

# Vaccines: From Smallpox To Coronavirus

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**Abstract—** This article provides a historical view of vaccines. It begins with the smallpox vaccine and extends to the race for approval and distribution of the coronavirus vaccine. The Health Belief Model undergirds this article as a decisionmaking mechanism for the health conscious consumer. Vaccine myths, facts and perspectives are also presented.

**Keywords-** (smallpox, coronavirus, vaccine, Jenner, efficacy)

## I. INTRODUCTION

Vaccines represent the height of success stories in public health. Through the use of vaccines, the effects of many diseases have been minimized or eradicated. Some of the diseases include diphtheria, measles, smallpox, and whooping cough.<sup>1</sup> Safe, affordable and effective vaccines have also helped to contain conditions such as polio and rubella – which were major threats little more than a century ago.<sup>2</sup>

Today, the need for another vaccine has emerged: coronavirus. Recent statistics show that there are 12,777,371 cases of coronavirus in the United States of America – with 263,687 deaths.<sup>3</sup> The numbers are staggering since the first death early in the year of 2020.<sup>4</sup> On Labor Day 2020, September 7, 2020, it was reported that about 26,000 individuals contracted coronavirus per day. Currently, November 2020, the daily number of individuals contracting the disease is about 170,000 per day. There are also approximately 88,000 individuals hospitalized in the United States with the coronavirus.<sup>5</sup>

## II. HISTORY OF VACCINES

Edward Jenner is at the forefront of the history of vaccines. Modern vaccine history began in the late 18<sup>th</sup> century with the discovery of smallpox vaccine by Edward Jenner. This discovery led to progress in the prevention of infectious diseases with inactivated vaccines including typhoid, plague and cholera.

As the knowledge of microbiology grew through the 20<sup>th</sup> century, rapid advances for the prevention of polio, varicella, influenza and other diseases occurred.<sup>6</sup>

Louis Pasteur's 1885 rabies vaccine also made an impact. And then with the emergence of bacteriology, developments rapidly followed for such diseases as diphtheria, tetanus, anthrax, tuberculosis and more through the 1930s. In the middle of the 20<sup>th</sup> century, laboratory vaccines lead to vaccines for measles, mumps and rubella. Edward Jenner, Louis Pasteur were great pioneers in the development of vaccines.<sup>7</sup>

Due to vaccines, infectious diseases have decreased – along with their debilitating effects. The value of vaccines far exceeds the risks.<sup>8</sup>

## III. CORONAVIRUS HISTORY

SARS CoV-2, that causes COVID-19 was first detected in Wuhan, China in late 2019. Experts say SARS CoV-2 originated in bats. SARS CoV-2 made the jump to humans at one of Wuhan's open air "wet markets".<sup>9</sup>

Others have linked the origin of the coronavirus to bats, chicken, camels, and cats – with the first discovery in chickens in the 1930s.

The vast majority of individuals in the United States of America are still vulnerable to the coronavirus.<sup>10</sup> Therefore, the recent coronavirus vaccines are potentially life saving discoveries.

## IV. THEORY - HEALTH BELIEF MODEL

The Health Belief Model appeared in the 1950s as a guide to research on tuberculosis screening. It is an expectancy value model. The model also stresses decisional balance.

Limitations of the model are noted in relation to habit forming behaviors.<sup>11</sup>

Key elements of the Health Belief Model focus on individual beliefs about health conditions, which predict individual behaviors. The model defines the key factors that influence health behaviors as individual's perceived threat to sickness or disease (perceived susceptibility), belief of consequence (perceived severity), potential positive benefits of action (perceived benefits), perceived barriers to action, exposure to factors that prompt actions (cues) and confidence in ability to succeed (self efficacy).<sup>12</sup>

This model supports the individual's quest to determine the value of a new vaccine – based on perceived benefits vs. threats.

## V. APPROVAL OF A VACCINE /

### VACCINE MYTHS

Before approval of vaccines by the Food and Drug Administration (FDA), scientists test them to make sure that they are safe and effective. Vaccines are the best defense against infectious diseases, but no vaccine is 100% safe or effective – since everyone's reaction to vaccines may differ.<sup>13</sup>

Despite the potential benefits of vaccines, some individuals have been reluctant to become vaccinated. Some of the myths associated with vaccines are as follows:

- .Vaccines cause autism.
- .Natural immunity is better than vaccine-acquired immunity.
- .Vaccines contain unsafe toxins.
- .Vaccines are not worth the risk.<sup>14</sup>

## VI. CDC VACCINE RECOMMENDATIONS

Some of the vaccines that the United States Centers For Disease Control (CDC) recommends are as follows:<sup>15</sup>

DTap – which prevents diphtheria, tetanus, pertussis

Hepatitis A – vaccine for acute viral disease that primarily affects the liver

Hepatitis B – vaccine for an acute liver disease

Hib- Haemophilus Influenza Type b – vaccine that helps prevents meningitis, pneumonia, bacteremia

HPV – Human Papillomavirus – a sexually transmitted disease linked to cancers in the female reproductive system

Influenza – vaccination for an air borne infection called the flu

MMR – vaccine that prevents measles, mumps and rubella

Meningococcal – vaccine that prevents the respiratory disease: meningitis Polio – vaccine that prevents polio, an infection caused by a virus that originates in the throat and intestinal tract

Shingles – vaccine that helps to prevent a skin condition caused by the herpes zoster virus that has been linked to exposure to varicella (chickenpox)

The CDC has recently expressed support for coronavirus vaccines as several companies are seeking emergency administration approval through the Food and Drug Administration.

## VII. CORONAVIRUS VACCINES

A race to develop coronavirus vaccines is underway to protect global citizens. United States news outlets report that public health officials must be transparent about any side effects of the coronavirus vaccines.<sup>16</sup>

While many companies are conducting clinical trials for a coronavirus vaccine, three companies have reported high efficacy rates in phase three of their clinical trials: AstraZeneca, Moderna and Pfizer.

AstraZeneca has reported 70% efficacy in preventing disease in large scale trials developed with the University of Oxford.<sup>17</sup> In one dosing scheme, Astra Zeneca's efficacy was 90%. AstraZeneca says about 3 billion doses could be ready in 2021. Results follow more than 23,000 people vaccinated in the United Kingdom and Brazil. No serious safety or issues have been documented. Standard refrigeration is required for the vaccine at a cost of \$3 - \$4 per dose.<sup>18</sup> AstraZeneca has been heralded as the cheaper vaccine – which is easier to transport. Two doses are required.

Moderna reports 95% effectiveness in its coronavirus vaccine partnership with the National Institute of Allergy and Infectious Diseases.<sup>19</sup> The UK will have 5 million doses by the spring of 2021. The

vaccine needs to be frozen at -20 C and can be stored for up to six months. 30,000 individuals have been involved in the Moderna trials – with half getting the vaccine and others getting an injected placebo.<sup>20</sup> Moderna may charge \$15.25 - \$25 per dose. Freezer storage and transport will be needed to prevent the RNA and the lipid particle that hold it together from degrading.<sup>21</sup>

Pfizer/BioNtech is seeking authorization for emergency use of its vaccine through the Food and Drug Administration (FDA). The vaccine has a 95% efficacy rate in Phase 3 of its clinical trial. Solicited safety data included 8,000 randomized participants: 38,000 participants in unsolicited safety data and some children in the trial (ages 12 – 15).<sup>22</sup> The Pfizer/BioNtech vaccine needs to be stored at -70C.<sup>23</sup> Pfizer and BioNtech will continue to monitor its participants in its multi-site / multi-national study. The estimated cost of the vaccine is \$19.50.

The United States Government has also initiated a free vaccine program at CVS and Walgreens for senior. The program will be available to seniors in skilled nursing home facilities, assisted living facilities, residential care homes and adult family homes.<sup>24</sup>

Other coronavirus trials are also being conducted by other companies in Russia, China and the United Kingdom.<sup>25</sup>

#### VIII. PERSPECTIVES ON THE CORONAVIRUS VACCINE

Through casual conversation, individuals that I have spoken to have expressed relief that coronavirus vaccines will be available soon – through widespread distribution. While they are anxious to resume their normal routines, they are not anxious to be among the first recipients of the vaccine. New accounts have reported that the initial vaccine recipients will likely include first responders, healthcare workers, governmental personnel, prison personnel and others.

Before vaccines are licensed by the FDA they are tested in the laboratory, in animals and then in humans.<sup>26</sup>

Traditionally, vaccine licensing could take 10 years or longer via three phases:

Phase 1 – 20 – 200 volunteers for a few months to evaluate basic safety.

Phase 2 – large numbers of volunteers to several hundred – for several months to a few years to determine doses needed and reactions.

Phase 3 – several hundred to several thousand volunteers - for several years with comparisons and controls.<sup>27</sup>

Many individuals have some concerns about potential long term side effects of the coronavirus vaccine. The number of doses or price may not be issues of constraint. As federal approval is being sought and distribution plans are being formalized, individuals will have more time to determine whether they will accept the coronavirus vaccination. Professionals have stressed the importance of vaccine acceptability (vaccinations) to eliminate the coronavirus. Experts estimate that 60-70% of the global population must be immunized to stop the virus from spreading easily.<sup>28</sup>

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