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The COVID-19 Pandemic

Science, Technology, and the Future
of Healthcare Delivery

 Springer

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Preface

The COVID-19 pandemic caused millions of deaths and upended the global economy. It is critical that we learn from this tragic period of time and provide a view of the landscape through which the pandemic drove, an overview of the science and technology that helps us understand the trajectory of the pandemic. Genomics, epidemiology, and health care throughout the COVID-19 pandemic, its virus, and pathogenicity are included. How the virus impacted and continues to affect our healthcare system and economy is discussed. Simulation modeling used to predict spread of the virus and risk of infection in America and globally, and the critical role of communication in pandemic response, provides an understanding of the landscape of the pandemic.

Synthetic biology was employed to develop and produce effective diagnostics that were rapidly deployed, with vaccine development in unlimited quantity a colossal achievement. US and global production of vaccine was unparalleled in human history. Most importantly, treatment of patients infected with the virus using telemedicine and virtual reality for remote intensive care settings introduced a whole new layer of medical care. Biotechnology played a major role in the COVID-19 pandemic response, with many advances in engineering sciences introduced.

The virus itself was analyzed and described in exacting detail. A broad overview of biodefense, closely coupled to this and earlier pandemics in human history, lays bare the cascading of potential subsequent pandemics threatening future human populations and provides a foundation for understanding the relentlessness of pandemics. Internationally, individual countries responded to COVID-19 uniquely, providing more information about pandemic response, including Vietnam, Afghanistan, and China, all of which present unique roles that they played. As would be expected, variants of the virus created the need for variable responses, hence chronology of the pandemic is detailed, highlighting the many factors at play.

Robotics and artificial intelligence, new technologies still developing, were introduced during COVID-19's relentless global spread and now are being incorporated into contemporary practice of medicine and applications for improving public health. The development of mRNA vaccines and their role in synthetic biology have become contemporary technologies. All of these novel applications are key for future healthcare systems, based essentially on the defense highway system, the Koop healthcare system, named for the former surgeon general who played a significant role in the conception of this dynamic system that is adaptable to future

pandemics. It integrates health care across all 50 states, territories, and tribal areas, helping us prepare a more effective response to the next, inevitable pandemic. The economics of the pandemic, from the perspective of the world bank, and the resilience and its role in preparing communities to respond to the pandemic are included.

Finally, disinformation having played a crucial role in the COVID-19 pandemic is discussed in this overview of COVID-19. In summary, the chapters in this book, as intended, provide a comprehensive and multidimensional view of the COVID-19 pandemic. We hope it will prove informative for our readers.

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The COVID-19 Timeline

Dec. 31, 2019:

The World Health Organization (WHO) Country Office in China translated a statement released by the Wuhan Municipal Health Commission regarding cases of “viral pneumonia.” The office contacted the International Health Regulations (IHR) center at the WHO Western Pacific Regional Office.

Around the same time, evidence of cases of “pneumonia of unknown cause” in Wuhan was discovered through a media report on ProMED, a program by the International Society for Infectious Diseases, by WHO’s Epidemic Intelligence from Open Sources platform (“Pneumonia of Unknown Cause—China” 2020).

Dec. 31, 2019:

WHO China Country Office was directly informed of cases of pneumonia of unknown cause in Wuhan, and all the cases were connected to the Huanan Seafood Wholesale Market in Wuhan (“CDC Museum COVID-19 Timeline” 2022).

Jan. 11, 2020:

The first death from “viral pneumonia” was a 61-year-old man in China. The Chinese media’s preliminary lab tests led to the discovery of a new type of coronavirus (Allam 2020).

Jan. 13, 2020:

The first case of the novel coronavirus outside of China was reported in Thailand by the Ministry of Public Health (“WHO Statement on Novel Coronavirus in Thailand” 2020) (“CDC Museum COVID-19 Timeline” 2022).

Jan. 20, 2020:

The first US laboratory-confirmed case of COVID-19 was officially confirmed in the state of Washington through samples taken on January 18 by the Centers for Disease Control and Prevention (CDC). To respond to this outbreak, the CDC activated the Emergency Operations Center (“CDC Museum COVID-19 Timeline” 2022).

Jan. 22, 2020:

During a WHO emergency meeting in Geneva, Director-General Dr. Tedros Adhanom Ghebreyesus stated, “Make no mistake, though, this is an emergency in China. But it has not yet become a global health emergency. It may yet become one.” Human-to-human spread of the novel coronavirus was confirmed by the WHO (“Statement on the Meeting of the International Health Regulations...” 2020).

Jan. 23, 2020:

China announced a lockdown in Wuhan (Feng 2021).

Jan. 23, 2020:

WHO held an Emergency Committee meeting under the International Health Regulations where representatives from South Korea, Thailand, China, and Japan discussed the coronavirus cases in their countries. China reported 557 cases total on this date (“Statement on the Meeting of the International Health Regulations...” 2020).

Jan. 27, 2020:

A Level 3 travel advisory was issued by the U.S. embassy in China to reconsider travel due to the coronavirus. Health officials in China had reported thousands of cases throughout the country (“China Travel Advisory: Level 3 – Reconsider Travel (28 Jan 2020)” 2020).

Jan. 27, 2020:

A press release was issued by the WHO regional director for Southeast Asia, urging countries in the region to prepare for increased detection of cases to prevent further spread (“WHO Calls for Urgent, Aggressive Actions...” 2020).

Jan. 27, 2020:

The CDC advised all travelers to cease nonessential travel to China (“CDC Advises Travelers to Avoid All Nonessential Travel to China” 2020).

January 27, 2020—12,545 cases globally

January 28, 2020—100 deaths globally

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Jan. 30, 2020:

WHO Director-General Ghebreyesus officially declared a public health emergency of international concern from the coronavirus outbreak (“Statement on the Second Meeting of the International Health Regulations...” 2020).

Feb. 1, 2020:

Four countries—the United States, Singapore, Russia, and Australia—all banned foreign travelers that recently traveled in China (“Timeline-How the Global Coronavirus Pandemic Unfolded” 2020).

Feb. 2, 2020:

The first coronavirus death outside of China was reported in the Philippines, and China's total cases rise to over 14,000 (Schnirring 2020).

Feb. 2, 2020:

The first Polymerase Chain Reaction (PCR) lab kits were shipped to the WHO Regional Offices ("Timeline: WHO's COVID-19 Response" 2022) ("Coronavirus disease (COVID-19) Situation Report 1 Philippines" 2020, p. 3).

Feb. 5, 2020:

The Diamond Princess cruise ship held 3700 passengers that had to quarantine for nearly a month after over 700 passengers tested positive and 14 died ("Timeline-How the Global Coronavirus Pandemic Unfolded" 2020).

Feb. 5, 2020:

WHO held the first daily media briefings by Director-General Dr. Tedros Adhanom Ghebreyesus ("Timeline: WHO's COVID-19 Response" 2022).

Feb. 7, 2020:

A Chinese whistleblower, Dr. Li Wenliang, died from the coronavirus (Lee 2020).

February 10, 2020—1,000 deaths globally
("WHO Coronavirus (COVID-19) Dashboard" 2022)

Feb. 11, 2020:

The coronavirus was officially named COVID-19 by the WHO. Director-General Tedros Adhanom Ghebreyesus explained that the "CO" stands for "corona," the "VI" stands for "virus," the "D" for "disease," and the "19" is for the identified year of 2019 ("WHO Director-General's Remarks..." 2020) ("Naming the Coronavirus Disease..." 2019).

Feb. 25, 2020:

An update on COVID-19 as well as the CDC's COVID-19 response to America was presented by the CDC ("Transcript for the CDC Telebriefing Update on COVID-19" 2020).

Feb. 25, 2020:

A COVID-19 case was reported in Egypt making it the first in Africa. Following this, the second case in WHO's African Region was confirmed in Algeria. The regional director for Africa urged all countries in the continent to step up their readiness for the virus ("A Second COVID-19 Case Is Confirmed in Africa" 2020).

February 29, 2020—1st death in the United States
("WHO Coronavirus (COVID-19) Dashboard" 2022)

March 1, 2020:

Both King County and the United States marked their second COVID-19 death (Hudetz 2020) (“Public Health Confirms Two More COVID-19 Cases...” 2020).

March 7, 2020:

WHO released a statement of action to delay, contain, control, reduce, and stop the impact of COVID-19 at every opportunity as the number of global cases surpasses 100,000 (“WHO Statement on Cases of COVID-19 Surpassing 100 000” 2020).

March 19, 2020:

California governor Gavin Newsom issued a stay-at-home order (“Governor Gavin Newsom Issues Stay at Home Order” 2020).

March 20, 2020:

Governor Andrew Cuomo of New York issued guidance on essential services under his “New York State on PAUSE” executive order (“Governor Cuomo...” 2020).

March 20, 2020—10,000 deaths globally

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

March 24, 2020:

The 2020 Olympics were delayed in a joint statement from the International Olympic Committee and the Tokyo 2020 Organizing Committee (“Joint Statement...” 2022).

March 26, 2020:

The CARES Act, which stands for Coronavirus Aid, Relief, and Economic Security, was passed by the U.S. Senate, providing \$2 trillion in aid to small businesses, hospitals, and both local and state governments while eliminating the Medicare sequester from May 2020 to December 31, 2020 (“CDC Museum COVID-19 Timeline” 2022) (“H.R. 748...” 2021).

April 2, 2020: Worldwide cases reach 1 million

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

April 7, 2020:

A report from the Chicago Tribune noted that 68% of the COVID-19-related deaths in Chicago occurred among the city’s African American community, illuminating racial disparities of the pandemic in the United States (“CDC Museum COVID-19 Timeline” 2022) (Kim and Bostwick 2020) (Unruh et al. 2022).

April 8, 2020:

The 11 million citizens of Wuhan were able to leave their homes after months as the city reopens (“Timeline-How the Global Coronavirus Pandemic Unfolded” 2020) (“Wuhan’s Lockdown Lifted” 2020).

April 8, 2020:

The United Nations created a COVID-19 Supply Chain Task Force to scale up the production of personal protective equipment, oxygen, and lab tests for countries in need (“WHO Director-General’s Opening Remarks...” 2022).

April 8, 2020:

The U.S. Health and Human Services announced the first contract for ventilator production goes to General Motors under the Defense Production Act (“CDC Museum COVID-19 Timeline” 2022).

April 9, 2020—100,000 deaths globally

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

April 13, 2020:

Restrictions began to ease in multiple European countries. Manufacturing and construction resumed in Spain, stores began to reopen in Italy and Austria, and schools returned for Danish children (Brandon 2020).

April 13, 2020:

One hundred thirty scientists, manufacturers, funders, and other stakeholders published a statement committing to working together with the WHO to develop a vaccine quickly against COVID-19 (“Public Statement for Collaboration on COVID-19 Vaccine Development” 2020).

April 13, 2020:

President Trump announced that the United States will stop funding to the World Health Organization, alarming the public health community (“CDC Museum COVID-19 Timeline” 2022).

April 24, 2020:

President Trump said that scientists should explore whether injecting disinfectant might help COVID-19 patients. Physicians worry people will poison themselves with bleach (“President Trump on ‘Injecting’ Disinfectants” 2020).

April 24, 2020:

Despite health experts warning against reopening states too early, the states of Georgia, Alaska, and Oklahoma began to reopen (“CDC Museum COVID-19 Timeline” 2022).

May 11, 2020:

A team of patients published the results of the first survey of “long COVID” symptoms. They reported more than 50 symptoms, including cognitive impairment and fatigue (McCorkell et al. 2020).

May 13, 2020:

The WHO warned that COVID-19 could become endemic like HIV and never go away. WHO emergencies expert Mike Ryan told an online briefing: “It is important to put this on the table: this virus may become just another endemic virus in our communities” (COVID-19 Virtual Press conference” 2020, p. 21).

May 14, 2020:

The United Nations warned of a looming mental illness crisis as millions of people were surrounded by death and disease and forced into isolation, poverty, and anxiety (“COVID-19 and the Need for Action on Mental Health” 2020).

May 15, 2020:

The White House announced Operation Warp Speed as a national effort to accelerate the development, manufacturing, and distribution of COVID-19 medical countermeasures (MCMs) (“Remarks by President Trump on Vaccine Development” 2020).

May 21, 2020: Worldwide cases reach 5 million

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

May 22, 2020:

Brazil overtook Russia to become the No. 2 in global cases while the United States stayed at the No. 1 spot (“Brazil...” 2022) (“India...” 2022) (“United States of America...” 2022).

May 28, 2020—100,000 deaths in the United States

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

(“CDC Museum COVID-19 Timeline” 2022)

May 29, 2020:

President Donald Trump claimed he was ending the United States’ relationship with WHO because of the organization’s poor handling of the COVID-19 outbreak. He also accused the UN agency of becoming a puppet organization of China (“Timeline-How the Global Coronavirus Pandemic Unfolded” 2020) (“Remarks by President Trump on Actions Against China” 2020).

May 29, 2020:

The COVID-19 Technology Access Pool (C-TAP) was launched by 30 countries and international partners, to increase access to vaccines, tests, and treatments for all people (“WHO and MPP Welcome NIH’s Offer...” 2022).

June 8, 2020:

New Zealand lifted all social and economic restrictions except border controls, one of the first countries to return almost to pre-pandemic normality (Menon 2020).

June 8, 2020:

The World Bank predicted that COVID-19 will cause the worst global economic recession since World War II (“COVID-19 to Plunge Global Economy...” 2020).

June 10, 2020:

The number of confirmed cases of COVID-19 hit 2 million in the United States as new infections continue to rise in 20 states (Chappell 2020).

June 15, 2020:

After 83 days of lockdown, England allowed retail stores to reopen (Aspinall 2022).

June 19, 2020:

Brazil’s cases topped 1 million, and deaths approached 50,000, marking its status as the world’s second worst-hit country (“Brazil...” 2022).

June 28, 2020: Worldwide cases reach 10 million

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

June 29, 2020—500,000 deaths globally

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

July 6, 2020:

India reported 700,000 infections, becoming the country with the third highest number of cases, behind the United States and Brazil. (“India...” 2022).

July 6, 2020:

A WHO survey found that 73 countries were at risk of running out of antiretroviral medications as a result of COVID-19. Twenty-four countries had critically low stock (“WHO: Access to HIV Medicines Severely Impacted...” 2020).

July 8, 2020:

Australia’s second-largest city, Melbourne, went back into lockdown (Bungard 2020).

Aug. 5, 2020:

As the global death toll topped 700,000, the WHO said young people must limit their partying instincts to help prevent new outbreaks during part of a live chat with Dr. Michael Ryan (“Live Q&A on #COVID19 with @DrMikeRyan and Dr @mvankerkhove. #AskWHO”, 12:50).

Aug. 6, 2020:

Africa's cases surpassed 1 million, with South Africa accounting for more than half of the caseload ("WHO Coronavirus (COVID-19) Dashboard" 2022) ("South Africa..." 2022).

Aug. 10, 2020:

Brazil's death toll reached 100,000, continuing to climb as cities reopen shops and dining ("Brazil..." 2022).

Aug. 11, 2020:

After less than 2 months of human testing, Russia became the first country to approve a COVID-19 vaccine, called Sputnik V (Burki 2020).

Sept. 7, 2020: WHO

India passed Brazil as the second-worst hit country, with more than 4.2 million cases, and the United States remained the worst affected country ("Brazil..." 2022) ("India..." 2022) ("United States of America..." 2022).

September 22, 2020—200,000 deaths in the United States

("WHO Coronavirus (COVID-19) Dashboard" 2022)

("CDC Museum COVID-19 Timeline" 2022)

Sept. 23, 2020:

Johnson & Johnson (J&J) began trials of a single-shot vaccine that could simplify distribution. Rivals from Moderna Inc, Pfizer Inc, and AstraZeneca all require two shots separated by several weeks ("Johnson & Johnson" 2020) (Routh 2020).

September 28, 2020—One million deaths globally

("WHO Coronavirus (COVID-19) Dashboard" 2022)

Sept. 29, 2020:

COVID-19-related deaths doubled from only half a million in the previous 3 months. The United States, Brazil, and India led in the burden of fatalities ("WHO Coronavirus (COVID-19) Dashboard" 2022).

Oct. 2, 2020:

President Trump tested positive for COVID-19 ("CDC Museum COVID-19 Timeline" 2022).

October 19, 2020—Global cases top 40 million

("WHO Coronavirus (COVID-19) Dashboard" 2022)

Oct. 22, 2020:

The U.S. Food and Drug Administration (FDA) approved Remdesivir, an antiviral, as the first COVID-19 drug (“FDA Approves First Treatment for COVID-19” 2020).

The U.S. reported an unprecedented 100,000 cases in one single day (“United States—COVID-19 Overview—Johns Hopkins” 2022).

Nov. 9, 2020:

The FDA issued Emergency Use Authorization (EUA) for Eli Lilly’s antibody treatment Bamlanivimab. It is authorized for treatment of recently diagnosed, mild to moderate COVID-19 in high-risk patients (“Coronavirus (COVID-19) Update: FDA Revokes...” 2021, para. 2).

November 9, 2020: Worldwide cases reach 50 million

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Nov. 16, 2020:

Moderna announced their preliminary phase three trial data which showed that their coronavirus vaccine has 94% efficacy in preventing COVID-19 (“Moderna’s COVID-19 Vaccine Candidate...” 2020).

Nov. 18, 2020:

The Pfizer-BioNTech vaccine was announced to be 95% effective (“Pfizer and BioNTech Conclude Phase 3 Study...” 2020).

Nov. 21, 2020:

The FDA granted EUA for monoclonal antibody treatment, the second treatment to be approved (“Coronavirus (COVID-19) Update: FDA Authorizes Monoclonal...” 2020).

Dec. 11, 2020:

FDA granted EUA for a COVID-19 vaccine made by Pfizer-BioNTech (“Pfizer and BioNTech Announce New Agreement...” 2022, para. 7).

Dec. 14, 2020:

Nurse Sandra Lindsay became the first person in the United States to receive a COVID-19 vaccine (“Senior UN Official...” 2022).

December 14, 2020—300,000 deaths in the United States

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

January 27, 2021: Worldwide cases reach 100 million

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Dec. 18, 2020:

The FDA issued an Emergency Use Authorization for the second COVID-19 vaccine, the Moderna vaccine (“FDA Takes Additional Action...” 2020).

January 15, 2021—Two million deaths globally

January 19, 2021—400,000 deaths in the United States

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Feb. 15, 2021:

The WHO granted emergency use for the AstraZeneca/Oxford COVID-19 vaccine (“WHO Lists Two Additional COVID-19 Vaccines...” 2021).

February 21, 2021—500,000 deaths in the United States

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Feb. 27, 2021:

FDA approved EUA for Johnson and Johnson’s one-shot COVID-19 vaccine (“Emergency Use Authorization” 2022).

April 13, 2021:

FDA and CDC announced a recommended pause in the administration of the Johnson and Johnson vaccine to investigate six reported cases of blood clots (“Coronavirus (COVID-19) Update: FDA Limits...” 2022, para. 6) (“CDC Museum COVID-19 Timeline” 2022).

April 17, 2021—Three million deaths globally

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

May 10, 2021:

WHO labeled the Delta variant, originally discovered in India in late 2020, as a variant of concern (“COVID-19 Virtual Press Conference Transcript—10 May 2021,” 2021).

June 14, 2021—600,000 deaths in the United States

July 3, 2021—Four million deaths globally

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Aug 4, 2021: Worldwide cases reach 200 million

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Aug. 23, 2021:

The FDA officially approved the Pfizer-BioNTech vaccine for those 16 and older (“FDA Approves First COVID-19 Vaccine” 2021).

Sept. 22, 2021:

FDA approved a booster dose of Pfizer-BioNTech following the two-shot sequence (“FDA Authorizes Booster...” 2021, para. 1).

October 1, 2021—700,000 deaths in the United States

October 5, 2021: Worldwide cases reach 235 million

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Oct. 8, 2021:

Brazil reported more than 600,000 deaths from COVID-19, the second country to do so after the United States (“Brazil...” 2022) (“United States of America...” 2022).

Oct. 11, 2021:

The World Health Organization recommended an additional dose of the vaccine for severely or moderately immunocompromised people (“WHO Advisory Group...” 2021).

Oct. 26, 2021:

FDA voted 17-0 recommending Pfizer-BioNTech’s COVID-19 vaccine in children ages 5 to 11 (“Vaccines and Related Biological Products Advisory Committee Meeting” 2021).

November 1, 2021—Five million deaths globally

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

November 9, 2021: Worldwide cases reach 250 million

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Nov. 16, 2021:

The WHO announced that almost all global COVID-19 cases (99%) originated from the delta strain (Towey 2021).

Nov. 26, 2021:

WHO announced that the Omicron variant is a variant of concern. It was first sequenced in South Africa (“Tracking Sars-COV-2 Variants” 2021).

December 15, 2021—800,000 deaths in the United States

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

Dec. 15, 2021:

The WHO UNITY Studies Collaborator Group published a preprint of a systematic review of COVID-19 seroprevalence studies. They concluded that true infections were underestimated, with a quarter of the global population having COVID-19 antibodies in April 2021 (Bergeri 2021).

Dec. 20, 2021:

CDC estimated that the Omicron variant comprised 73% of U.S. COVID-19 cases (“CDC COVID Data Tracker” 2022).

Dec. 27, 2021:

The CDC shortened the recommended isolation period for COVID-positive Americans from 10 days to 5 days if symptoms were improving. People who were fully vaccinated and boosted did not need to quarantine following exposure but should wear masks (“CDC Updates and Shortens Recommended Isolation...” 2021).

Dec. 22, 2021:

The FDA granted EAU for Pfizer’s Paxlovid, the first oral antiviral COVID-19 drug (“Coronavirus (COVID-19) Update: FDA Authorizes First Oral Antiviral for Treatment of COVID-19” 2021).

Jan. 3, 2022:
The FDA amended the EUA of the Pfizer-BioNTech vaccine to expand the single booster use for children 12–15. They also allowed for a third dose for immunocompromised children 5–11 (“Coronavirus (COVID-19) Update: FDA Takes Multiple Actions...” 2022).

Jan. 19, 2022

The Biden Administration launched a program to mail COVID-19 test kits directly to American households (“Fact Sheet: The Biden Administration to Begin...” 2022).

Jan. 21, 2022:

The FDA officially approved the Moderna vaccine for individuals 18 and older (“Coronavirus (COVID-19) Update: FDA Takes Key Action...” 2022).

February 4, 2022—900,000 deaths in the United States
 (“WHO Coronavirus (COVID-19) Dashboard” 2022)

Feb. 24, 2022:

A report by the Lancet estimated that 6.7 million children had suffered from COVID-19-associated orphanhood and caregiver death in the past 2 years (“COVID-19-Associated Orphanhood” 2022).

Feb. 25, 2022:

The CDC recommended wearing a mask based on individual comfort preferences and regional COVID-19 levels (“Use and Care of Masks” 2022).

March 2, 2022:

The U.S. federal government launched the “Test to Treat” response wherein people that test positive for COVID-19 at a pharmacy can receive antiviral pills immediately for free (“Remarks by President Biden in State of the Union Address” 2022).

March 7, 2022—Global COVID-19 deaths exceed 6 million

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

March 30, 2022:

FDA authorized a second booster dose for Americans ages 50 and older, along with some immunocompromised individuals, at least 4 months after their initial booster (“Coronavirus (COVID-19) Update: FDA Authorizes Second...” 2022, para. 2).

April 8, 2022:

A Commonwealth Fund study estimated that the U.S. vaccination campaign prevented 2.2 million deaths, 17 million hospitalizations, and 66 million infections (Schneider et al. 2022).

April 12, 2022: Worldwide cases reach 500 million**May 12, 2022—1 million deaths in the United States**

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

May 17, 2022:

The FDA expanded eligibility for the Pfizer-BioNTech vaccine booster dose for children 5–11 (“Coronavirus (COVID-19) Update: FDA Expands Eligibility...” 2022).

June 17, 2022:

Moderna and Pfizer-BioNTech vaccines for children as young as 6 months were authorized by the FDA (“Coronavirus (COVID-19) Update: FDA Authorizes Moderna...” 2022).

June 18, 2022:

The CDC recommended COVID-19 vaccines for children 6 months to 5 years old (“CDC Recommends COVID-19 Vaccines for Young Children” 2022).

June 26, 2022:

The CDC announced that data from the Household Pulse Survey found that 19% of American adults that had COVID-19 still had symptoms (long COVID) (“Nearly One in Five American Adults...” 2022).

Aug. 17, 2022:

CDC director Dr. Rachel Walensky sent messages within the CDC admitting missteps during the pandemic. She noted that the agency must develop better

procedures to respond more efficiently to the next public health emergency (Edwards 2022).

Aug. 31, 2022

The FDA authorized bivalent COVID-19 vaccines from Moderna and Pfizer-BioNTech for use as a booster. These vaccines protect against both the original strain and the Omicron variant (“Coronavirus (COVID-19) Update: FDA Authorizes Moderna, Pfizer-BioNTech Bivalent...” 2022).

Sept. 1, 2022:

The *New England Journal of Medicine* published a study on Pfizer’s Paxlovid use for severe COVID-19 outcomes, announcing that mortality for those above 65 years old was reduced by 81%. There was no evidence of benefits for younger adults (Arbel et al. 2022).

Oct. 19, 2022:

The CDC authorized Novavax Monovalent boosters for adults 18 and older (“CDC Allows Novavax Monovalent...” 2022).

Statistics**Global Status as of April 2022**

Total cases: **500 million**

Total deaths: **6.21 million**

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

US Status as of June 2022

Total cases: **85.7 million**

Total deaths: **1.01 million**

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

US Status as of November 2022

Total cases: **96 million**

Total deaths: **1.06 million**

(“United States of America...” 2022)

Global Status as of December 2022

Total cases: **641.4 million**

Total deaths: **6.62 million**

(“WHO Coronavirus (COVID-19) Dashboard” 2022)

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Introduction to Pandemics and Biodefense

David R. Franz

1 Introduction

History can be known to all of us; some of it we have lived and some we have learned from others or read about. While we can't change history, we can learn from history. Our understanding of the present depends to a great extent on where we have been, what we have done and observed, and our resulting frame of reference; unfortunately, today it also depends on who we choose to believe [1]. The present is changing constantly, and the future is unknown. For the most part, we are “driving in the dark” regarding the future [2]. It's likely that the more we know about the past, the better we will be at imagining the future. Finally, we all will have a different perspective regarding what the future might hold, depending on which part of “the historical infectious disease, human behavior, and technology elephant” we understand the best. The authors who have contributed to this volume, as a group, have seen and understand a significant part of our complex “pandemic and biodefense” history. Some have spent careers focused on reducing the negative impact on society of pandemics, epidemics, bioterrorism, biological warfare, and even laboratory accidents or technical surprises. This introductory chapter contains a brief overview of my perspective and understanding of our history regarding *pandemics and biodefense*.

2 The Big Ones We Remember

I grew up in Kansas, roughly midway, as the crow flies, between the small town of Satanta, in southwest Kansas, and Fort Riley in northeast Kansas, both locations often mentioned in the story of the “great influenza” of the early twentieth century

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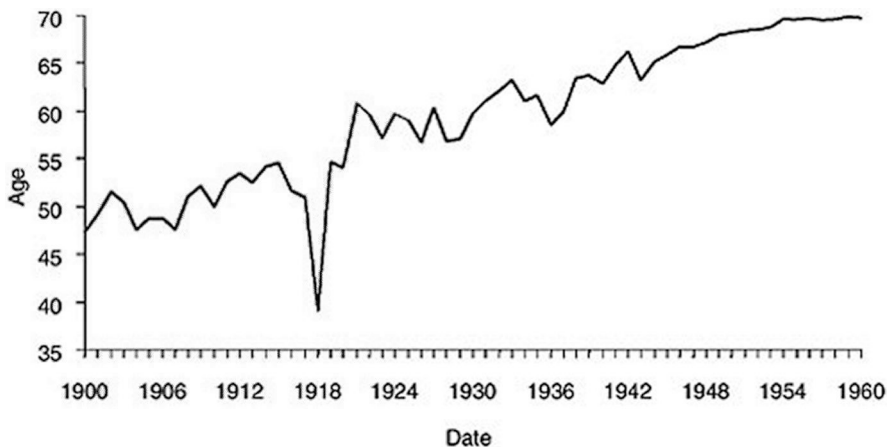


Fig. 1 Prof. Joshua Lederberg carried a viewgraph with this x - y plot in his briefcase for many of his informal “lecture/discussions” before groups of scientists and citizens. It depicts the average age at death in the United States and clearly demonstrates the impact of the 1918 pandemic flu virus

[3]. I recall my mother introducing me to her elementary school classmate who survived the flu. The rest I’ve had to get from books, like most of my peers. Medicine, technologies, transportation, communication, and knowledge of microbes and their workings were much different at that time and the global impact of WWI probably enhanced spread and worked counter to response and control. It is thought that 50 million humans died globally and more than one-half million in the USA. That pandemic drastically changed the life expectancy of Americans, as depicted in a viewgraph chart (Fig. 1), which the late Nobel Laureate Joshua Lederberg used in many of his presentations. The high mortality in the healthy 20- to 40-year-old age group was a surprise. Our predecessors fought that pandemic, not with mRNA vaccines and antiviral drugs, but to a great extent with nonpharmaceutical interventions (NPI). It’s interesting that, like our ancestors a century before our time, we started our current COVID-19 pandemic with little more than NPI in our armamentarium as well.

In the background, while the great influenza burned through the younger population, we had come to live with smallpox. This disease of approximately 30% mortality was endemic and pandemic at various times in history. It may have killed 300 million people globally in the twentieth century [4]. Its DNA has been sequenced from mummies that are thousands of years old. Records of inoculations for smallpox in China date back to the tenth century. In a huge accomplishment, the disease was eradicated in 1977—declared officially so in 1979—with a massive vaccination program led by the World Health Organization and in cooperation with many nations. In the end, a vaccine, essentially a “weakened” orthopoxvirus called *vaccina*, and global cooperation were what made eradication possible. In the final stages, a process called “ring vaccination” was used to build walls of immunity