Analysis of which Demographic Should be Vaccinated for COVID-19, Specifically in New York City and Los Angeles

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COVID-19 Data Project: Special Projects

Abstract

As research regarding COVID-19 treatment and prevention continues, the success of these efforts is truly dependent on global coordination and access to treatment. Using reference millennial populations, 18-44 years old, from New York City and Los Angeles, we examine the importance and necessity of a vaccine in response to SARS-Cov-2 pandemic, while researching novel vaccine production, such as mRNA vaccine clinical trials.

COVID-19 Overview

In March 2020, the WHO declared COVID-19 a pandemic, with the novel SARS-Cov-2 virus as the etiologic agent. COVID-19 is characterized by causing severe acute respiratory syndrome, with symptoms ranging from mild to severe, leading to death. The outbreak began in Wuhan, China with the modes of infection being direct and indirect transmission. As the infection continued to spread across the global, research showed that the virus spreads from person to person through viral droplets and instances through inanimate vehicles such as plastic, cardboard, and metals.[1]

The COVID-19 infection has an incubation period of about 48 hours, and symptoms onset between 2 to 14 days after exposure to SARS-Cov-2 virus.[2] Most common symptoms include shortness of breath, fever and cough. Individuals can be asymptomatic as well, showcasing that the virus may be latent in infection.[2] All populations are highly susceptible in contracting the virus due to the ease of spread and its sustainability between individuals. However, older populations and individuals with comorbidities are more susceptible to an infection resulting in severe symptoms and death. Currently there is no vaccine available for preventing COVID-19.

The United States has predominantly been affected by the pandemic, with over 3.3 million confirmed cases and roughly 135,000 deaths due to COVID-19, as of July 13th, 2020.[3] New York City being the first greatly affected geographic region for the pandemic in the U.S., had 6,378 cases and 597 deaths at its peak.[4] While, in Los Angeles the first wave of cases and deaths of the pandemic is arising as seen in **Figure 1**. Both regions are cities with a big population and showcase the virus' quality of high infection rates in comparison to the the death rates. Also, for NYC the peak number of deaths occur within the same time frame as the peak number of cases. For LA, the peak number of deaths occurred prior to the peak number of cases. This may be due to the time frame selected for analysis and does not account for the number of deaths that occurred after July 7th, 2020.

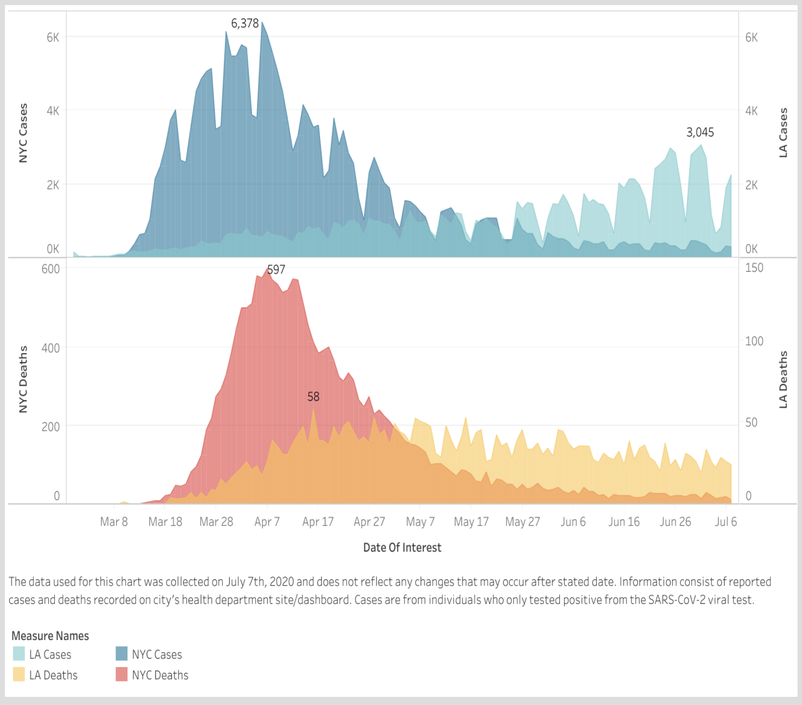

Figure 1. *COVID-19 Cases and Death for NYC and LA Between February 29th and July 7th, 2020.* Color shows daily count of cases and deaths for NYC and LA individually, with maximum value noted.
Note: Data obtained from LA County Department of Health COVID-19 Dashboard and NYC Department of Health COVID-19 [4,5]

Age Epidemiology in NYC and LA

In New York City and Los Angeles, COVID-19 has had disproportionately affected individuals over 65 years old, not with infection rates but with case-fatality rates as depicted in **Figure 2.** A majority of those infected with COVID-19 are between the ages of 18 and 64, but the highest case-fatality rate exists among those who are over 65. While the case fatality rates are higher in New York City, there is a similar trend in largest case fatality rates and a low case count among older adults in both cities. In Los Angeles, those over 65 years old, as of July 7, 2020 had a case-fatality rate of 17.28%, while individuals ages 18 to 40 had a case-fatality of 0.21%. While compared to adults over 65 in New York City, this cohort had a case-fatality of 36.46% and individuals between the ages of 18 to 44 had a case fatality of 0.91%. This increased case-fatality can be attributed to a decline in immune system function as a person ages.

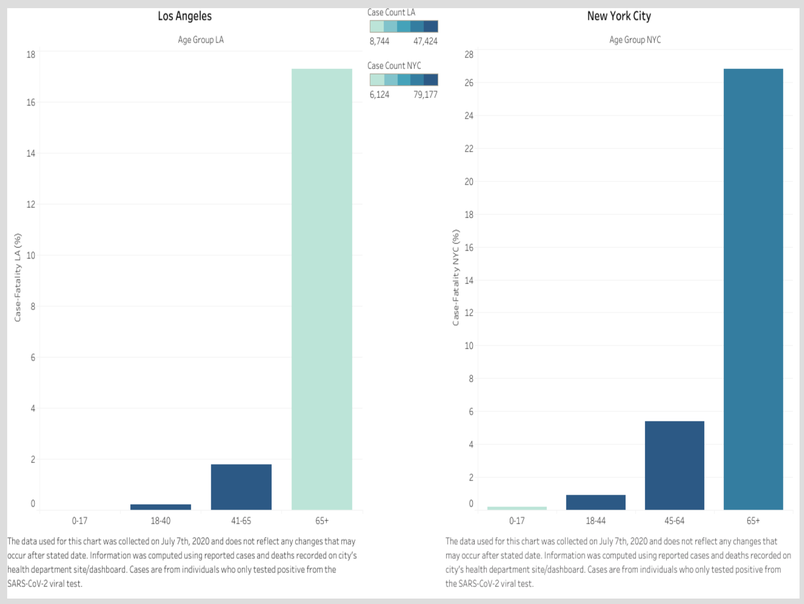

Figure 2. Age Distribution of COVID-19 Case Fatality Rates from February 29, 2020 to July 7, 2020 . Color shows the sum of Case Count for NYC and LA, respectively.
Note: Data obtained from LA County Department of Health COVID-19 Dashboard and NYC Department of Health COVID-19: Data [4,5]

Old Age and Declined Immunity

The elderly have a decreased production in immune cells and therefore cannot respond as adequately to pathogens as younger individuals.[6] This decreased immune function means that older adults are unable to fight off viruses, especially novel viruses such as SARS-CoV-2. This makes older individuals more susceptible to serious disease and complications due to COVID-19, increasing their mortality rate. This weakened immune system also relates to the efficacy and effectiveness of vaccines in older adults[7]. Because there is no existing vaccine for coronaviruses, the influenza vaccines will be used as an example. Influenza vaccines in the elderly are less effective because antibody responses are lower than the antibody response in young adults. Protection against influenza in those ages 75 or older is 29%-46% and persons 60 to 74 is 41%-58%.[8] One meta-analysis on influenza vaccine responses concluded that, when adjusting for age, younger adults (ages 17 to 59) had a 2 to 4 times greater immune response than the elderly[9].

Since vaccines are most effective in younger individuals and COVID-19 has a larger infection rate among younger individuals, a COVID-19 vaccine should target the younger age group. When vaccinating younger adults, herd immunity can develop and will help to protect the elderly while using the limited resources to provide immunity to those who will respond the best. However, deciding who should be vaccinated first depends on the type of vaccine developed and the outcomes of clinical trials conducted.

COVID-19 Vaccine Clinical Trials

As of early April 2020, the research and development landscape for clinical trial activity includes 115 vaccine candidates, 78 confirmed as active while 37 remain unconfirmed or undetermined.[11] Of the confirmed 78 active projects, 73 projects are at preclinical stages and moving fast to clinical development.[11] The combination of large multinational vaccine developers and small and/or inexperienced large-scale vaccine manufacturers is important in coordination efforts to meet current global demands.[11] Currently, treatment is focused on RNA polymerases as adaptation of SARS-CoV-2 readily occurs creating frequent mutations and recombination events.[13] Moderna, one of the 78 large scale multinational vaccine developers introduced a Phase 1, open label trial targeting the RNA protein, mRNA-1273, modeled in **Figure 3.**[14] A novel lipid, mRNA-1273 is a nanoparticle (LNP)-encapsulated mRNA-based vaccine which encodes full-length, prefusion stabilized spike protein of SARS-CoV-2.[14] Implementation of a variety of trials are all in effort to report safety, immunogenicity, reactogenicity, and tolerability of proposed vaccinations.[14,15] In addition to efficacy assessments, trials will examine the vaccine's safety in healthy adult volunteers with ranging eligibility criteria per clinical trial.[11]

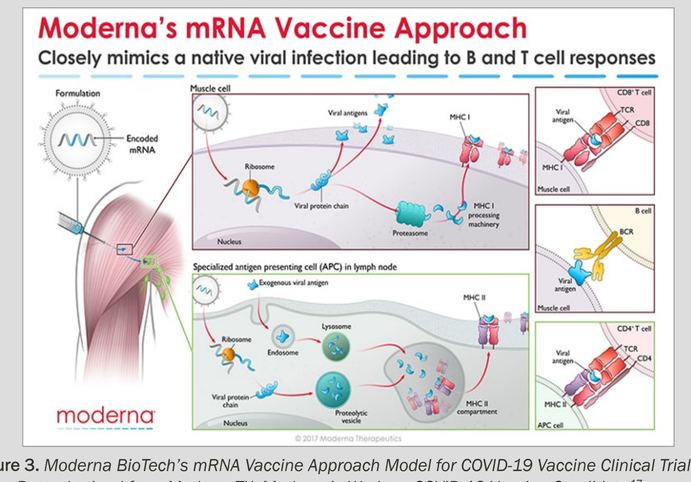

Figure 3. *Moderna BioTech's mRNA Vaccine Approach Model for COVID-19 Vaccine Clinical Trials*
Note: Data obtained from ModernaTX, Moderna's Work on COVID-19 Vaccine Candidate[17]

COVID-19 Vaccine Production Summary

The efforts being made in vaccine production should follow three general rules; manufacture and deployment at scale, speed, and global access.[10] These imperative rules are a far cry from traditional vaccine development, which on average can take over 10 years from start to finish, even in comparison to the first Ebola vaccine created in a 5-year accelerated timeline.[11] Although costly in production, CEPI estimating the development of up to three vaccines in a span of a year will require an investment of roughly 2.0 billion U.S. dollars.[10,16] This rapid progress in production within the pharmaceutical industry clearly demonstrates the commitment and active efforts in protecting people at home and abroad.

Conclusion

The outlook of COVID-19 vaccination seems promising due to rapid developments of a vaccine and the industry's and federal government's commitment to creating a vaccine despite the cost. However, with the virus continuously spreading across America and the growing gap in healthcare about this virus and the disease, development of a COVID-19 vaccine is uniquely challenging.

Once a vaccine is developed and released, the process of vaccinating the population is the next challenge. When looking at New York City and Los Angeles, the statistics show that the elderly is the demographic that is predominantly affected with a higher risk of death than other age groups. On one hand, this demographic should receive the vaccine first but with great potential for a decline in immunity as one ages, vaccinating the elderly may result in more adverse effects. The prime demographic to be vaccinated are individuals aged 18-40 years old since they are the group with the highest infection rates while having low mortality rates, as seen in New York City and Los Angeles. In other words if this group was vaccinated, they could help produce herd immunity and protect those who are at a higher risk of dying from COVID-19. However, there is much research that needs to be conducted to better understand COVID-19 and the virus and develop a vaccine that works best for preventing the disease, in order to determine what is the best suited vaccination process for the U.S.

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