implanted in the minds of healthcare workers in order to overcome the pandemic and restore a sense of normalcy as soon as possible.

The objective of this paper will be reviewing all peer-reviewed literature available regarding mass vaccination initiatives, their history, planning, and changes that have occurred. Additionally, various instances of anecdotal evidence will be presented based on practicum experiences obtained at Allegheny Health Network and the mass vaccination efforts they conducted. The researcher will assess pitfalls that could be identified from past and present practices and how their modification and optimization can lead to future success with mass vaccination efforts during a pandemic.

2.0 A Brief History of Vaccines

Vaccines, and inoculation methods specifically, have been present for centuries. They can trace their documented history all the way back to the mid-1500s, where practices in China and India involved intentional exposure intranasally and intradermally to the smallpox virus in order to provide overall protection from the disease.^{1,8} From there, variolation (which is interchangeable with inoculation) was introduced to Great Britain and various colonies through interactions that the wife of a British diplomat had in Constantinople, where she noticed that individuals were not contracting smallpox. Additionally, she observed the practice of variolation as a common practice and ultimately had both her children inoculated with the same practice.⁸ The practice involved taking a sample of pus from an infected individual with smallpox and placing the needle on an open wound of a healthy individual. This led to protection from smallpox but also ran the risk of conferring the severe form of the disease on the inoculated individual. In 1796, Dr. Edward Jenner utilized a different technique, where he instead relied upon cowpox and inoculated an eight-year-old child with the infected needle. From there, he waited a few months before exposing the child directly to smallpox, which the child did not develop. Thus, the term “vaccination” was created, derived from the Latin word for “cow”, as Jenner had used the cowpox virus for his vaccine.⁹

The method by which vaccines work is one rooted in their ability to provide immunity to patients upon administration. Depending on the vaccination being administered, it contains antigens that may be partially alive or completely killed. These antigens, when present in the body, produce a response from the carrier’s immune system. In the instance of vaccines, it allows the antibodies tasked with fighting off the antigen to become familiar with them and recognize that anytime they present, they require destruction in order to prevent infection.¹⁰

There are two predominant forms of vaccines: live attenuated and inactivated vaccines. The live attenuated include a weaker form of the bacteria/virus, which prevents it from spreading within the body upon administration. It stimulates the immune system just enough to produce a response and can provide lifelong immunity from a pathogen. Most commonly, these types of vaccines are in the MMR and chickenpox vaccines. For inactivated vaccines, they contain a killed form of the infectious pathogen which has been treated with chemicals or heat prior to administration and include examples such as the pertussis (whooping cough) and rabies vaccines. Although the infectious pathogen is considered “dead”, the immune system is still able to recognize the antigens and produce a response the next time it is exposed to the infection.¹⁰

The creation of the smallpox vaccine led to the desire to pursue the total eradication of any disease that was preventable with a vaccine. As time went on, more and more diseases were identified as preventable and this led to more vaccine development, supported by various national and international bodies of health. Specifically with the smallpox virus, the World Health Organization sought to totally eradicate the disease through mass vaccination programs. Although it took almost 10 years to come to fruition, smallpox was considered eradicated in 1977.¹¹

Since the invention of the smallpox vaccine, multiple vaccines have been developed in response to newly discovered pathogens – whether they are bacterial or viral in nature. Their utilization in preventing infection has been valuable on a global scale and has led to the eradication of many infectious conditions.

3.0 Methods of Identifying Literature

A literature search was conducted on PubMed utilizing MeSH terms: “mass vaccinations”, “blitz vaccines”, “mass vaccine efforts”, and “coordinating vaccinations”. Surprisingly, there were very few results in the primary literature that discussed mass vaccinations and their impact on public health and the ability to stop the spread of a pandemic pathogen. Of the literature identified, one particular book titled, *Mass Vaccination: Global Aspects – Progress and Obstacles* contained a plethora of pertinent chapters that discussed planning and implementation of mass vaccine clinics. Published in 2006, this book falls short of documenting the H1N1 pandemic of 2009, which would have been the most recent instance that required mass vaccination efforts prior to the COVID-19 pandemic that is ongoing at the writing of this essay. Additionally, sources of literature were identified that briefly discuss efforts related to the polio vaccine developed by Jonas Salk and how the effective rollout of his vaccine helped lead to the eventual eradication of poliomyelitis from the United States and many parts of the world.¹²

From there, a search was done to identify literature related specifically to the COVID-19 pandemic and assess their applicability for use. Only one such article was evaluated and utilized in the nature of this essay. *Mass-Vaccination Sites – An Essential Innovation to Curb the COVID-19 Pandemic* was a perspective article published in *the New England Journal of Medicine* and discussed many of the initial layouts and plans associated with mass clinics for COVID-19 vaccine and where improvement could have been made. It provided lessons for leaders in healthcare to consider as the vaccination effort across the United States was starting to pick up steam and access to the vaccine was increasing, allowing for more shots into more arms.¹³

4.0 Mass Vaccination Efforts

Mass Vaccination: Global Aspects – Progress and Obstacles begins by describing mass vaccinations as a *blitzkrieg* tactic of eradicating or fighting off an infection disease. Blitzkrieg is a German term meaning “lightning war” and entails utilizing an overwhelming force with an element of speed against an opponent. With vaccines, it is evident that the opponent is the infection and the tactics employed by mass vaccination efforts work to protect the population with speed and precision so as to decrease the mortality rate associated with the pathogen.¹²

Other than the rollout of the smallpox vaccine, the vaccine for poliomyelitis (synonymous with polio) was also renowned for having an effective mass vaccination program associated with it. Starting with the inactivated poliovirus vaccine (IPV) created by Jonas Salk and continuing with the oral poliovirus vaccine (OPV) created by Albert Sabin, mass vaccination efforts were the primary method of administration in order to accomplish a complete eradication of the virus. For the sake of success and effectiveness, the WHO chose went with the OPV because it did not need trained professionals to administer it, it was considered to have decreased community transfer, and it held the potential to pass on immunity to those who came in contact with the vaccinated. This would allow the population to reach a state of protection sooner than anticipated.¹¹

With regard to these mass efforts, there was much planning that needed to be done, including determining where the clinics were to be held and when they would be held, as polio pandemic periods typically occurred during a certain time of the year. With the approval of the IPV, schools, churches, and workplaces became the primary sources for these mass vaccination efforts. However, when the OPV received approval after massive testing and success was

conducted in the Soviet Union, the manner in which mass campaigns were conducted shifted, as the ability to administer such vaccines became less of a hassle.

“Sabin Oral Sundays” as they became known, were a series of consecutive Sundays in 1960 where thousands lined up across the city of Cincinnati in order to receive the OPV. This milder manner of administering the vaccine created a world of difference for children, and even led to the writing of the song *A Spoonful of Sugar*, which was made popular by the movie *Mary Poppins*.¹⁴ As stated, the OPV had many advantages over the IPV and therefore was used throughout the world in order to assist with polio eradication. The way it was chemically structured gave it a slight advantage over the IPV, but it also had a much more serious side effect of *vaccine associated paralytic poliomyelitis (VAPP)*. From the 1990s onwards, IPV was, and still is, the primary vaccine used to vaccinate against the poliovirus.⁹

The efforts to vaccinate large populations with the polio vaccine could be classified into three separate approaches: 1) national events, 2) specialized events in areas that were suffering more than others and lacked adequate access to the vaccine, and 3) clean-ups, or in other words, finding the remaining small-sized populations who require vaccination to prevent any additional transmission of the virus.

For the most part, efforts involved parents and guardians bringing children to locations that had been setup in communities, as this provided the easiest of administrations and allowed health officials to direct and dictate the processes. However, more endemic areas were at a disadvantage as they did not have healthcare professionals or volunteers readily available, which meant that they could not attend the fixed-sites that existed. They had to rely on the alternative method, which involved going from house to house, which is part of the reason the OPV was more effective in

helping combat the virus. It could be administered by a lay person after some quick training and did not need a needle to be effective. ¹⁵

5.0 Mass Vaccination Efforts and the COVID-19 Pandemic

Although there is not much published, peer-reviewed literature available regarding the steps taken to conduct mass vaccination clinics during the COVID-19 pandemic, a brief search provides extensive new reports of instances where ingenuity was utilized to provide seamless vaccination efforts. Across the United States, health systems partnered with local, state, and federal health departments to coordinate vaccine clinics and administer as many doses as possible. Furthermore, there was coordination with movie theaters, sports teams, convention centers, malls, and many others to identify locations for clinics to be hosted. One peer-reviewed article published in the *New England Journal of Medicine* (Goralnick et. al) discussed certain instances of ingenuity across the country.¹³ Goralnick et. al cited Gillette Stadium in Boston hosting a vaccine clinic and how a Chick-fil-A manager utilized their experience with drive-thru service to assist in the coordination of a clinic in South Carolina. Upon conducting another search, there was more data identified, including commentary regarding a drive-thru clinic hosted by UHealth in Colorado, which at the time of the event, was the largest vaccination effort in the United States.¹⁶

As part of my practicum at Allegheny General Hospital and Allegheny Health Network (AHN), I was exposed to this innovative aspect from an early phase. Leaders from across the network and a variety of backgrounds, pooled together in order to determine what would be the most effective and safest way to vaccinate the people of Western Pennsylvania. By assessing their methods and techniques, it is clear to see that they utilized similar practices to what was used in the mid 1900s during the polio epidemic. However, in 2021, there are much more resources and much better technology available to help coordinate such efforts. Using their affiliation with the Pittsburgh Pirates organization, AHN leaders met with those in charge at PNC and determined that

to being hosting mass vaccination clinics at the stadium until at least the baseball season began. However, this was only the start for AHN and myself on what would be an experience that only few will ever witness.

From PNC Park, AHN collected motivation and began partnering with local businesses with large gathering spaces in order to host their clinics. Dick's Sporting Goods offered their headquarters, the Monroeville Convention Center opened its doors, and soon after, churches and offices across Western Pennsylvania began hosting pharmacists, nurses, physicians, and other healthcare providers to administer the vaccine. AHN also made an effort to partner with organizations that would allow them to vaccinate those who did not have access to the vaccine otherwise.

Nevertheless, as prepared as some may be, there is always the opportunity for things to go wrong, which is what happened for other systems seeking to conduct mass clinics. One of the biggest challenges that was identified during the rollout of the COVID-19 vaccine was not only the temperature storage requirements for the vaccine, but rather it was more so the availability of the vaccine altogether. States varied in their ability to acquire supply and the demand was certainly greater than the supply. As health systems were vaccinating patients, there was a sense of uneasiness as at times, as there was no guarantee that a second dose would be available for a patient in the time frame they had expected. The primary issues were not delays in vaccine administration or reactions to the vaccine itself, but rather something that was completely out of the control of the vaccinators and healthcare leaders who had made it a goal to protect the public.

6.0 Impact on Public Health Practice

The work of implementing and optimizing mass vaccination clinics has led to changes in how public health departments can operate in some respects. First, public health departments no longer have to operate independently in order to provide urgent and necessary care in the form of vaccinations during a pandemic. Health systems have established that they have the (arguably larger) bandwidth to support such efforts without impacting their ability to operate and provide patient care. However, collaboration between the two serves as an even better tool and allows a flow of various resources to go back and forth between each organization.

Further, there will soon be an increase of published literature that provides strategies on how mass vaccination clinics operated at various sites across the world. The sharing of this information will allow for an optimization in the process relative to the available resources. This will allow health systems and public health departments to better understand and determine their role in impacting public health and how they can best use their resources to provide vaccinations or other forms of medical treatment in case of any outbreak or situation.

The increase in available literature will also allow organizations to assess their operations for other initiatives that they may not have utilized in a long time, thus allowing them to reassess and evaluate their processes in order to ensure there is no lag time involved when their services are needed.

As with the positives, there come negatives and one particular instance is that of vaccine hesitancy. The faster rollout of the COVID19 vaccine certainly provided individuals with reasons to be hesitant about receiving it. They questioned the safety and efficacy and claimed that it would not matter whether they received it or not. As time has gone on and more data is released, the

uncertainty these individuals possess only increases and their willingness to accept the vaccine decreases. This is a detriment to public health because they are refusing a preventative medication that would significantly decrease their likelihood of contracting COVID and staying out of the hospital due to COVID. Furthermore, they can also serve as carriers of the virus and pass it on to many at-risk populations, perhaps causing them to become sick and end up in the hospital.

Moving forward, the goal should be to ensure that public health officials and providers within healthcare systems work with the public to educate and provide clear information regarding the safety and efficacy of new vaccines. It is unfair to certain individuals to classify them as irresponsible for not accepting a vaccine if they truly do not understand what studies are evaluating or what the benefit to them is. There needs to be more work done in effectively communicating to the general public as their comprehension of complex medical topics is not the same as a health official.

7.0 Conclusion

Although there has never been a perfect guideline to conducting mass vaccinations throughout history, the unfortunate reality is that enough pandemics that require them have occurred, especially since the turn of the century. As international and local health organizations alike look to the future, their focus should be on assessing the availability of a multitude of things including vaccine, supplies, volunteers, healthcare providers, sites, and technological resources. However, with interruptions in supply chain, as experienced with COVID, institutions need to be readily able to adapt and plan appropriately. Additionally, if a vaccine does not already exist for an infectious pathogen, additional planning must be expected to be completed if there is any hope to maintain a constant flow of vaccinations into patients' arms.

COVID brought with it many learning opportunities for a multitude of reasons, however for the purpose of this essay, it provided us with the ability to better plan for the occurrence of a pandemic, with the hopes that it never happens again. Moving forward, the goal of healthcare institutions, both public and private, should be to ensure that plans are constantly updated and assessed for feasibility and that community relationships are maintained, as infectious pandemics can run rampant very quickly and affect the lives of countless individuals.

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