



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**WE'RE OUT OF WHAT? THE DISASTROUS
CONSEQUENCES OF SUPPLY SHORTAGES
ON FIRST RESPONDERS DURING
PUBLIC HEALTH EMERGENCIES**

by

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December 2023

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REPORT DOCUMENTATION PAGE			<i>Form Approved OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC, 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE December 2023		3. REPORT TYPE AND DATES COVERED Master's thesis
4. TITLE AND SUBTITLE WE'RE OUT OF WHAT? THE DISASTROUS CONSEQUENCES OF SUPPLY SHORTAGES ON FIRST RESPONDERS DURING PUBLIC HEALTH EMERGENCIES			5. FUNDING NUMBERS	
6. AUTHOR(S) Brent E. Baker				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.			12b. DISTRIBUTION CODE A	
13. ABSTRACT (maximum 200 words) Every link in the global supply chain was strained to the breaking point during the COVID-19 pandemic. First responders experienced shortages of life-saving personal protective equipment (PPE), which led to workplace illness and even death. This thesis explores how first-responder agencies could embrace a "layered defense" approach to understanding PPE supply chain risks and adopt policies that promote resource sharing, risk assessment, and cooperative purchasing before the next significant public health emergency. This thesis investigates modern manufacturing and the global supply chain while looking at case studies of past outbreaks to better understand how first responders must prepare for the future. This thesis concludes that steps must be taken to protect first responders. It recommends solutions such as fully stocking the Strategic National Stockpile and allowing states and municipalities to use the federal supply schedule to purchase PPE. Additionally, state and local officials must make decisions that maximize buying power while providing cost-effective storage with reasonable access. Some strategies include purchasing supplies cooperatively and using alternate supply chains. While there is no crystal ball for forecasting when, where, and what the next pandemic will be, the country must prepare now.				
14. SUBJECT TERMS PPE, personal protective equipment, public health, first responders, disaster, shortage, supply chain, emergency, police, fire, EMS, responder, safety, pandemic, outbreak, COVID-19, just in time, lean, stockpile			15. NUMBER OF PAGES 165	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UU	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18

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**WE'RE OUT OF WHAT? THE DISASTROUS CONSEQUENCES OF SUPPLY
SHORTAGES ON FIRST RESPONDERS DURING PUBLIC HEALTH
EMERGENCIES**

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Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF ARTS IN SECURITY STUDIES
(HOMELAND SECURITY AND DEFENSE)**

from the

**NAVAL POSTGRADUATE SCHOOL
December 2023**

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ABSTRACT

Every link in the global supply chain was strained to the breaking point during the COVID-19 pandemic. First responders experienced shortages of life-saving personal protective equipment (PPE), which led to workplace illness and even death. This thesis explores how first-responder agencies could embrace a “layered defense” approach to understanding PPE supply chain risks and adopt policies that promote resource sharing, risk assessment, and cooperative purchasing before the next significant public health emergency. This thesis investigates modern manufacturing and the global supply chain while looking at case studies of past outbreaks to better understand how first responders must prepare for the future. This thesis concludes that steps must be taken to protect first responders. It recommends solutions such as fully stocking the Strategic National Stockpile and allowing states and municipalities to use the federal supply schedule to purchase PPE. Additionally, state and local officials must make decisions that maximize buying power while providing cost-effective storage with reasonable access. Some strategies include purchasing supplies cooperatively and using alternate supply chains. While there is no crystal ball for forecasting when, where, and what the next pandemic will be, the country must prepare now.

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LIST OF ACRONYMS AND ABBREVIATIONS

AIDS	acquired immunodeficiency syndrome
ASPR	Administration for Strategic Preparedness and Response
BYOB	bring your own bottle
CBRN	chemical, biological, radiological, and nuclear
CDC	Centers for Disease Control and Prevention
COVID-19	coronavirus disease 2019
DHS	Department of Homeland Security
DMAT	Disaster Medical Assistance Team
DOJ	Department of Justice
DPA	Defense Production Act
EMS	emergency medical service(s)
EMT	emergency medical technician
EO	executive order
ER	emergency room
ESF	emergency support function
FDA	Food and Drug Administration
FDNY	Fire Department of the City of New York
FEMA	Federal Emergency Management Agency
FSS	federal supply schedule
GAO	Government Accountability Office
HEPA	high-efficiency particulate air
HHS	(Department of) Health and Human Services
HIPAA	Health Insurance Portability and Accountability Act
HIV	human immunodeficiency virus
HPAI	high pathogenicity avian influenza
IAFF	International Association of Fire Firefighters
IMF	International Monetary Fund

JIT	just in time
LPAI	low pathogenicity avian influenza
MERS	Middle East respiratory syndrome
MOU	memorandum of understanding
NDMS	National Disaster Medical System
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
OIG	Office of Inspector General
PA	public assistance
PHE	public health emergency
PPE	personal protective equipment
RNA	ribonucleic acid
SARS	severe acute respiratory syndrome
SNS	Strategic National Stockpile
UP	universal precaution
VHF	viral hemorrhagic fever
WHO	World Health Organization

EXECUTIVE SUMMARY

During the coronavirus disease 2019 (COVID-19) pandemic, every link in the global supply chain was strained to the breaking point. The modern economy places tremendous reliance on global supply chains, but dependence on them created shortages of personal protective equipment (PPE) that put U.S. first responders at risk. According to the World Health Organization, “PPE includes, but is not limited to, laboratory coats, gowns, full-body suits, gloves, protective footwear, safety glasses, safety goggles, masks, and respirators.”¹ This thesis defines PPE as medical equipment, whether durable or disposable, used to isolate a first responder from a medical patient. It concerns specific non-reusable PPE, disposable medical examination gloves, face shields, surgical masks (simple masks), isolation gowns, and N95 respirators. Most PPE is manufactured internationally, notably in China, where COVID-19 originated. PPE demand skyrocketed, and production could not scale up to meet demand. This global shortage of PPE meant that first-responder agencies did not have the tools they needed to protect their staff.

Lean and just-in-time manufacturing intentionally limit supply and inventories in favor of efficiency.² Efficient supply chain management limits the volume of available raw materials and inventory. Notably, lean and just-in-time manufacturing rely on moving raw materials and goods efficiently. These manufacturing approaches require both materials and labor, so a shortage of either can disrupt output. In this context, PPE became scarce during COVID-19.

PPE shortages during COVID-19 caused illness and death among U.S. first responders. Indeed, COVID-19 was the leading killer of first responders in 2020.³ One

¹ World Health Organization, *Personal Protective Equipment* (Geneva: World Health Organization, 2020), x, <https://apps.who.int/iris/handle/10665/337961>.

² Cansu Tayaksi, Muhittin Sagnak, and Yigit Kazancoglu, “A New Holistic Conceptual Framework for Leanness Assessment,” *International Journal of Mathematical, Engineering and Management Sciences* 5, no. 4 (2020): 567, <https://doi.org/10.33889/IJMEMS.2020.5.4.047>.

³ Evan Goodenow, “COVID Leading Cause of Death for Police, Firefighters,” *Winchester Star*, March 21, 2023, https://www.winchesterstar.com/winchester_star/covid-leading-cause-of-death-for-police-firefighters/article_141d63be-ceb1-5ef0-ba11-9db5fb3c92b8.html.

study found that emergency medical service (EMS) workers died at a rate of 14 per 100,000 nationwide, compared to five and three per 100,000 for nurses and physicians, respectively.⁴ EMS workers—emergency medical technicians and paramedics—paid the highest price compared to other first responders and healthcare workers. Their disproportionate mortality resulted from austere work environments; the cramped space of ambulances, which offered little ventilation; and supply chain shortages.

When the supplies stopped flowing, the shortages of PPE created a hyper-competitive environment whereby countries contended with each other.⁵ Competition in the United States was fierce as well. States had to get creative to source PPE. In one extreme case, Massachusetts Governor Charlie Baker and Robert Kraft, the owner of the New England Patriots, sent the football team’s private jet to fly PPE to Massachusetts.⁶

By looking at the PPE used in past public health emergencies, including human immunodeficiency virus/acquired immunodeficiency syndrome, various types of flu, and COVID-19, decision-makers can reasonably predict the types of PPE needed for future outbreaks. This thesis uses lessons from past outbreaks to inform a series of recommendations at the federal, state, and local levels that embrace a layered defense approach to understanding PPE supply chain risks. The approach is then used to suggest policies that promote resource sharing, risk assessment, field innovation, and cooperative purchasing. The recommendations intend to ensure that U.S. first responders have adequate PPE to protect themselves when responding to the next public health emergency.

During the global COVID-19 pandemic, the Federal Emergency Management Agency’s ability to usurp already-purchased supplies and reallocate equipment left some agencies without PPE. This federal overreach hurt first responders by warping the free

⁴ Brian J. Maguire et al., “COVID-19 Fatalities among EMS Clinicians,” EMS1, September 25, 2020, <https://www.ems1.com/ems-products/personal-protective-equipment-ppe/articles/covid-19-fatalities-among-ems-clinicians-BMzHbuegIn1xNLrP/>.

⁵ International Crisis Group, *COVID-19 and Conflict: Seven Trends to Watch* (New York: International Crisis Group, 2020), <https://www.crisisgroup.org/global/sb4-covid-19-and-conflict-seven-trends-watch>.

⁶ Terry Nguyen, “The Trump Administration Has Made Getting Necessary Medical Equipment Difficult,” Vox, April 4, 2020, <https://www.vox.com/2020/4/4/21208122/ppe-distribution-trump-administration-states>.

market in several ways, making it harder to obtain essential PPE. The federal government must balance authority with the unintended consequences. One federal solution is thus fully funding the Strategic National Stockpile. Although never intended as the sole solution, the stockpile must hold the appropriate supplies and quantities for chemical, biological, radiological, and nuclear attacks; medical supplies; and PPE to defend the nation during a global outbreak.

Another solution involves leveraging the federal government's tremendous purchasing power by allowing states and municipalities to access the federal supply schedule (FSS). With such access, states can leverage a supply chain separate from the open market. Accessing the FSS will increase buying power, decrease pressure on the open market, and save taxpayer dollars when states purchase at a discount.

At the state and local levels, small agencies and sparsely populated states have little buying power on the open market. Americans understand the idea of purchasing power and buying in bulk. Stores like Costco and Sam's Club cater to consumers and businesses that understand the savings involved in larger quantities. A statewide purchasing and storage program might make the most sense in sparsely populated states like Wyoming. Likewise, a geographically small state with dense populations like Rhode Island might choose a statewide program.

This thesis asserts that the COVID-19 response was imperfect, and the likelihood of a future pandemic is high. By looking at COVID-19, along with other past public health outbreaks, the nation can forecast the specific types of equipment its first responders will require and plan accordingly. There is no crystal ball forecasting when, where, and what the next pandemic will be; however, preparing now is the best way to protect everyone's future.

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ACKNOWLEDGMENTS

Entrance into the Center for Homeland Defense and Security's master's degree program has been one of my life's most challenging and rewarding experiences. This thesis is the product of practical experience, world-class instruction, determination, and curiosity. It has been an inspiring experience that would not have been possible without the help of many people.

The first is Judd Freed (master's cohort 1001/1002), who in the spring of 2015 held an information session in Saint Paul, where I first learned about CHDS and the master's program. Without him, I would not have applied, and this thesis would not exist.

Many chiefs supported me through this endeavor. Chief Brian LaCroix encouraged me to apply to CHDS. Chief Susan Long supported my educational pursuits during my tenure at Allina Health EMS and offered encouragement throughout the program. Chief Skip Kirkwood (ELP 1502) supported me and regularly checked in. Deputy Chief Kevin Miller helped me balance work, school, and home.

I received tremendous community support from public safety officials and community members such as Ramsey County Commissioner Trista Martinson, Director Terry Stoltzman of Anoka County Emergency Management, Ramsey County Undersheriff Rich Clark, Blaine Police Deputy Chief Dan Pelky, and Dr. Chris Caulkins of Century College. Thank you all for your contributions.

Thank you to my colleagues at Allina Health EMS. Senior Manager Dave Matteson understood the academic rigors I would face. The entire North Metro leadership team covered my responsibilities during residency. Thank you for being in my cheering section.

To the staff of CHDS—my thesis advisors, Lynda Peters and Shannon Brown, who kept me on task; my writing coach, Marianne Taflinger, who helped organize my thoughts; librarian Greta Marlatt, who I am positive possesses the patience of a saint—thank you doesn't seem like enough. Scott Martis, thanks for keeping the cohort afloat. I would not have survived this program without your support. Thank you, Glen Woodbury and Chris

Bellavita, for taking a chance on me. I am also grateful to the staff of CHDS, who constantly challenged me to think differently by considering diverse views.

To my classmates, thank you for your endless ideas, contributions, and, most of all, patience as I continued to ramble on about facemasks, hand sanitizer, and toilet paper.

Most importantly, thank you to my family. To my parents, Debby and Bob, thank you for raising me right and instilling the values of hard work, persistence, and love. Mollie the Pug's unconditional love and entertainment kept my spirits up.

And finally, to my wife Alison—who has stuck with me throughout every crazy idea, deployment, disappointment, and setback—thank you for being with me every step of the way. You're all I need and more than I deserve.

This thesis is dedicated to the first responders who died in the line of duty from COVID-19. Your sacrifice is not forgotten.

I. INTRODUCTION

During the coronavirus disease 2019 (COVID-19) pandemic, every link in the global supply chain was strained to the breaking point. The modern economy places tremendous reliance on the global supply chain. Lean and just-in-time manufacturing methods intentionally limit supply and inventories in favor of efficiency.¹ Efficient supply chain management necessarily limits the volume of available raw materials and inventory. In addition, storing inventory is expensive.² Lean and just-in-time manufacturing rely on continuously moving raw materials and goods while efficiently managing inventories and labor to produce goods based on ever-changing demand signals; these manufacturing approaches rely on the availability of both materials and labor, so a shortage of either can disrupt output.

Global supply chains experienced shortages of personal protective equipment (PPE) that put first responders at risk. In 2020, for example, the World Health Organization (WHO) determined that 89 million masks were needed monthly to combat the spread of COVID-19.³ Consequently, PPE production needed to increase by 40 percent to fill the gap.⁴ Addressing the deficit was impossible, however, because production could not increase that quickly. Most PPE is manufactured internationally, notably in China, where COVID-19 originated. During the pandemic, China saw several manufacturing breakdowns. First, the factories shut down. Then, various countries instituted travel bans and stay-at-home orders, which affected manufacturing and shipping. Finally, exports of

¹ Cansu Tayaksi, Muhittin Sagnak, and Yigit Kazancoglu, “A New Holistic Conceptual Framework for Leanness Assessment,” *International Journal of Mathematical, Engineering and Management Sciences* 5, no. 4 (2020): 567, <https://doi.org/10.33889/IJMEMS.2020.5.4.047>.

² Ernst F. Bolten, *Managing Time and Space in the Modern Warehouse* (New York: American Management Association, 1997), 2.

³ “Shortage of Personal Protective Equipment Endangering Health Workers Worldwide,” World Health Organization, March 3, 2020, para. 8, <https://www.who.int/news/item/03-03-2020-shortage-of-personal-protective-equipment-endangering-health-workers-worldwide>.

⁴ World Health Organization.

PPE ceased.⁵ Meanwhile, first-responder agencies worldwide burned through their PPE at dramatically increased rates. PPE shortages led to price increases, which stressed already-tight public safety budgets.

Once supplies stopped flowing, countries competed for dwindling resources, creating a hyper-competitive market.⁶ Within the United States, shortages left first-responder agencies scrambling to find adequate amounts of PPE to supply necessary protection against contracting COVID-19. In this connection, Maureen Shawn Kennedy, a registered nurse and editor in chief of the *American Journal of Nursing*, lamented, “States have been left to forage for resources on their own, resulting in bidding wars among them and with the federal government over supplies.”⁷ She experienced the struggle to get PPE firsthand. In addition, then-New York Governor Andrew Cuomo described his state’s experience as similar to “being on eBay with 50 other states bidding on a ventilator.”⁸ At the local level, emergency medical services (EMS) competed with fire and police for PPE. Consequently, unprotected first responders contracted COVID-19, causing illness, disability, and sometimes death. In 2020, the Centers for Disease Control and Prevention (CDC) estimated that 60.3 of every 100,000 protective service workers died of COVID-19.⁹ This figure is double the mortality of healthcare support workers and triple that of healthcare practitioners and technicians. With proper PPE, deaths could have been prevented. In the future, federal, state, and local governments must better protect the first-responder workforce with appropriate PPE during public health emergencies.

⁵ Cyn-Young Park et al., *Global Shortage of Personal Protective Equipment amid COVID-19: Supply Chains, Bottlenecks, and Policy Implications*, ADB Briefs No. 130 (Manila: Asian Development Bank, 2020), 2, <https://doi.org/10.22617/BRF200128-2>.

⁶ International Crisis Group, *COVID-19 and Conflict: Seven Trends to Watch* (New York: International Crisis Group, 2020), <https://www.crisisgroup.org/global/sb4-covid-19-and-conflict-seven-trends-watch>.

⁷ Maureen Shawn Kennedy, “No Time for Silence,” *American Journal of Nursing* 120, no. 10 (October 2020): 7, <https://doi.org/10.1097/01.NAJ.0000718532.28639.67>.

⁸ Lauren Feiner, “States Are Bidding against Each Other and the Federal Government for Important Medical Supplies—and It’s Driving Up Prices,” CNBC, April 11, 2020, para. 10, <https://www.cnbc.com/2020/04/09/why-states-and-the-federal-government-are-bidding-on-ppe.html>.

⁹ Rachael M. Billock, Andrea L. Steege, and Arialdi M. Miniño, “COVID-19 Mortality by Usual Occupation and Industry: 46 States and New York City, United States, 2020,” *National Health Statistics Reports* 71, no. 6 (2022): 4, <https://doi.org/10.15620/cdc:120292>.

Every first-responder agency plans, trains, and prepares for various emergencies. Different situations require tools and equipment. For example, fire departments need hoses to move water from a hydrant to the location of a fire. Every piece of equipment has a life expectancy. Some equipment like fire hoses is durable and reused for years. Other equipment, such as exam gloves, is designed for one-time use. Most medical PPE is intended to be single-use for hygiene and infection control. But single-use items are consumed quickly and PPE supplies depleted exponentially during a disease outbreak, such as the flu season or COVID-19. Because these items are consumed rapidly, an agency must keep more on hand or have a functioning supply chain to resupply quickly.

Every emergency starts and ends at the local level. The local jurisdiction must attempt to handle the emergency before asking for outside help. When an emergency exceeds local capabilities, it can be escalated to the next level of government. In most cases, the city asks the county for assistance, the county asks for state aid, and the state asks for federal help. Typically, the flow of such requests is dictated by statute. This thesis aims to explore past health emergencies, understand current arguments within the government involving the supply chain, and create a set of recommendations for first-responder agencies.

A. RESEARCH QUESTION

How can first-responder agencies embrace a “layered defense” approach to understanding PPE supply chain risks and use this approach to adopt policies that promote resource sharing, risk assessment, and cooperative purchasing before the next significant public health emergency?

B. RESEARCH DESIGN AND CHAPTER OVERVIEW

Chapter II begins by defining PPE and its importance in keeping first responders safe. It is generally accepted that PPE, such as medical exam gloves, gowns or isolation suits, N95 respirator masks, and face shields, is necessary when near a highly contagious person, so this thesis examines each type of PPE. Since medical PPE consumption increases during public health emergencies, this thesis examines the literature describing two manufacturing models—lean and just in time. These two models were selected because

they are the modern manufacturing and logistics industry standards. By understanding how PPE is manufactured and identifying weaknesses in the supply chain, public safety agencies can build resiliency. Then, the chapter examines the global supply chain, including factors like disruptors and alternate supply chains. It explores just-in-time and lean manufacturing in the context of supply chains and then examines means of transportation and shipping, including ports, canals, and the Strategic National Stockpile.

Chapters III and IV explore past public health crises—human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) during the 1970s–1990s, severe acute respiratory syndrome (SARS) during the 2002–2004 outbreak, influenza A H5N1 (avian/bird flu) from 2002 to 2005, swine flu (N1H1) from 2009 to 2010, Middle East respiratory syndrome (MERS) in 2012, and COVID-19 from 2019 to 2023. HIV/AIDS was selected because it represents a significant milestone in using medical exam gloves by first responders to prevent exposure. Bird and swine flu were included due to the unusual characteristics of these outbreaks. MERS, while contained in the Middle East, had a high mortality rate and significant potential to become a global outbreak. SARS and COVID-19 were chosen because both involve respiratory diseases that require N95 respirators to provide the best protection for first responders. During each public health outbreak, first responders learned PPE’s importance in responder health and safety, sometimes creating spikes in PPE demand. Each public health crisis is analyzed by diagnosis; disease transmission; symptoms, which often resemble other illnesses; necessary PPE; first-responder vulnerability; stigma related to the illness; and economic impact.

This thesis does not focus on insect-borne diseases like West Nile, Zika virus, or malaria outbreaks that occurred during the 2010 to 2023 timeframe because of the minimal impact those diseases had on the U.S. first-responder community. In addition, the widespread availability of bug repellent containing DEET (N,N-diethyl-meta-toluamide), long-sleeved clothing like shirts and pants, and mosquito netting and screens, and their many substitutions, effectively mitigated these threats.

Chapter V explains federal authority for obtaining PPE. Applicable federal laws during public health crises include the Public Health Services Act, the Defense Production Act, and the Stafford Act. The thesis also examines relevant executive orders issued by the

Trump and Biden administrations during the COVID-19 pandemic. The chapter ends with complications that may arise when these federal authorities are used.

Finally, Chapter VI provides a path forward for local agencies in the form of recommendations that first-responder agencies can employ to acquire adequate PPE to protect themselves as they respond to the next public health emergency.

Aside from the research conducted for this thesis, some of the chapter content draws from this author's professional experience, training, and education, including over 24 years of experience with EMS, the National Disaster Medical System, and emergency management disciplines. As a paramedic and paramedic supervisor, this author was responsible for 9-1-1 responses in suburban Saint Paul, Minnesota, including high-population areas such as the Mall of America and the Minneapolis–Saint Paul International Airport during the HIV/AIDS, SARS, avian flu, and swine flu pandemics. As a logistics chief for his agency during the COVID-19 pandemic, this author was responsible for procuring PPE for EMS staff. This extensive background informs many of the discussions in this thesis.

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II. PPE AND THE GLOBAL SUPPLY CHAIN

This chapter outlines PPE and its vulnerabilities before defining the just-in-time (JIT) and lean manufacturing models, supply chain processes, and the supply disruptions that can result from the models' design. Modern manufacturing's "no waste" design makes the supply chain fragile, and alternative supply chains, whether through alternate manufacturers or the Strategic National Stockpile, cannot adequately fill the gaps in emergencies.¹⁰

A. PPE DEFINED

Before this thesis can demonstrate the supply chain effects of JIT and lean manufacturing, this section must define PPE and its vulnerabilities. Generally, PPE is equipment or clothing worn by personnel to minimize exposure to hazards. According to the WHO, "PPE includes, but is not limited to, laboratory coats, gowns, full-body suits, gloves, protective footwear, safety glasses, safety goggles, masks, and respirators."¹¹ Likewise, ballistic vests, uniforms, heavy boots, and firefighter turnout gear protect against specific threats and qualify as PPE. This thesis, however, defines PPE as medical equipment, whether durable or disposable, used to isolate a first responder from a medical patient. This thesis focuses on specific non-reusable PPE, generally the five following items: disposable medical examination gloves, face shields, surgical masks (sometimes called simple masks), isolation gowns, and N95 respirators.¹²

¹⁰ This chapter draws from the author's experience as a paramedic and paramedic supervisor responsible for 9-1-1 responses in suburban Saint Paul, Minnesota, including high-population areas such as the Mall of America and the Minneapolis–Saint Paul International Airport during the HIV/AIDS, SARS, avian flu, and swine flu pandemics. As a logistics chief for his agency during the COVID-19 pandemic, this author was responsible for procuring PPE for EMS staff. The author of this thesis understands that domestic manufacturing could solve some of the supply chain issues; however, it is naive and unrealistic to expect all PPE manufacturing to be "re-shored" and produced domestically.

¹¹ World Health Organization, *Personal Protective Equipment* (Geneva: World Health Organization, 2020), x, <https://apps.who.int/iris/handle/10665/337961>.

¹² Face shields can be either disposable or reusable.

Figures 1–6 depict the five CDC-recommended types of PPE, which are the focus of this thesis, and alternate PPE for encounters with COVID-19 patients. The CDC makes its recommendations based on science and best practices at publication. As a disease evolves or mutates and health experts learn more about the disease, protection levels and recommendations change. By looking at the PPE used in past public health emergencies, including HIV/AIDS, various types of flu, and COVID-19, the types needed for future outbreaks can be predicted. PPE substitutions are possible, typically when combined or layered with additional equipment. For example, when layered with a face shield, a surgical mask could be substituted in cases where an N95 mask is unavailable (see Figure 1 and Table 1).

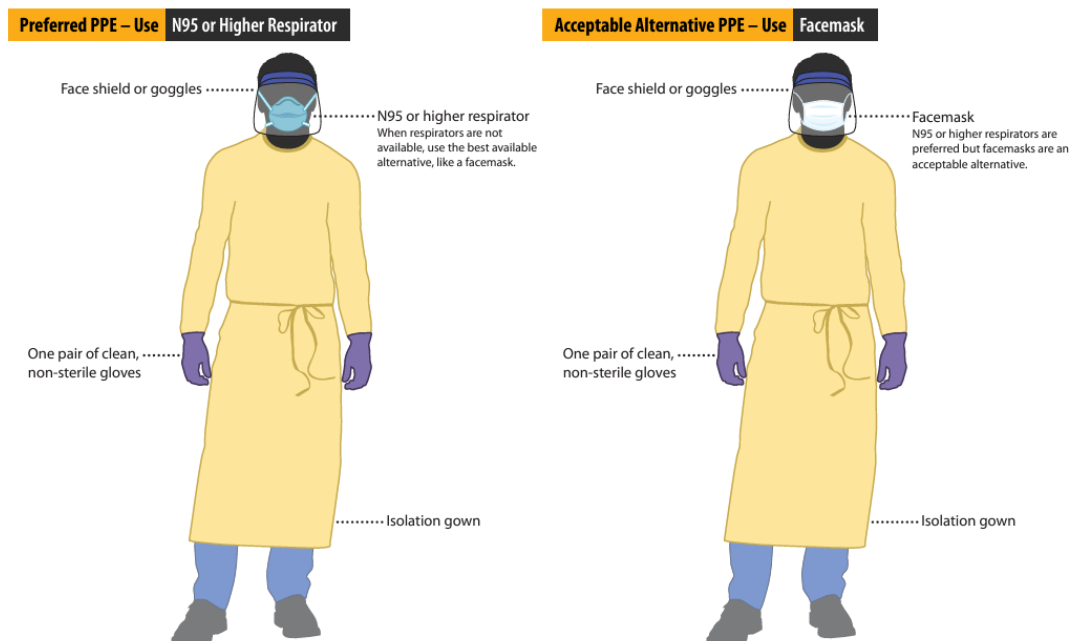


Figure 1. Recommended PPE for COVID-19 Patients.¹³

¹³ Source: “Use Personal Protective Equipment (PPE) When Caring for Patients with Confirmed or Suspected COVID-19,” Centers for Disease Control and Prevention, June 3, 2020, https://www.cdc.gov/coronavirus/2019-ncov/downloads/A_FS_HCP_COVID19_PPE.pdf.



Figure 2. Example of Disposable Medical Exam Gloves.¹⁴

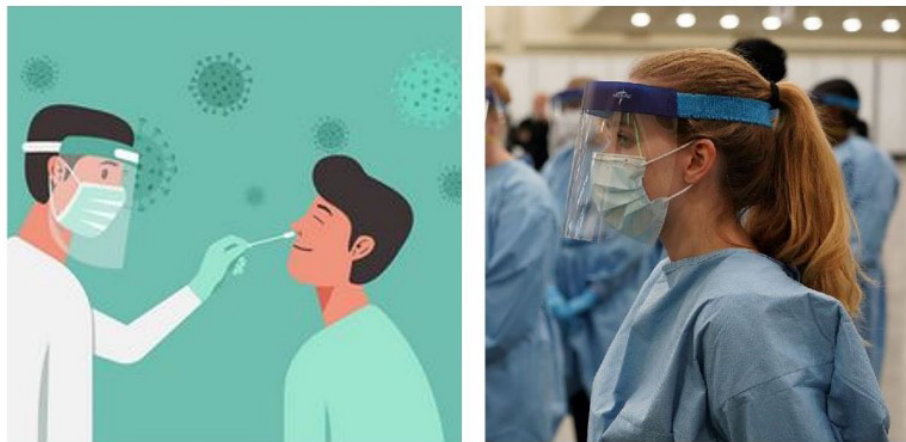


Figure 3. Examples of Disposable Face Shields.¹⁵

¹⁴ Source: “Coronavirus (COVID-19) and Medical Devices: Medical Gloves for COVID-19,” Food and Drug Administration, December 12, 2022, <https://www.fda.gov/medical-devices/coronavirus-covid-19-and-medical-devices/medical-gloves-covid-19>; “New Patient Examination Glove Available in the SNS,” Administration for Strategic Preparedness and Response, accessed November 26, 2023, <https://aspr.hhs.gov/443/SNS/Pages/New-Patient-Examination-Glove.aspx>.

¹⁵ Source: “Coronavirus Disease 2019 (COVID-19),” Centers for Disease Control and Prevention, February 11, 2020, <https://www.cdc.gov/coronavirus/2019-ncov/index.html>; Federal Emergency Management Agency, *Pandemic Response to Coronavirus Disease 2019 (COVID-19): Initial Assessment Report* (Washington, DC: Federal Emergency Management Agency, 2021), cover page, https://www.fema.gov/sites/default/files/documents/fema_covid-19-initial-assessment-report_2021.pdf.



Figure 4. Example of Disposable Surgical Mask (Simple Mask).¹⁶



Figure 5. Examples of Isolation Gowns.¹⁷

¹⁶ Source: “N95 Respirators, Surgical Masks, Face Masks, and Barrier Face Coverings,” Food and Drug Administration, March 10, 2023, <https://www.fda.gov/medical-devices/personal-protective-equipment-infection-control/n95-respirators-surgical-masks-face-masks-and-barrier-face-coverings>; “Considerations for Selecting Protective Clothing Used in Healthcare for Protection against Microorganisms in Blood and Body Fluids,” National Personal Protective Technology Laboratory, April 9, 2020, <https://www.cdc.gov/niosh/npptl/topics/protectiveclothing/default.html>.

¹⁷ Source: National Personal Protective Technology Laboratory, “Considerations for Selecting Protective Clothing”; “Nebraska PPE,” David J. Sencer CDC Museum, accessed August 20, 2023, <http://www.cdcmuseum.org/items/show/366>.



Figure 6. Examples of N95 Respirator Masks.¹⁸

Table 1. Understanding the Protection Difference between a Surgical Mask and an N95 Respirator.¹⁹

Understanding the Difference		
	 Surgical Mask	 N95 Respirator
Testing and Approval	Cleared by the U.S. Food and Drug Administration (FDA)	Evaluated, tested, and approved by NIOSH as per the requirements in 42 CFR Part 84
Intended Use and Purpose	Fluid resistant and provides the wearer protection against large droplets, splashes, or sprays of bodily or other hazardous fluids. Protects the patient from the wearer's respiratory emissions.	Reduces wearer's exposure to particles including small particle aerosols and large droplets (only non-oil aerosols).
Face Seal Fit	Loose-fitting	Tight-fitting
Fit Testing Requirement	No	Yes
User Seal Check Requirement	No	Yes. Required each time the respirator is donned (put on)
Filtration	Does NOT provide the wearer with a reliable level of protection from inhaling smaller airborne particles and is not considered respiratory protection	Filters out at least 95% of airborne particles including large and small particles
Leakage	Leakage occurs around the edge of the mask when user inhales	When properly fitted and donned, minimal leakage occurs around edges of the respirator when user inhales
Use Limitations	Disposable. Discard after each patient encounter.	Ideally should be discarded after each patient encounter and after aerosol-generating procedures. It should also be discarded when it becomes damaged or deformed; no longer forms an effective seal to the face; becomes wet or visibly dirty; breathing becomes difficult; or if it becomes contaminated with blood, respiratory or nasal secretions, or other bodily fluids from patients.

This information provides clarification regarding respirator and mask use in workplaces in which employees are exposed to respiratory hazards. It is not specific for the COVID-19 pandemic.

 Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

¹⁸ Source: Food and Drug Administration, “N95 Respirators, Surgical Masks, Face Masks, and Barrier Face Coverings”; David J. Sencer CDC Museum, “Nebraska PPE.”

¹⁹ Source: “Understanding the Difference,” infographic, Centers for Disease Control and Prevention, March 10, 2023, <https://archive.cdc.gov/#/details?url=https://www.cdc.gov/niosh/npptl/pdfs/UnderstandDifferenceInfographic-508.pdf>.

Managers must calculate PPE usage to ensure an adequate supply. Most medical PPE is disposable because it reduces the risk of infection resulting from improperly cleaned gear. Disposable equipment means an agency needs a greater quantity of PPE. Early in the COVID-19 pandemic, for example, the CDC created a calculator to aid healthcare facilities and first responders in understanding how quickly disposable supplies are used. The tool calculates the average consumption rate, commonly called a “burn rate,” for each type of PPE entered in the spreadsheet.²⁰ The National Institute for Occupational Safety and Health (NIOSH) recently created a mobile-based app based on the burn rate calculator (see Figure 7). Both the calculator and app assist healthcare facilities and first responders with future ordering needs because shortages will occur without the knowledge of PPE consumption.

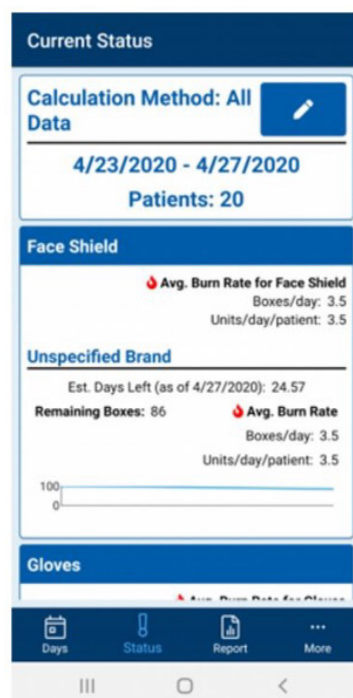


Figure 7. NIOSH PPE Burn Rate App.²¹

²⁰ “Personal Protective Equipment Use Tracking Tools,” National Institute for Occupational Safety and Health, May 8, 2023, <https://www.cdc.gov/niosh/topics/pandemic/ppe.html>.

²¹ Source: National Institute for Occupational Safety and Health.

The Federal Emergency Management Agency (FEMA) disseminated the calculator nationwide through various sources, including trade publications such as EMS1 and FireRescue1; social media platforms like YouTube; and government sites including the Office of Justice Programs, EMS.gov, and HHS.gov. It is impossible to say how many agencies used this calculator; however, this author's home agency used it successfully, thus improving the agency's ability to keep adequate PPE on hand to protect responders.²² Calculators like these helped agencies determine how much PPE they used so they had enough readily available to avoid running out.

B. SUPPLY CHAIN

An extensive network of commodities and goods to manufacture PPE precedes shipment to responders. This process is called a network supply chain. Stadtler and Kilger define a supply chain as “two or more legally separated organizations linked by material, information, and financial flows. These organizations may be firms producing parts, components, and end products, logistic service providers, and even the (ultimate) customer.”²³ Supply chains are complex. The supply chain block depicted in Figure 8 shows the process of creating goods, from left to right, starting with commodities and ending with the market. The second block describes the transportation chain, which involves shipping at different distribution levels. The final block represents potential disruptions at each stage of the chain.

²² The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author's professional experience, training, and education.

²³ Hartmut Stadtler and Christoph Kilger, eds., *Supply Chain Management and Advanced Planning* (Berlin: Springer, 2008), 7, <https://doi.org/10.1007/978-3-540-74512-9>.

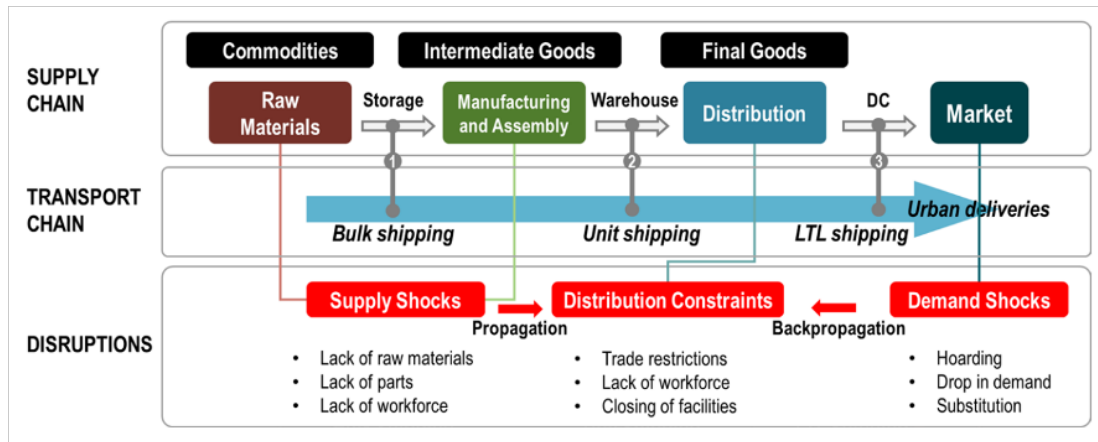


Figure 8. Impacts of Disruptions on Supply Chains.²⁴

The last mile in distribution is often the most complicated part of the transportation chain. According to Lim, Jin, and Srail, who study distribution and logistics management, “The term ‘last mile’ originated in the telecommunications industry and refers to the final leg of a network.”²⁵ Today, the last mile is the final step of the delivery process, typically considered the supply chain’s most expensive and least efficient segment. An example of the last mile is a load of PPE traveling from a local warehouse to a hospital.

1. Disruptors

Disruptions to the supply chain can happen at any point. The first potential disruption along the chain is a supply shock. Notteboom, Pallis, and Rodrigue warn, “Supply shocks represent an unexpected sudden change in the availability of raw materials, parts, and manufacturing capabilities.”²⁶ For example, if a hurricane hits a rubber plantation, it will hamper the manufacturing of tires because the damaged trees can no

²⁴ Source: Theo Notteboom, Thanos Pallis, and Jean-Paul Rodrigue, “Disruptions and Resilience in Global Container Shipping and Ports: The COVID-19 Pandemic versus the 2008–2009 Financial Crisis,” *Maritime Economics & Logistics* 23, no. 2 (June 2021): 184, <https://doi.org/10.1057/s41278-020-00180-5>. Image used with permission from the publisher.

²⁵ Stanley Frederick W. T. Lim, Xin Jin, and Jagjit Singh Srail, “Consumer-Driven e-Commerce: A Literature Review, Design Framework, and Research Agenda on Last-Mile Logistics Models,” *International Journal of Physical Distribution & Logistics Management* 48, no. 3 (2018): 309, <https://doi.org/10.1108/IJPDLM-02-2017-0081>.

²⁶ Notteboom, Pallis, and Rodrigue, “Disruptions and Resilience,” 184.

longer produce the rubber needed. The cost of materials is not a significant factor; instead, the lack of essential components disrupts the supply. Large buffers of stockpiled materials can delay or minimize supply shock because the materials are available for ready use if the collected materials are safe.

The next factor in supply chain disruption involves distribution capabilities. Notteboom, Pallis, and Rodrigue remark on critical causes of this disruption: “Distribution capabilities can be impaired by restrictions on trade, the lack of a workforce, or the closing of key distribution facilities such as airports, ports, or distribution centers.”²⁷ Inventory could be unavailable if the distribution is unavailable, creating shortages independent of demand. A lack of truck drivers is a type of distribution interruption, as is a lack of workers due to their being sick with COVID-19.

The next disruptor type is a demand shock in the supply chain. Notteboom, Pallis, and Rodrigue explain, “Demand shocks imply a sudden change in demand due to unforeseen circumstances.”²⁸ Americans felt this shock when a sudden toilet paper shortage appeared during the early days of COVID-19 because people perceived a lack and hoarded available goods. According to Notteboom, Pallis, and Rodrigue, people follow a predictable pattern: “Consumers undertake a substitution of their consumption patterns towards essential goods and shift their consumption depending on the scarcity and price of items.”²⁹ For the toilet paper shortage, prices fluctuated, but because few substitutions were available, consumers paid increased costs and reduced discretionary spending elsewhere. In addition, during stay-at-home orders, restaurants substituted takeout for dining in, thus increasing home delivery. Surges in computer sales occurred as people moved from the office to telecommuting. Demand shocks are tricky because the reason for demand is not always predictable, nor are the consequences.

Many shocks within the supply chain can have a forward or backward effect. Notteboom, Pallis, and Rodrigue explain the implications: “Shocks can propagate within

²⁷ Notteboom, Pallis, and Rodrigue, 185.

²⁸ Notteboom, Pallis, and Rodrigue, 185.

²⁹ Notteboom, Pallis, and Rodrigue, 185.

supply chains, depending on where they occur. Propagations include labor strikes or severe weather. During a pandemic, the coevolution of propagation and backpropagation mechanisms creates several concurrent shocks.”³⁰ For example, hoarding supplies, such as cleaning chemicals, paper products, and food, quickly shifts inventory from warehouses to final markets, such as grocery stores or residential homes, causing disruptions in distribution. Backpropagation or lower demand occurred during various lockdown measures early in the COVID-19 pandemic. Because people stayed home, demand for some products and services—such as gasoline or tourism—declined, which depressed needs in those areas and caused a surplus. In some cases, lower demand caused lower prices, such as with gasoline; in other cases, the reduced demand caused a collapse, like in tourism. Such disruptions, whether due to natural disasters, labor strikes, or a global pandemic, profoundly affect the supply chain, making it a frail system.

COVID-19 thus highlights the frailty of the global supply chain. One academic study found that the COVID-19 pandemic created four bottlenecks—in raw materials, manufacturing, distribution, and the end-user or last mile.³¹ Raw materials like filtering fabric for N95 masks were in severe shortage. Factory employees in China became ill, decreasing manufacturing capacity during a spike in demand. Trade restrictions globally forced stoppages of completed goods, impacting distribution. Finally, shortages created panic, leading to price spikes and hoarding. A Congressional Research Service report from December 2020 reinforces academics’ findings: “The pandemic . . . demonstrated the potential limitations of globalized supply chains, as public health countermeasures created difficulties maintaining production, while high global demand interrupted distribution.”³² In short, COVID-19 revealed weaknesses in the global supply chain, leading to PPE shortages that harmed unprotected first responders.

³⁰ Notteboom, Pallis, and Rodrigue, 185.

³¹ Park et al., *Global Shortage of Personal Protective Equipment*, 5.

³² Michael H. Cecire et al., *COVID-19 and Domestic PPE Production and Distribution: Issues and Policy Options*, CRS Report No. R46628 (Washington, DC: Congressional Research Service, 2020), 2.

2. Alternate Supply Chains

Supply shortages can force first responders to source PPE through new distribution channels to protect themselves. Besides first responders, several industries use PPE to protect employees from occupational hazards, and swapping manufacturing processes is possible when supplies dwindle. Painters and woodworkers must protect their lungs from contaminants like aerosolized paint and sawdust. Butchers must protect themselves from splashes of contaminated meat. Even mechanics use disposable gloves to protect themselves from grease, oil, and other contaminants. There is little difference between a mechanic's disposable nitrile gloves and the nitrile medical exam gloves that first responders use. Because of stay-at-home orders, these industries had fewer workers consuming PPE. The underuse meant less demand, opening an opportunity for first responders to procure PPE from those supply chains.

Necessity is the mother of invention. According to Nissen et al., COVID-19 set up this dynamic:

The COVID-19 pandemic has substantially increased the demand for disinfectants. The regular supply to the market is insufficient, and producers cannot raise their production capacities fast enough. As a result, new suppliers have entered the market, but for various reasons: some want to make a profit. Others want to cover their fixed costs (i.e., they do not have to file for bankruptcy). The third group of suppliers simply wants to help.³³

One sector that quickly switched manufacturing during the COVID-19 pandemic was breweries and distilleries. With stay-at-home orders declared by several governors, most breweries and distilleries could not fill their beer halls and lounges. According to Thomson and Bullied, “Many breweries and distilleries quickly arrived at the same conclusion: their facilities could produce hand sanitizer to help mitigate viral transmission in their

³³ Christian Thomas Nis Nissen et al., *Disinfectant Shortage: A Multicountry Comparison of Breweries and Distilleries Responses to the COVID-19 Pandemic* (Detroit: Industrial Engineering and Operations Management Society International, 2020), 324, <http://www.ieomsociety.org/detroit2020/papers/77.pdf>.

communities while sustaining revenues through the crisis.”³⁴ This adaptiveness showed American entrepreneurial spirit and ingenuity during COVID-19.

Although the switch from beer to hand sanitizer occurred quickly, government regulations had to be met. Miron and Partin explain,

The transition was not without government hurdles, but in this instance, government cooperated with common sense. First, the Alcohol and Tobacco Tax and Trade Bureau waived requirements to obtain permits to manufacture hand sanitizer legally and agreed to waive the federal excise tax for alcohol-based hand sanitizer products.³⁵

In addition, the Food and Drug Administration temporarily changed its stance, saying, “The agency does not intend to take action against manufacturing firms that prepare alcohol-based hand sanitizers for consumer use and for use as health care personnel hand rubs during this ongoing public health emergency.”³⁶ In this case, the government temporarily eliminated regulation for the public good to save lives.

Hand sanitizer production increased, but bottling presented a hurdle. Breweries could not use aluminum cans because modern beer cans have a plastic lining. The WHO notes that hand sanitizer, which in high concentrations can be corrosive, degrades aluminum storage containers. According to Thomson and Bullied,

Questions have been raised about the resilience of can liners against highly alcoholic solutions such as hand sanitizer. . . . For facilities that move forward with canning, it is recommended that regardless of liner composition, cans clearly state that the product is to be transferred to a plastic or glass container within four to six weeks of packaging date.³⁷

In some cases, breweries and distilleries had to procure plastic bottles for distribution, creating demand in the container supply chain.³⁸ Others sold hand sanitizer in their regular

³⁴ Euan L. Thomson and Andrew R. Bullied, “Production of Ethanol-Based Hand Sanitizer in Breweries during the COVID-19 Crisis,” *Master Brewers Association of the Americas* 57, no. 1 (2020): 47, <https://doi.org/10.1094/TQ-57-1-0417-01>.

³⁵ Jeffrey Miron and Erin Partin, *From Spirits to Sanitizer* (Washington, DC: Cato Institute, 2020), under “Summary,” <https://policycommons.net/artifacts/1321032/from-spirits-to-sanitizer/1924318/>.

³⁶ Miron and Partin, under “Summary.”

³⁷ Thomson and Bullied, “Production of Ethanol-Based Hand Sanitizer,” 49.

³⁸ Thomson and Bullied, 49.

glassware. Businesses that could not find a bottle supplier chose a “bring your own bottle” (BYOB) approach, charging by the ounce.³⁹ Because bottles were scarce, producers became innovative. Although producers and regulators deviated from norms, the need for hand sanitizer trumped common practice.

Online stores catering to new markets represent a novel supply chain developed during COVID-19. For example, Amazon opened a “COVID-19 Shop,” a virtual storefront available only to organizations and businesses related to the COVID-19 response.⁴⁰ Examples of approved companies were hospitals, first responders, and clinics. Standard COVID-19 supplies such as exam gloves, thermometers, and facemasks were available through the storefront. Instead of employing a mass advertising campaign, Amazon spread the word through professional organizations like the American Ambulance Association, which shared information through its network, including a link to the application. Once vetted, organizations could order significant amounts of PPE and supplies with free expedited shipping.⁴¹ In this case, a sizable sympathetic vendor with substantial purchasing power restricted access to goods by using a vetting process to limit who could purchase the scarce supplies. Although not exactly a free-market idea, in this case, Amazon was willing to take the step in an altruistic move to help during the COVID-19 pandemic.

During COVID-19, this author’s agency employed several tactics to obtain adequate PPE for its emergency medical technicians (EMTs) and paramedics. The agency purchased N95 respirators from Home Depot as an alternate supply chain. Likewise, it substituted meat-processing butcher gowns for medical isolation gowns. It bought drums of alcohol-based hand sanitizer from a local brewery. When the quantity needed challenged the brewery’s BYOB policy, the brewery supplied barrels of hand sanitizer to the agency. It also took part in the Amazon COVID-19 store, purchasing small amounts of supplies, including thermometers and extra-small-size gloves, which were hard to find in small

³⁹ The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author’s professional experience, training, and education.

⁴⁰ Lisa Johnston, “Amazon Opens Dedicated COVID-19 Store,” RIS News, April 26, 2020, <https://risnews.com/amazon-opens-dedicated-covid-19-store>.

⁴¹ Amanda Riordan, “EMS Granted Access to the Amazon COVID-19 Store!,” American Ambulance Association, April 5, 2020, <https://ambulance.org/2020/04/05/amazon-covid19/>.

quantities. Without such tactics and programs, the organization would have had difficulty acquiring PPE supplies.⁴²

Producers, vendors, and distributors had to get creative during the COVID-19 pandemic. Producers sometimes defied regulations and free markets to assist first responders. In other cases, restrictions were temporarily lifted. These practices could be models for future responses during the next public health emergency. However, all these methods require some level of planning and the willingness of regulators and companies to collaborate.

C. MANUFACTURING OPTIONS AND IMPLICATIONS

Manufacturing is a complicated process. Most products are the sum of individual components frequently made in different manufacturing plants. For example, the N95 respirator depicted previously in Figure 6 has five elements: the mask-shaped filtering material, elastic straps, a pliable metal nose piece, a foam chin rest, and staples or glue to attach the straps. These components are most likely manufactured in separate factories and completed in a finishing shop. A stoppage at the elastic plant causes disruptions downstream. JIT and lean manufacturing, which prioritize having no surplus, add complexity to the manufacturing process. Push and pull manufacturing represent additional methods. All these techniques have strengths and weaknesses.

1. JIT and Lean

JIT and lean manufacturing principles work well in regular times and ideal conditions but are not flexible enough for worldwide emergencies. JIT and lean manufacturing principles are modern techniques that companies of every size use to minimize waste and maximize profit. The University of Cambridge Institute for Manufacturing defines JIT as “the production of goods to meet the customer demand

⁴² The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author’s professional experience, training, and education.

exactly, in time, quality and quantity.”⁴³ When everything works well, JIT and lean are highly efficient manufacturing models.

In standard terms, JIT aims to produce a product with minimum waste. Developed in the early 1970s in Japan, JIT obsesses over continuous improvement and quality control—every team member’s responsibility. Many industries also use it to avoid interruptions and shortages. Taiichi Ohno, the father of JIT, first employed the method at the Toyota Company.⁴⁴ For this reason, JIT is renowned for being the Toyota production system.⁴⁵ The oil crisis in the early 1970s led to interest in the Toyota production system. When orders are received, JIT “pulls” inventory through the production process.⁴⁶ Minimizing waste translates to savings for the customer.

Similarly, lean production seeks to eliminate waste. According to Sundar et al., “The concept of lean manufacturing was developed for maximizing the resource utilization through minimization of waste.”⁴⁷ Anything that does not add value is a target for elimination. From the customer’s perspective, “value” equals the price the customer is willing to pay.⁴⁸ That value disappears if something along the lean manufacturing chain fails to support timely delivery.

The main difference between JIT and lean is the approach. JIT manufacturing focuses on the business side of manufacturing, stressing efficiency. Lean manufacturing focuses on the consumer side of manufacturing, stressing the customer’s desire. They both

⁴³ “JIT Just-in-Time Manufacturing,” University of Cambridge Institute for Manufacturing, accessed July 13, 2023, para. 1, <https://www.ifm.eng.cam.ac.uk/research/dstools/jit-just-in-time-manufacturing/>.

⁴⁴ University of Cambridge Institute for Manufacturing.

⁴⁵ Caroline Banton, Michael Boyle, and Jiwon Ma, “Just-in-Time (JIT): Definition, Example, and Pros & Cons,” Investopedia, March 14, 2023, <https://www.investopedia.com/terms/j/jit.asp>.

⁴⁶ Rosemary R. Fullerton and Cheryl S. McWatters, “The Production Performance Benefits from JIT Implementation,” *Journal of Operations Management* 19, no. 1 (January 2001): 83, [https://doi.org/10.1016/S0272-6963\(00\)00051-6](https://doi.org/10.1016/S0272-6963(00)00051-6).

⁴⁷ R. Sundar, A. N. Balaji, and R. M. Satheesh Kumar, “A Review on Lean Manufacturing Implementation Techniques,” in “12th Global Congress on Manufacturing and Management,” ed. M. Anthony Xavier and Prasad K. D. V. Yarlagadda, special issue, *Procedia Engineering* 97 (2014): 1875, <https://doi.org/10.1016/j.proeng.2014.12.341>.

⁴⁸ Maria Virginia and Claudiu Vasile, “Lean Manufacturing: The When, the Where, the Who,” *Management and Economics* 18, no. 4 (2013): 404.

emphasize eliminating waste, delivering value to the customer, and improving efficiency. JIT and lean identify seven types of waste: 1) waste from overproduction, 2) waste of waiting time, 3) transportation waste, 4) processing waste, 5) inventory waste, 6) waste of motion, and 7) waste from product defects (see Figure 9).⁴⁹

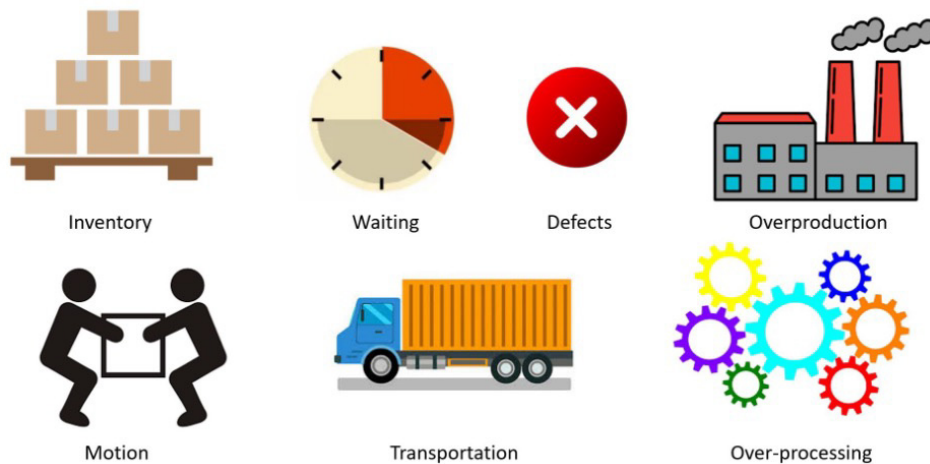


Figure 9. The Seven Types of Waste in Manufacturing.⁵⁰

JIT and lean aim to deliver suitable materials at the right time and place and in the exact amount needed. JIT and lean seek to maximize efficiency and eliminate waste, providing maximum profit. However, any disruption has a ripple effect down the chain. Without even a modest stockpile of materials or supplies, JIT and lean are fragile manufacturing processes, especially for essential medical supplies during times of crisis.

a. Advantages

The advantage of JIT is that it focuses on savings. JIT and lean eliminate buffer stock because inventory requires storage. The savings of time, physical space, and storage costs are major selling points passed on to the consumer, lowering the price of goods.

⁴⁹ University of Cambridge Institute for Manufacturing, “Just-in-Time Manufacturing.”

⁵⁰ This image is the author’s interpretation of the seven wastes using open-source clip art.

b. Disadvantages

The most significant disadvantage of JIT and lean involves inventory and disruptions in the supply chain. Any breakdown in the chain causes a manufacturing stoppage because the system has no redundancies or flexes. Breakdowns lead to delays and supply shortages.

2. Push versus Pull

PPE manufacturing comes from a pull model, like JIT or lean. However, some manufacturers use a “push” strategy for other types of products. The *Economist* calls push manufacturing the “just-in-case” method.⁵¹ Push and pull are thus two different techniques for producing goods based on customers’ demands.

Push seeks to keep products in stock before customers order them. Long-term plans, predictions, and historical trends drive manufacturers that use the push method.⁵² For example, shovel manufacturers increase production of snow shovels ahead of winter so there is an adequate supply by the first snowfall. Similarly, a small engine producer like Toro builds snowblowers in the summer in anticipation of winter and then switches to producing lawnmowers over winter when the grass is dormant in northern climates. Another example of push manufacturing is Coca-Cola. Coke knows it has a popular product, so it predicts demand and pushes inventory out to stores.⁵³ Lego uses a similar strategy to predict the hot new toy for Christmas and produces more of that product ahead of holiday demand.⁵⁴

On the other hand, customer demand drives pull as the process rapidly reacts to demand rather than anticipating it. Manufacturers use a pull methodology in making ambulances, fire trucks, and custom cars. PPE producers use pull; thus, switching to a push

⁵¹ “Just-in-Time,” *Economist*, July 6, 2009, para. 1, <https://www.economist.com/news/2009/07/06/just-in-time>.

⁵² Toshendra Kumar Sharma, “A Comprehensive Guide to Push and Pull Strategy in Supply Chain Management,” Blockchain Council, September 27, 2023, <https://www.blockchain-council.org/blockchain/what-is-push-and-pull-strategy-in-supply-chain-management/>.

⁵³ Sharma.

⁵⁴ Sharma.

model could make PPE supplies more abundant, especially considering the just-in-case ideology.

D. TRANSPORTATION AND SHIPPING

A manufactured product must move from point A to point B; in most cases, this involves transportation or shipping. Along the transportation route, ports, canals, and warehouses become nodes that goods pass through. These nodes create other potential pinch points in the frail supply chain.

1. Ports

Ports are central pinch points in the global supply chain. The Bureau of Transportation Statistics defines ports as “places where cargo is transferred between ships and trucks, trains, pipelines, storage facilities, or refineries.”⁵⁵ These places act as funnels through which goods pass. Yazir et al., experts in maritime logistics, state, “Maritime shipping constitutes approximately 90% of global goods trade.”⁵⁶ Most of the cargo entering the United States comes by sea on ships. According to *Global Trade* magazine, the United States has around 360 commercial ports.⁵⁷ The U.S. Army Corps of Engineers lists the following as the top 10 ports by waterborne tonnage:

- Port of Houston (Texas)
- Port of South Louisiana
- Port of Corpus Christi (Texas)
- Port of New York (New York and New Jersey)
- Port of New Orleans (Louisiana)

⁵⁵ Bureau of Transportation Statistics, *Port Performance Freight Statistics Program: Annual Report to Congress 2016* (Washington, DC: Bureau of Transportation Statistics, 2017), 3, https://www.bts.gov/sites/bts.dot.gov/files/legacy/PPFS_Annual_Report.pdf.

⁵⁶ Devran Yazir et al., “Effects of COVID-19 on Maritime Industry: A Review,” *International Maritime Health* 71, no. 4 (2020): 253, <https://doi.org/10.5603/IMH.2020.0044>.

⁵⁷ “U.S. Ports,” *Global Trade*, accessed August 5, 2023, <https://www.globaltrademag.com/us-ports/>.

- Port of Long Beach (California)
- Port of Greater Baton Rouge (Louisiana)
- Port of Beaumont (Texas)
- Port of Los Angeles (California)
- Port of Virginia.⁵⁸

a. Advantages

Ports have several advantages, some of which are depicted in Figure 10. The first advantage involves the U.S. economy. The Environmental Protection Agency explains that ports act as a gateway for trade.⁵⁹ Almost 30 percent of the U.S. gross domestic product moves through ports.⁶⁰ Moreover, U.S. ports alone supply over 31 million jobs.⁶¹ Shipping by sea is environmentally responsible because it is more fuel efficient than shipping by air.⁶² In addition, shipping by sea is frequently the most cost-effective method.⁶³ Another advantage involves improving life with the exchange of commodities. These include petroleum; food; building materials like steel; and finished products like clothing, electronics, and cars.⁶⁴ In sum, ports are essential for international trade that supports modern life.

⁵⁸ “Waterborne Tonnage for Principal U.S. Ports and All 50 States and U.S. Territories; Waterborne Tonnages for Domestic, Foreign, Imports, Exports and Intra-State Waterborne Traffic,” U.S. Army Corps of Engineers, 2020, <https://usace.contentdm.oclc.org/digital/collection/p16021coll2/id/7447>.

⁵⁹ “Ports Primer: 2.1 The Role of Ports,” Environmental Protection Agency, September 18, 2016, <https://www.epa.gov/community-port-collaboration/ports-primer-21-role-ports>.

⁶⁰ Environmental Protection Agency.

⁶¹ “Economic Impact of U.S. Seaports,” infographic, American Association of Port Authorities, 2018, https://www.aapa-ports.org/files/PTB_Economic%20impact%20of%20U.S.%20seaports-ver2.pdf.

⁶² Union Pacific, “Pros & Cons of Water Transport: Ship Speed, Shipment Visibility, More,” *Track Record*, January 24, 2023, <http://www.up.com/up/customers/track-record/tr082719-water-pros-cons.htm>.

⁶³ Union Pacific.

⁶⁴ Environmental Protection Agency, “Ports Primer.”

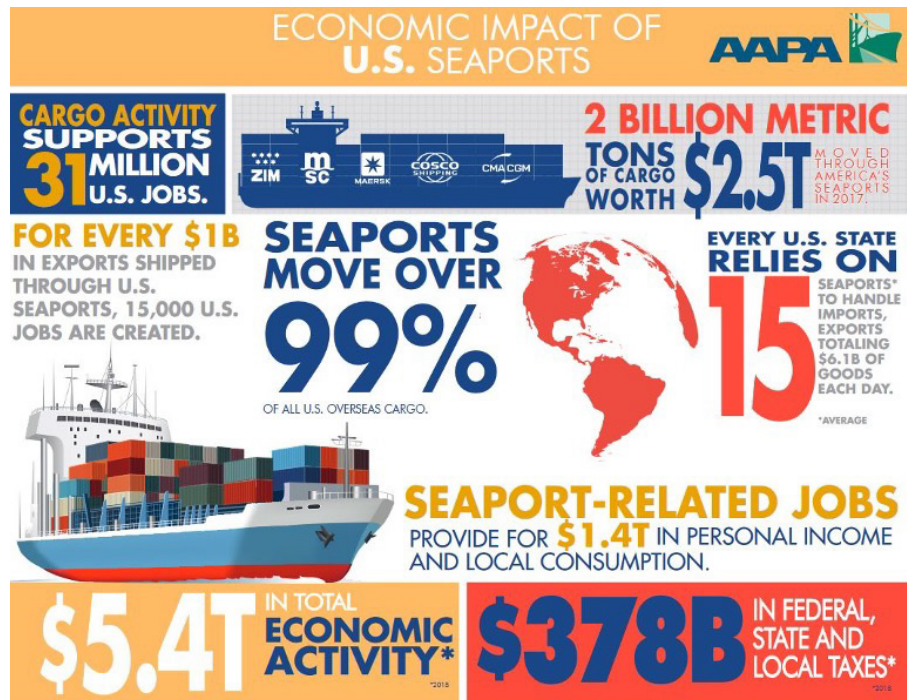


Figure 10. The Economic Impact of U.S. Seaports in 2018.⁶⁵

b. *Disadvantages*

The most significant disadvantage of ports is that they create a pinch point in the supply chain. As previously stated, 90 percent of global trade moves through ports. Shipping by sea can be slow and prone to weather delays.⁶⁶ Because of the mass quantities of goods traveling through ports, they become inflexible with loading and unloading times. In 2021, for example, the Port of Long Beach experienced significant shipping delays. Ships from Asia spent weeks offshore waiting to unload. In 2022, the United Nations Conference on Trade and Development released a guidebook on resilient maritime logistics. Using the Port of Long Beach as a case study, the guidebook acknowledged the significant disruptions from the COVID-19 pandemic. At the onset of the COVID-19 pandemic, the Ports of Long Beach and Los Angeles averaged 30 container ships waiting to unload; by August 2021, the number had swelled to an average of 60–80 at any given

⁶⁵ Source: American Association of Port Authorities, “Economic Impact of U.S. Seaports.” Image used with permission from the publisher.

⁶⁶ Union Pacific, “Pros & Cons of Water Transport.”

time.⁶⁷ Dani Anguiano of the *Guardian* reported that contributing factors included a “pandemic-induced buying boom” and supply chain disruptions that caused containers to sit on the dock longer, backlogging ships waiting to unload.⁶⁸ Thousands of tons of goods, including essential PPE, sat idle. Danny Miranda, president of the union representing dockworkers, described the incident as “being on a freeway in traffic.”⁶⁹ This stoppage created critical shortages that put first responders at risk.

2. Canals

Canals are another essential component of the international supply chain. According to the National Ocean Service, “A canal is a human-made waterway that allows boats and ships to pass from one body of water to another.”⁷⁰ Two significant canals enable international water navigation: the Panama Canal, which connects the Pacific and Atlantic Oceans in Central America, and the Suez Canal, which connects the Mediterranean Sea to the Red Sea in the Middle East. Without canals, boats would spend additional weeks traveling around continents.

a. Advantages

The most significant advantage of canals is the shortening of distances of travel. The Suez Canal in Egypt, for example, is a 120-mile-long artificial canal that connects the Mediterranean Sea to the Red Sea and, in a larger sense, the Indian Ocean. According to Kahn and Rahman, marine and engineering experts, “The Suez Canal provides the shortest

⁶⁷ Mark Bloch, ed., “Case Study 1: Ports of Los Angeles and Long Beach, United States,” in *Building Capacity to Manage Risks and Enhance Resilience* (Geneva: United Nations Conference on Trade and Development, 2022), <https://resilientmaritimelogistics.unctad.org/guidebook/case-study-1-ports-los-angeles-and-long-beach-united-states>.

⁶⁸ Dani Anguiano, “‘Like a Freeway in Traffic’: America’s Busiest Ports Choked by a Pandemic Holiday,” *Guardian*, December 21, 2021, para. 2, <https://www.theguardian.com/business/2021/dec/21/inside-americas-busiest-port-during-holidays>.

⁶⁹ Anguiano, para. 3.

⁷⁰ “What Is a Canal?,” National Ocean Service, January 20, 2023, para. 1, <https://oceanservice.noaa.gov/facts/canal.html>.

sea link connecting Asia to Europe.”⁷¹ Without the Suez Canal, ships would have to navigate the Horn of Africa, an approximate 3,700-mile (6,000 km) course, adding weeks to the journey and costing hundreds of thousands of dollars in fuel, salaries, and maintenance costs. Figure 11 is a visual representation of the distance saved in traversing the Suez Canal. Ramos et al. explain the importance of the Suez Canal this way: “On an average day, the canal caters to nearly fifty vessels carrying essential commodities. It was responsible for the transit of over 19,000 ships in 2019, representing nearly a third of the world’s container ship traffic, equating to nearly 1.25 billion metric tons of cargo, accounting for about 12% to 13% of world trade per year.”⁷² Without canals like the Suez Canal, shipping would take longer and cost significantly more.

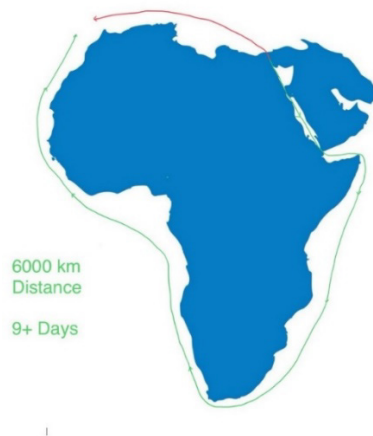


Figure 11. Distance Saved Using the Suez Canal.⁷³

Another central shipping canal is the Panama Canal, a 51-mile-long passage through the isthmus of Panama. Without the Panama Canal, Cho et al. explain, sailors

⁷¹ Irfan Ahmed Khan and Syed Rahman, “Review and Analysis of Blockage of Suez Canal Region Due to Giant Container Ship,” *Marine Technology Society Journal* 55, no. 5 (2021): 39, <https://doi.org/10.4031/MTSJ.55.5.5>.

⁷² Kimberly G. Ramos et al., “Suez Canal Blockage and Its Global Impact on Healthcare amidst the COVID-19 Pandemic,” *International Maritime Health* 72, no. 2 (2021): 145, <https://doi.org/10.5603/IMH.2021.0026>.

⁷³ This figure is the author’s interpretation of the distance and time savings of the Suez Canal using open-source clip art, data from previously sourced information, and hand-drawn lines by Alison K. Baker.

would have to round Cape Horn at the tip of South America, an additional 8,000-mile (12,800 km) trip.⁷⁴ The extra distance would add weeks and thousands of dollars in additional costs, similar to the Suez Canal situation. Figure 12 is a visual representation of the distance saved in traversing the Panama Canal. On average, 40 ships pass through the Panama Canal a day.⁷⁵ Silverstein explains that 6 percent of global maritime traffic passes through the Panama Canal.⁷⁶ In 2021 alone, over 516 million tons of cargo transited the Panama Canal.⁷⁷ The Panama Canal is thus another cost- and time-saving route.



Figure 12. Distance Saved Using the Panama Canal.⁷⁸

⁷⁴ *Encyclopedia Britannica*, s.v. “Panama Canal,” accessed August 5, 2023, <https://www.britannica.com/topic/Panama-Canal>.

⁷⁵ Prajyot Sinha, “10 Important Panama Canal Facts Everyone Should Know,” *Marine Insight*, June 4, 2022, <https://www.marineinsight.com/guidelines/10-important-panama-canals-facts-everyone-should-know/>.

⁷⁶ Ken Silverstein, “Climate Change Threatens Panama Canal and Global Maritime Trade,” *Forbes*, August 8, 2022, <https://www.forbes.com/sites/kensilverstein/2022/08/08/climate-change-threatens-panama-canal-and-global-maritime-trade/>.

⁷⁷ Sinha, “10 Important Panama Canal Facts Everyone Should Know.”

⁷⁸ Source: “Sea History for Kids: Canal Crazy,” National Maritime Historical Society, accessed November 15, 2023, <https://seahistory.org/sea-history-for-kids/canal-crazy/>. Image used with permission from the publisher.

b. Disadvantages

Canals, like ports, present other pinch points along the supply chain, as shown on March 23, 2021, during the middle of the COVID-19 pandemic. The merchant vessel *Ever Given* ran aground, causing a blockage in the Suez Canal. This blockage disrupted “an estimated \$9.6 billion of trade daily.”⁷⁹ The jam lasted six days, causing an estimated loss of \$57.6 billion. The blockage of the Suez Canal caused a global shortage of essential goods, including medical supplies and PPE, again putting first responders at risk during the COVID-19 pandemic.

3. Warehouses

Warehouses are an essential part of the global shipping and transportation system. A warehouse is a large building meant to store goods or supplies. Modern American warehouses are cavernous places with tens of thousands of cubic feet of space. Warehouses lie in industrial locations near major transportation routes, including ports, interstate highway systems, and rail lines.

The layout is an essential aspect of designing a warehouse. Hassen, an expert in mechanical engineering, has determined that

it [the layout] should also be concerned with the arrangement of the functional areas of the warehouse, determining the number and location of docks and input/output (I/O) points, determining the number of aisles, their dimensions, and orientation, estimating space requirements, designing the flow pattern, and forming picking zones.⁸⁰

Old warehouses located in the center of major metropolitan areas no longer meet the needs of modern supply chains. For this reason, “warehouse districts” are becoming destinations for nightclubs and trendy apartments.

⁷⁹ Ramos et al., “Suez Canal Blockage and Its Global Impact,” 145.

⁸⁰ Mohsen M. D. Hassen, “A Framework for the Design of Warehouse Layout,” *Facilities* 20, no. 13/14 (2002): 432, <https://doi.org/10.1108/02632770210454377>.

a. *Advantages*

Warehouses have many advantages. One of the most significant advantages of warehouses is reduced shipping time. Customers in the Amazon age expect fast shipping. When placed correctly, warehouses can offer a shorter distance to transport or ship goods to the consumer. Warehouses keep goods safe from the elements. The most significant advantage for organizations using a warehouse is inventory control, defined by *Merriam-Webster* as the “coordination and supervision of the supply, storage, distribution, and recording of materials to maintain quantities adequate for current needs without excessive oversupply or loss.”⁸¹ Warehouses also offer long-term storage, which is particularly handy for just-in-case items.

b. *Disadvantages*

Warehouses are expensive. Depending on the location of the warehouse in the world, the structure may need heating and cooling, which incur expenses. Facilities within the warehouse, such as loading docks, shelving, and employee break areas, require a unique design and thought, further increasing costs. Warehouse workers are another expense. The warehouse size, number of various products, and type of goods determine the number of employees the warehouse owner needs.

Most organizations keep minimal inventory on hand. While some organizations stock up on consumables, Sperry et al. note that from a trucker’s experience, “As a general rule, they’re just-in-time freight. They don’t do a lot [of warehousing] because that’s a lot of lost money.”⁸² Most first-responder agencies relied on a fragile JIT supply chain instead of warehousing needed PPE supplies during COVID-19, which resulted in PPE shortages, leading to illness and, in some cases, death. Although inventory and warehouse space increase expenses, stockpiling supplies ensures adequate supplies.

⁸¹ *Merriam-Webster*, s.v. “inventory control,” accessed October 11, 2023, <https://www.merriam-webster.com/dictionary/inventory+control>.

⁸² Danielle Sperry et al., “Trucking in the Era of COVID-19,” *American Behavioral Scientist* (2022), <https://doi.org/10.1177/00027642211066039>.

4. Strategic National Stockpile

One unique source of critical supplies for PPE and other necessary medical supplies is the Strategic National Stockpile (SNS). In 1999, the U.S. Congress appropriated \$51 million for the CDC to create a vaccine and pharmaceutical stockpile.⁸³ Initially called the National Pharmaceutical Stockpile, it became the SNS after the 9/11 terrorist attacks.⁸⁴ The reserve stockpile expanded its initial focus from drugs and vaccines to chemical, biological, radiological, and nuclear (CBRN) hazards and other threats, including flu and natural disasters.⁸⁵ While the name and mission have changed, the goal remains clear: provide supplies to responders nationwide during national emergencies.

The 2002 revision to the SNS's authorizing legislation specifically defined the mission of the SNS as "provid [ing] for the emergency health security of the United States . . . in the event of a bioterrorist attack or other public health emergency."⁸⁶ Robarge-Silkiner explains, "The mission of the SNS is to deliver critical medical assets to the site of a national emergency."⁸⁷ Various emergencies have required access to inventory stored in the SNS, including the 9/11 attacks, the Amerithrax attacks, Ebola, Zika virus, COVID-19, and several hurricanes.⁸⁸ The SNS remains a viable national resource following the country's darkest days.

⁸³ Omnibus Consolidated and Emergency Supplemental Appropriations Act, Pub. L. No. 105–277 § 358, 112 Stat. 2681 (1999), <https://www.govinfo.gov/content/pkg/PLAW-105publ277/pdf/PLAW-105publ277.pdf>.

⁸⁴ Frank Gottron and Taylor R. Wyatt, *The Strategic National Stockpile: Overview and Issues for Congress*, CRS Report No. R47400 (Washington, DC: Congressional Research Service, 2023), 1, <https://crsreports.congress.gov/product/pdf/R/R47400>.

⁸⁵ Daniel Gerstein, *The Strategic National Stockpile and COVID-19: Rethinking the Stockpile* (Santa Monica, CA: RAND Corporation, 2020), 3, <https://doi.org/10.7249/CTA530-1>.

⁸⁶ Public Health Security and Bioterrorism Preparedness and Response Act of 2002, Pub. L. No. 107–188 § 613, 116 Stat. 594 (2002), <https://www.govinfo.gov/content/pkg/PLAW-107publ188/pdf/PLAW-107publ188.pdf>.

⁸⁷ Stacy A. Robarge-Silkiner, *Introduction to the Strategic National Stockpile* (Topeka: Kansas Department of Health and Environment, 2007), 4, <https://pdfs.semanticscholar.org/e70a/04217ad668c6821a0da98bd2bcf6523d47c4.pdf>.

⁸⁸ "Stockpile Responses," Administration for Strategic Preparedness and Response, accessed January 29, 2023, <https://aspr.hhs.gov:443/SNS/Pages/Stockpile-Responses.aspx>.

Currently, the SNS has been the responsibility of the assistant secretary for preparedness and response of the Department of Health and Human Services (HHS). In July 2022, the HHS secretary announced the elevation of the assistant secretary for preparedness and response from a staff position to an operating division.⁸⁹ The promotion elevated the department, putting the Administration for Strategic Preparedness and Response (ASPR) on the same footing as the CDC or the Food and Drug Administration (FDA) under HHS. Although elevation added prominence, it did not come with a larger budget, making it primarily symbolic. Time will tell whether the structural change makes a meaningful difference.

The stockpile offers a variety of supplies for national emergencies. The SNS also provides specific item support, which makes up a large portion of the reserve. These supplies include vaccines, antivirals, and antitoxins. Figures 13 and 14 depict an SNS warehouse and logistics experts from HHS coordinating supplies.

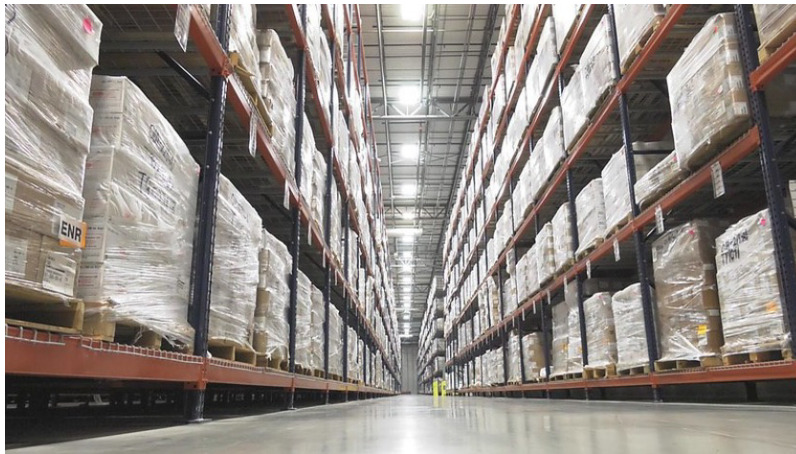


Figure 13. The Interior of an SNS Warehouse.⁹⁰

⁸⁹ “HHS Strengthens Country’s Preparedness for Health Emergencies, Announces Administration for Strategic Preparedness and Response (ASPR),” Department of Health and Human Services, July 22, 2022, <https://www.hhs.gov/about/news/2022/07/22/hhs-strengthens-countrys-preparedness-health-emergencies-announces-administration-for-strategic-preparedness-response.html>.

⁹⁰ Source: Administration for Strategic Preparedness and Response, “Strategic National Stockpile in Pictures,” Flickr, 2021, <https://www.flickr.com/photos/asprgov/sets/72157718487942018/with/50994945302/>.



Figure 14. Emergency Responders Coordinating the Deployment of Resources from the SNS.⁹¹

a. Advantages

There are many benefits of the SNS. The first advantage is location. The SNS has “push packs” strategically located at undisclosed locations for delivery anywhere within the United States for a federally declared disaster. Robarge-Silkiner details the contents of a push pack:

- There are 12 Push Packages located strategically around the United States (6% of SNS assets).
- Each package contains
 - Large amounts of prepackaged, individual 10-day regiments for over 300,000 people
 - Intravenous drugs and supplies for administration
 - Chemical antidotes and related supplies
 - Airway management supplies
 - Medical/Surgical supplies.⁹²

Siripurapu and Berman explain that each 12-hour push pack holds 50 tons of medical supplies.⁹³ The contents and locations of these packs are a closely guarded secret for security purposes.

⁹¹ Source: Administration for Strategic Preparedness and Response.

⁹² Robarge-Silkiner, *Introduction to the Strategic National Stockpile*, 10.

⁹³ Anshu Siripurapu and Noah Berman, “The State of U.S. Strategic Stockpiles,” Council on Foreign Relations, March 2, 2023, <https://www.cfr.org/backgrounders/state-us-strategic-stockpiles>.

b. Disadvantages

The SNS has its share of disadvantages. Gerstein lays out four shortfalls of the SNS in its current form:

1. unrealistic expectations for the SNS,
2. the historical underfunding of the stockpile and SLTT [state, local, tribal, and territorial] public health preparedness,
3. a lack of timely decisions regarding energizing supply chains, and
4. the federal government's altering of the mission of the SNS during the national emergency.⁹⁴

The most significant disadvantages of the SNS are its size, scope, and status as a temporary measure, not a solution. As former SNS administrator Greg Burel remarked to NBC News during a March 2020 interview, "The Strategic National Stockpile is not designed to be the sole solution to these problems."⁹⁵ The SNS is intended for brief periods in a regional setting until the supply chain normalizes, not a drawn-out global pandemic such as COVID-19.

Funding and appropriations have riddled the stockpile from its inception. Figure 15 depicts annual appropriations by year since its inception. The SNS holds roughly \$8 billion in supplies.⁹⁶ The annual budget for the SNS is approximately \$575 million.⁹⁷ Every medication and most medical supplies have expiration dates that force administrators to make decisions that lead to supply shortfalls. A 2022 Government Accountability Office (GAO) analysis found that the SNS had the recommended types of medical countermeasures but not the appropriate quantities.⁹⁸ The U.S. government asserts that the SNS is an essential national asset. Still, Congress has historically not funded the stockpile

⁹⁴ Gerstein, *The Strategic National Stockpile and COVID-19*, 4.

⁹⁵ Sarah Fitzpatrick, "Why the Strategic National Stockpile Isn't Meant to Solve a Crisis Like Coronavirus," NBC News, March 28, 2020, para. 3, <https://www.nbcnews.com/health/health-care/why-strategic-national-stockpile-isn-t-meant-solve-crisis-coronavirus-n1170376>.

⁹⁶ Donovan Slack and Dinah Voyles Pulver, "US Never Spent Enough on Emergency Stockpile, Former Managers Say," *USA Today*, April 16, 2020, <https://www.usatoday.com/story/news/investigations/2020/03/27/u-s-never-spent-enough-emergency-stockpile-former-managers-say/2915567001/>.

⁹⁷ Gerstein, *The Strategic National Stockpile and COVID-19*, 6.

⁹⁸ Mary Denigan-Macauley, *Public Health Preparedness: HHS Should Address Strategic National Stockpile Requirements and Inventory Risks*, GAO-23-106210 (Washington, DC: Government Accountability Office, 2022), <https://www.gao.gov/products/gao-23-106210>.

fully, meaning it is not a national priority, which puts responders and healthcare workers at risk.

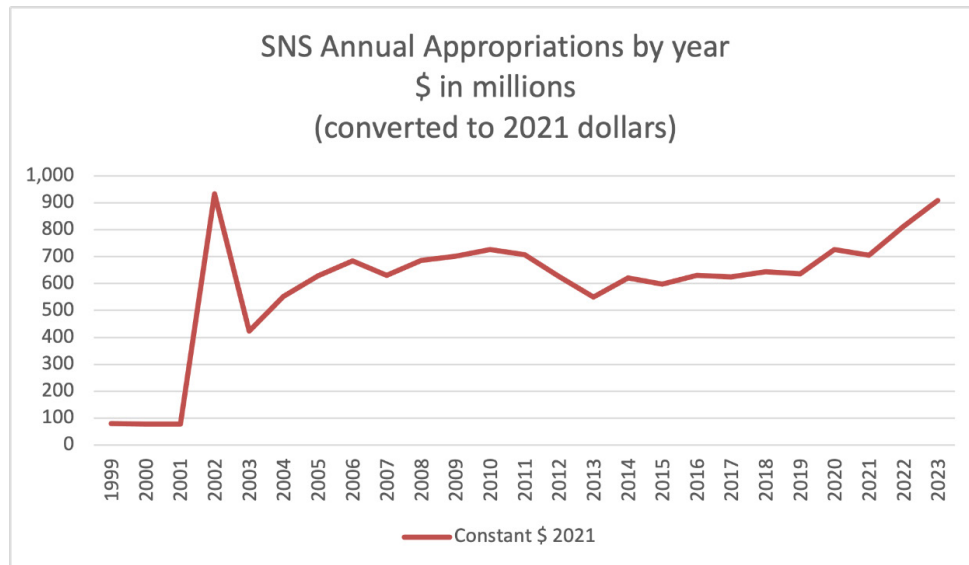


Figure 15. SNS Appropriations by Year, Converted to 2021 Dollars.⁹⁹

At the start of COVID-19, the stockpile was not at total capacity. The 2009 H1N1 (bird flu) pandemic consumed stockpiled supplies but never resupplied the SNS. Burel explained in a March 2020 interview that HHS failed to restock a significant amount of PPE after deploying it.¹⁰⁰ However, the PPE stock remained depleted because the SNS did not receive additional appropriations.¹⁰¹ Burel continued, “Once we used it, the money was not there to rebuy it.”¹⁰² There was no money to resupply the stockpile, and inventory was ineffectual during the next pandemic—COVID-19. *USA Today* reported that during the COVID-19 pandemic, New York State requested 30,000 ventilators and 3 million N95 masks, and California asked for 10,000 ventilators and 20 million masks.¹⁰³ The SNS had

⁹⁹ Adapted from Gottron and Wyatt, *The Strategic National Stockpile*, 6–7.

¹⁰⁰ Fitzpatrick, “Why the Strategic National Stockpile Isn’t Meant to Solve a Crisis.”

¹⁰¹ Fitzpatrick.

¹⁰² Slack and Pulver, “US Never Spent Enough on Emergency Stockpile.”

¹⁰³ Slack and Pulver.

only 16,600 ventilators and 12 million N95 masks. In other words, the SNS had merely a fraction of the supplies needed to handle a nationwide response when the pandemic hit.

Disasters always start at the local level and escalate depending on size and complexity. For SNS activation and deployment, the county first must declare an emergency. Then, the state's governor must declare an emergency and ask the federal government for help. If one of the officials in the request chain does not believe the crisis rises to the scale of state or federal aid, the community will not receive assistance. Although the SNS is an excellent source of medical supplies and equipment, requesting and receiving resources from it is uncertain because it depends on layers of local, state, and federal decisions. As Gerstein explained in testimony to the U.S. Senate in June 2020, "In the case of an emergency, state governors can request deployment of the SNS, but the federal government ultimately determines to release the stockpile."¹⁰⁴ Gottron and Wyatt agree with Gerstein: "The HHS and ASPR policy, not federal statute, dictate the mechanisms for deploying and distributing SNS assets."¹⁰⁵ Thus, the release of supplies has the potential for politicization. For example, if a democratic governor asks for assistance from the federal government, but a republican president does not believe the support is needed, perhaps based on political ideology, the request might be denied.

Tribal access to the SNS was another problem during COVID-19. As detailed in the *National Response Framework*, tribal heads can request federal aid directly during an emergency.¹⁰⁶ However, during the COVID-19 pandemic, ASPR indicated that tribes could utilize the SNS only by coordinating through a state health office or requesting assets through the Indian Health Organization's emergency point of contact.¹⁰⁷ Officials directed the tribes to order SNS supplies in a method different from published procedures.

¹⁰⁴ Gerstein, *The Strategic National Stockpile and COVID-19-19*, 4.

¹⁰⁵ Gottron and Wyatt, *The Strategic National Stockpile*, 13.

¹⁰⁶ Department of Homeland Security, *National Response Framework*, 4th ed. (Washington, DC: Department of Homeland Security, 2019), 33, https://www.fema.gov/sites/default/files/2020-04/NRF_FINALApproved_2011028.pdf.

¹⁰⁷ Gottron and Wyatt, *The Strategic National Stockpile*, 13.

Overall, the SNS is helpful under specific circumstances for regional disasters but does not satisfy the needs for nationwide emergencies or disasters. In its current form, it cannot address a national health emergency like COVID-19, as demonstrated during the pandemic.

E. CONCLUSION

The manufacturing and transportation of PPE is a complicated process. Manufacturing techniques like JIT and lean leave the United States vulnerable because they resist stockpiling or warehousing inventory, favoring just in time over just in case. The debate over push versus pull is another complication. PPE is currently manufactured using pull, a methodology where demand drives the supply. Push, on the other hand, tries to anticipate demand for products, such as producing beach towels ahead of summer. Because push anticipates needs, it requires more planning with transportation and warehousing. This is why push is sometimes called a just-in-case strategy.

When the COVID-19 pandemic hit, breakdowns occurred along every stage of supply chains, from ill employees in manufacturing plants to stoppages in harbors to a blockage in the Suez Canal to truck driver shortages. The mishaps led to needs in everything from toilet paper to lifesaving medical supplies. Finding substitutes and alternate supply chains is possible but problematic if they are not pre-established and further complicated if multiple agencies attempt to use them. For example, if every EMS agency in a metro area goes to its local Home Depot for N95 masks, Home Depot will eventually run out of inventory.

As a result, first responders did not have adequate PPE due to heavy reliance on modern manufacturing like JIT, causing some responders to become ill or die. Although federal safeguards like the SNS exist, they are insufficient to address lifesaving PPE shortages because they are designed to assist regional disasters, not nationwide events. Without significant change, the United States will repeat the same mistakes of the COVID-19 pandemic.

The following two chapters explore past public health outbreaks, highlighting PPE's importance for first responders, starting with HIV/AIDS. HIV was a touchstone

event for first responders; the illness initiated responders' use of PPE in the field. The outbreaks in the upcoming chapters demonstrate the importance of basic PPE, such as gloves, gowns, face shields, surgical masks, and N95 respirators. By examining the past, future needs can be predicted, and the information can be used to address future supply chain issues and potential federal intervention measures.

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III. PPE AND U.S. PUBLIC HEALTH OUTBREAKS, 1970–2010

The late 1960s through the 1980s transformed public safety. Police and fire services had been around for over a century by that point, but modern EMS did not evolve until 1966, when the first federal standards for EMS training were introduced.¹⁰⁸ Then, in 1973, Congress approved the EMS Systems Act.¹⁰⁹ The law established ambulance specifications and curricula for newly created paramedics. Because EMS was a relatively new discipline within public safety, it had a lot of catching up to do.

Not until the discovery of HIV/AIDS did public safety personnel use medical PPE to prevent exposure. Near the start of the HIV/AIDS epidemic, around 1985, the medical field adopted universal precautions (UPs), which dictated that all bodily fluids be considered infected.¹¹⁰ This idea, according to the CDC, meant treating “blood and certain body fluids of all patients . . . [as] potentially infectious for human immunodeficiency virus (HIV), hepatitis B virus, and other bloodborne pathogens.”¹¹¹ Although UPs were a reaction to HIV/AIDS, they became standard guidelines for preventing exposure to many pathogens.¹¹² Because public safety agencies work in field environments that lack running water and laundry services, single-use PPE became a practical way for first responders to protect themselves, creating a dependence on disposable PPE and making supply chains vital in providing it to first responders.

¹⁰⁸ “A Brief History of EMS,” National EMS Memorial Foundation, accessed November 26, 2023, <https://www.emsmemorial.org/ems-history>.

¹⁰⁹ Emergency Medical Services Systems Act, Pub. L. No. 93–154, 82 Stat. 1304 (1973), <https://www.congress.gov/bill/93rd-congress/senate-bill/2410/text>.

¹¹⁰ Phenelle Segal, “The Role of Personal Protective Equipment in Infection Prevention History,” *Infection Control Today*, October 17, 2016, <https://www.infectioncontrolday.com/view/role-personal-protective-equipment-infection-prevention-history>.

¹¹¹ Centers for Disease Control and Prevention, “Perspectives in Disease Prevention and Health Promotion Update: Universal Precautions for Prevention of Transmission of Human Immunodeficiency Virus, Hepatitis B Virus, and Other Bloodborne Pathogens in Health-Care Settings,” *Morbidity and Mortality Weekly Report* 37, no. 24 (1988): 377–88.

¹¹² Ian M. Broussard and Chadi I. Kahwaji, “Universal Precautions,” in *StatPearls* (Treasure Island, FL: StatPearls Publishing, 2023), <http://www.ncbi.nlm.nih.gov/books/NBK470223/>.

Due to periodic outbreaks and pandemics of contagious diseases, each of which necessitates the use of PPE, this chapter explores HIV/AIDS, SARS, and H5N1 (avian) and N1H1 (swine) influenza. This thesis excludes Ebola, Lassa, and other viral hemorrhagic fevers (VHFs) from examination. VHFs require a significantly higher level of PPE because their mortality rate is considerably higher. Fortunately, most VHFs occur in sub-Saharan Africa and have yet to pose a significant threat to first responders in the United States.¹¹³

A. HIV/AIDS, 1970 TO PRESENT

HIV/AIDS was a significant global epidemic. Scientists believe HIV moved from infected chimps to hunters in 1920 in the Congo.¹¹⁴ It spread to Haiti and the Caribbean before reaching New York City around 1970.¹¹⁵ Then, as Bennington-Castro remarks, “Health officials in the United States became aware of AIDS in 1981.”¹¹⁶ Greene elaborates that “in 1981, a new immunodeficiency disease [emerged] in gay men in the U.S.”¹¹⁷ It quickly spread throughout the homosexual population. Greene also notes,

In 1982, the same immunodeficiency disease was diagnosed in Europe. The Disease is named Acquired Immunodeficiency Syndrome (AIDS) by the CDC in the U.S. By late 1982, epidemiologic evidence indicated that AIDS was an infectious disease transferred by bodily fluids and by exposure to contaminated blood or blood products.¹¹⁸

By 1983, U.S. health experts knew they had a health crisis affecting over 1,000 Americans.¹¹⁹ It would become one of the biggest epidemics in the United States.

¹¹³ This chapter, in part, draws from the author’s experience as a paramedic and paramedic supervisor responsible for 9-1-1 responses during the HIV/AIDS, SARS, avian flu, and swine flu pandemics.

¹¹⁴ “History of AIDS,” History Channel, February 21, 2021, <https://www.history.com/topics/1980s/history-of-aids>.

¹¹⁵ Joseph Bennington-Castro, “How AIDS Remained an Unspoken—but Deadly—Epidemic for Years,” History Channel, August 22, 2023, para. 4, <https://www.history.com/news/aids-epidemic-ronald-reagan>.

¹¹⁶ Bennington-Castro, para. 5.

¹¹⁷ Warner C. Greene, “A History of AIDS: Looking Back to See Ahead,” *European Journal of Immunology* 37, no. S1 (2007): S96, <https://doi.org/10.1002/eji.200737441>.

¹¹⁸ Greene.

¹¹⁹ Bennington-Castro, “How AIDS Remained an Unspoken Epidemic,” para. 11.

Disease transmission for HIV/AIDS is difficult and occurs only under specific conditions. According to the CDC, HIV makes people ill by attacking the immune system, destroying white blood cells, and weakening the body's ability to fight infection.¹²⁰ Certain bodily fluids, including blood, transmit HIV.¹²¹ For transmission to occur, HIV-infected fluids must enter the bloodstream, such as through open cuts or sores, through mucous membranes, or by direct injection.¹²² HIV does not live long outside the host, which makes the disease harder to transmit from person to person and more manageable to contain because touching surfaces like doorknobs or countertops does not result in transmission.

HIV symptoms are the same as many other illnesses. Fever and chills, sore throat, fatigue, and muscle aches are common for HIV, as well as dozens of other diseases.¹²³ However, someone may have less-common symptoms of HIV, such as a rash, night sweats, or mouth ulcers, or none at all.¹²⁴ Figure 16 depicts common symptoms of HIV. The only way to know whether a person has HIV is through testing.

¹²⁰ "About HIV," Centers for Disease Control and Prevention, June 30, 2022, <https://www.cdc.gov/hiv/basics/whatishiv.html>; "HIV Basics," Centers for Disease Control and Prevention, March 2, 2023, <https://www.cdc.gov/hiv/basics/index.html>.

¹²¹ "How Is HIV Transmitted?," Minority HIV/AIDS Fund, June 16, 2022, <https://www.hiv.gov/hiv-basics/overview/about-hiv-and-aids/how-is-hiv-transmitted>.

¹²² Minority HIV/AIDS Fund.

¹²³ Centers for Disease Control and Prevention, "About HIV."

¹²⁴ Centers for Disease Control and Prevention.

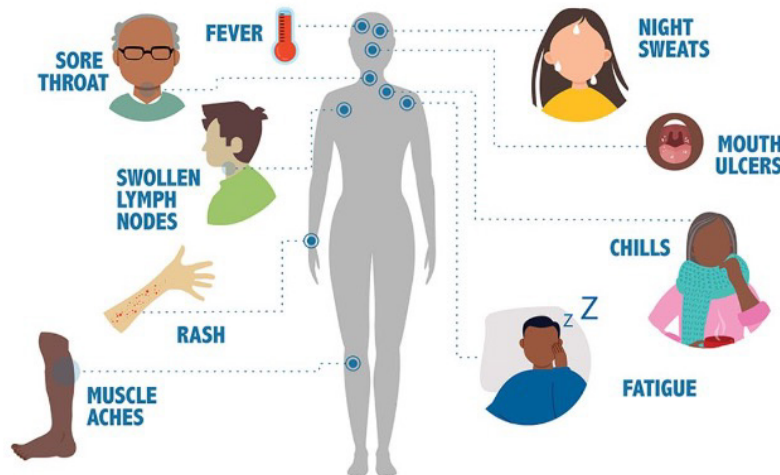


Figure 16. Symptoms of HIV.¹²⁵

HIV/AIDS destroys the immune system. As the HIV infection multiplies, it attacks white blood cells called CD4 (a T-cell).¹²⁶ When a T-cell count drops below 200 per millimeter of blood, the patient is diagnosed with AIDS.¹²⁷ Because of the low white blood cell count, opportunistic infections such as pneumonia or tuberculosis or various cancers can take hold.¹²⁸ Death comes from multiple diseases that a healthy immune system can otherwise fight off.¹²⁹ People typically die from a secondary cause because of a weakened immune system, not AIDS.

1. PPE and First-Responder Vulnerability

HIV/AIDS caused the first-responder community to use medical PPE to protect against infection. Although firefighters used turnout gear and some police officers started wearing ballistic vests, this disease marked a paradigm shift in workplace hazards

¹²⁵ Source: Centers for Disease Control and Prevention, “About HIV.”

¹²⁶ “CD4 Count (or T-Cell Count),” Department of Veterans Affairs, accessed April 20, 2023, <https://www.hiv.va.gov/patient/diagnosis/labs-CD4-count.asp>.

¹²⁷ “AIDS and Opportunistic Infections,” Centers for Disease Control and Prevention, March 30, 2022, <https://www.cdc.gov/hiv/basics/livingwithhiv/opportunisticinfections.html>.

¹²⁸ Centers for Disease Control and Prevention.

¹²⁹ “Pandemics That Changed History,” History Channel, December 21, 2021, <https://www.history.com/topics/middle-ages/pandemics-timeline>.

for first responders. For the first time, first responders realized they could die from physical contact with a citizen during the regular performance of their jobs. Barnard et al. understand the dangers HIV/AIDS poses to first responders. They contend, “Law enforcement officers and first responders (paramedics, firefighters) may be routinely exposed to the human immunodeficiency virus (HIV) through occupational activity.”¹³⁰ Transmission of HIV/AIDS by exposure to blood or other bodily fluids threatens their lives.

The fear for first responders was real. First responders could acquire accidental infections of HIV from patients in various situations, including spit in the mouth, unintentional needle sticks when starting an IV line or injecting medication, or open cuts.¹³¹ Basic PPE, such as gloves and gowns, protect first responders in close contact with someone infected with HIV/AIDS.

Responders had to use UPs to prevent acquiring the disease. Before HIV/AIDS, first responders often had uniforms covered in blood, and having a bloody uniform became a badge of honor, indicative of “real work” or a “good call.”¹³² Although institutionalizing the idea of first responders’ wearing exam gloves on every call took years, eventually, it became a widely accepted practice. Today, any EMT or paramedic taking the national registry exam must verbalize or physically don PPE during the practical exam; failure to do so results in a no-pass on the evaluation.¹³³ Without HIV/AIDS and the rule of UPs, today’s first responders would not have developed the muscle memory to use PPE on every medical call.

Because HIV/AIDS is spread by direct contact with infected bodily fluids, it is possible for exposure by contact, droplet, or splashing of infected fluids. The CDC

¹³⁰ Rebecca Barnard et al., “AIDS Knowledge, Occupational Precautions, and Public Education Activities among Law Enforcement Officers and First Responders,” *Journal of Public Health Policy* 15, no. 4 (1994): 460, <https://doi.org/10.2307/3343027>.

¹³¹ Minority HIV/AIDS Fund, “How Is HIV Transmitted?”

¹³² The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author’s professional experience, training, and education.

¹³³ “Advanced Level Psychomotor Exams,” National Registry of Emergency Medical Technicians, accessed September 15, 2023, <https://www.nremt.org/Document/aemt-paramedic-psychomotor-exams>.

recommends using UPs by considering all patients potentially infected. The CDC advises using gloves, a surgical mask, gown, and eye protection when interacting with an HIV/AIDS patient if there is a reasonable expectation of encountering bodily fluids.¹³⁴ PPE for HIV/AIDS patients varies depending on the symptoms they are exhibiting and the aid a first responder might render. There has been no indication of a PPE shortage during the HIV/AIDS era.

2. Economic Impact

The economic impact of the global HIV/AIDS epidemic is hard to measure. The most current economic impact research focuses on Africa, where HIV/AIDS remains a significant problem. According to Medeiros, “This disease has remained a horrifying part of life for millions of people for several decades.”¹³⁵ An estimated one million people in the United States have HIV/AIDS.¹³⁶ Inconsistent reporting of cases, economic differences, and the still-present stigma of HIV/AIDS worldwide make measuring the economic impact challenging.

One level of the economic impact is on the infected patients and their families, described as a direct cost that includes medical care. Advanced HIV patients require significant medical treatment and care, often more expensive than what is used for other health conditions.¹³⁷ A 2021 study found that the estimated lifetime medical cost for an HIV patient is around \$420,000 in 2019 dollars.¹³⁸ This cost is significant compared to

¹³⁴ James Mason, “Recommendations for Prevention of HIV Transmission in Health-Care Settings,” *Morbidity and Mortality Weekly Report* 36, no. 2S (1987), <https://www.cdc.gov/mmwr/preview/mmwrhtml/00023587.htm>.

¹³⁵ Vasco Medeiros, “The Economic Impacts of AIDS,” News-Medical, June 1, 2022, para. 2, <https://www.news-medical.net/health/The-Economic-Impacts-of-AIDS.aspx>.

¹³⁶ Medeiros.

¹³⁷ John Stover and Lori Bollinger, *The Economic Impact of AIDS* (Washington, DC: Futures Group International, 1999), 8, https://pdf.usaid.gov/pdf_docs/PNACM899.pdf.

¹³⁸ Adrienna Bingham et al., “Estimated Lifetime HIV-Related Medical Costs in the United States,” *Sexually Transmitted Diseases* 48, no. 4 (April 2021): 299–304, <https://doi.org/10.1097/OLQ.0000000000001366>.

the first-year cost of cancer, which is around \$169,000 for breast cancer in 2019 dollars, according to a 2022 cancer study.¹³⁹ HIV/AIDS is quite expensive to treat.

HIV/AIDS has the most significant impact on the local community. HIV/AIDS affects entire communities because removing working-age adults from the workforce has a devastating economic impact.¹⁴⁰ People with advanced HIV often cannot work because of profound weakness. In this way, having fewer workers can cause labor shortages, resulting in fewer taxes collected and a weakened economy. Likewise, orphans need care and services from the government, which depletes government funds.¹⁴¹ A community with many HIV/AIDS patients is challenged to sustain itself.

3. Analysis

HIV/AIDS continues to threaten the first-responder community, but it is no longer the death sentence it once was. Fortunately, over the last 40 years, pharmaceutical companies have made giant leaps toward managing the condition with drugs: several FDA-approved drugs called antiretroviral therapies are now available.¹⁴² Pre-exposure prophylaxis drugs are available in the United States, which can reduce the risk of acquiring HIV from IV drug use or sexual intercourse.¹⁴³ Despite the current lack of an HIV vaccine, messenger ribonucleic acid (RNA) vaccine technology, first used in the COVID-19 vaccine, has shown promise.¹⁴⁴ However, humanity will continue to live with HIV/AIDS for the foreseeable future.

¹³⁹ Ya-Chen Tina Shih et al., “Costs around the First Year of Diagnosis for 4 Common Cancers among the Privately Insured,” *Journal of the National Cancer Institute* 114, no. 10 (October 2022): 1392–99, <https://doi.org/10.1093/jnci/djac141>.

¹⁴⁰ Stover and Bollinger, *The Economic Impact of AIDS*, 3.

¹⁴¹ Stover and Bollinger, 3.

¹⁴² “FDA-Approved HIV Medicines,” National Institutes of Health, March 23, 2023, <https://hivinfo.nih.gov/understanding-hiv/fact-sheets/fda-approved-hiv-medicines>.

¹⁴³ “About PrEP,” Centers for Disease Control and Prevention, July 12, 2022, <https://www.cdc.gov/hiv/basics/prep/about-prep.html>.

¹⁴⁴ “mRNA Vaccine Technology: A Promising Idea for Fighting HIV,” National Institutes of Health, February 20, 2023, <https://covid19.nih.gov/news-and-stories/mrna-vaccine-technology-promising-idea-fighting-hiv>.

B. SARS, 2002–2003

Bursting on the scene shortly after the terrorist attacks on 9/11, SARS had a considerable lag between its discovery and declared public health threat. The virus originated in bats and most likely spread to humans through China’s live animal markets (also known as “wet markets”).¹⁴⁵ First presenting as a case of atypical pneumonia in southern China on November 16, 2002, the virus was unknown to the international community until an outbreak in China in February 2003.¹⁴⁶ The Chinese government had kept the initial discovery under wraps, not disclosing it for four months, so the WHO did not issue a global alert until March 12, 2003.¹⁴⁷ By July 5, 2003, the WHO declared SARS contained.¹⁴⁸ LeDuc and Barry called SARS “the first pandemic of the 21st century,” a prelude to pandemics to come.¹⁴⁹

SARS surprised public health officials. The virus caused a highly contagious respiratory illness that can be fatal to some.¹⁵⁰ Travelers quickly spread it across the globe. According to the WHO, “It was the first severe and readily transmissible new disease to emerge in the 21st century and showed a clear capacity to spread along the routes of international air travel.”¹⁵¹ Its transmission resulted from close contact with an infected person, which set off a series of infections.¹⁵² Unlike HIV/AIDS, SARS

¹⁴⁵ Annamarie Bindenagel Šehović, “SARS and H5N1,” in *Coordinating Global Health Policy Responses* (Cham, Switzerland: Springer International Publishing, 2017), 92, https://doi.org/10.1007/978-3-319-52006-3_5.

¹⁴⁶ “CDC SARS Response Timeline,” Centers for Disease Control and Prevention, April 26, 2013, <https://stacks.cdc.gov/view/cdc/44683>; “Severe Acute Respiratory Syndrome (SARS),” World Health Organization, accessed April 20, 2023, https://www.who.int/health-topics/severe-acute-respiratory-syndrome#tab=tab_1.

¹⁴⁷ Centers for Disease Control and Prevention, “CDC SARS Response Timeline.”

¹⁴⁸ Centers for Disease Control and Prevention.

¹⁴⁹ James W. LeDuc and M. Anita Barry, “SARS, the First Pandemic of the 21st Century,” *Emerging Infectious Diseases* 10, no. 11 (November 2004): e26, https://doi.org/10.3201/eid1011.040797_02.

¹⁵⁰ “Severe Acute Respiratory Syndrome (SARS): Symptoms and Causes,” Mayo Clinic, accessed April 21, 2023, <https://www.mayoclinic.org/diseases-conditions/sars/symptoms-causes/syc-20351765>.

¹⁵¹ World Health Organization, “Severe Acute Respiratory Syndrome,” para. 2.

¹⁵² “Severe Acute Respiratory Syndrome (SARS),” Johns Hopkins Medicine, January 28, 2020, <https://www.hopkinsmedicine.org/health/conditions-and-diseases/severe-acute-respiratory-syndrome-sars>.

could live on surfaces outside a host.¹⁵³ Thus, people could contract SARS from surface contact with everyday items like doorknobs, railings, and elevator buttons. Touching a contaminated object and then touching one's mouth and nose was one way to contract SARS.¹⁵⁴ This feature aided its spread during the 2002–2004 outbreak.

Diagnosing SARS is tricky because it presents like other diseases and conditions. First, it mimics pneumonia but also other common ailments with such symptoms as fever, headache, body aches, and chills.¹⁵⁵ Shortness of breath, a dry cough, and difficulty breathing are critical differences between SARS and other common illnesses.¹⁵⁶ Because of the common symptoms of SARS, diagnosing it involves gathering a detailed history of a person's travel and interactions with infected people.

1. PPE and First-Responder Vulnerability

Protection against SARS is simple. Frequent handwashing is a good technique to prevent the spread of the disease. The WHO recommends that people in contact with infected SARS patients use PPE, including a mask, goggles, and an apron.¹⁵⁷ Because SARS is a respiratory illness, N95 respirators gained importance.

As a young paramedic with a recent memory of the 9/11 terrorist attacks and knowledge of the Amerithrax letters in September–October 2001, this author can attest that SARS was a genuine concern for first responders. When someone sneezed or coughed on an incoming international flight, it triggered an emergency response. Every passenger was medically evaluated, sometimes taking hours. It was the first time this author used an N95 respirator. Until then, EMS crews used N95 respirators only for tuberculosis patients, and annual N95 fit testing was for something they thought they would never need. SARS was the first time after the HIV/AIDS epidemic that responders, particularly those near international travel hubs, worried about contracting

¹⁵³ World Health Organization, "Severe Acute Respiratory Syndrome."

¹⁵⁴ Johns Hopkins Medicine, "Severe Acute Respiratory Syndrome."

¹⁵⁵ Johns Hopkins Medicine.

¹⁵⁶ World Health Organization, "Severe Acute Respiratory Syndrome."

¹⁵⁷ World Health Organization.

a deadly disease from a patient. As a paramedic at the Minneapolis–Saint Paul International Airport, this author was acutely aware of SARS and had screening questions ready for ill patients, but while working in the suburbs the next day, SARS was barely a thought during medical assessments.¹⁵⁸

SARS is a respiratory infection with coughing as a significant symptom. As such, droplet precautions are required. The CDC recommends gloves, gowns, N95 respirators, and eye protection.¹⁵⁹ Coughing or sneezing patients pose a risk to responders as infected droplets enter the air (see Figure 17). During the SARS outbreak, there was no indication of a PPE shortage.



Figure 17. Depiction of a Sneeze with a Plume of Airborne Droplets.¹⁶⁰

¹⁵⁸ The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author's professional experience, training, and education.

¹⁵⁹ Centers for Disease Control and Prevention, "Supplement I: Infection Control in Healthcare, Home, and Community Settings," in *Public Health Guidance for Community-Level Preparedness and Response to Severe Acute Respiratory Syndrome (SARS)*, version 2 (Atlanta: Centers for Disease Control and Prevention, 2004), <https://www.cdc.gov/sars/guidance/i-infection/healthcare.pdf>.

¹⁶⁰ Source: Centers for Disease Control and Prevention, "Sneeze," Public Health Image Library, 2009, <https://phil.cdc.gov/Details.aspx?pid=11162>.

2. Economic Impact

The SARS outbreak had a tremendous impact on the global economy. According to the WHO, at least 8,096 people contracted SARS across 29 countries, and at least 774 died during the 2002–2004 SARS outbreak.¹⁶¹ According to the WHO, the mortality rate for SARS was around 3 percent.¹⁶² Economists estimate a global loss of \$40 billion from diminished tourism, absenteeism, and escalated healthcare costs.¹⁶³ Although a worldwide outbreak, with hundreds of deaths and billions of dollars lost, SARS motivated U.S. public health and first-responder agencies very little to prepare for the next public health crisis.

3. Analysis

The SARS outbreak came at an interesting time in world history. Shortly after the 9/11 attacks on America and the Amerithrax letters, it was an unsettling time for first responders in the United States. Although first responders were fixated on terrorism, a public health crisis emerged. Because SARS was airborne, rather than transmitted through physical contact as with HIV, it was a more contagious disease. The low mortality rate did little to quell media coverage. The most significant impact on U.S. society was the economic disruption. For first responders, SARS represented an emerging public health threat outside its borders. EMS started planning for pandemic responses for the first time, increasing the importance of PPE beyond gloves on every call.

C. AVIAN FLU, 2002–2005

The next public health crisis was the avian flu outbreak from 2002 to 2005. Avian flu, or bird flu, has been around for over a hundred years. First mentioned in 1878 as the

¹⁶¹ “Summary of Probable SARS Cases with Onset of Illness from 1 November 2002 to 31 July 2003,” World Health Organization, December 31, 2003, https://web.archive.org/web/20200319162659/https://www.who.int/csr/sars/country/table2004_04_21/en/.

¹⁶² World Health Organization, “Severe Acute Respiratory Syndrome.”

¹⁶³ “The SARS Epidemic,” University of Massachusetts Amherst, Science, Technology & Society Initiative, accessed April 21, 2023, <https://www.umass.edu/sts/ethics/online/cases/SARS/case.html>.

“fowl plague,” it was described as a contagious bird disease with high mortality.¹⁶⁴ It first presented before the discovery of viruses. In 1955, after viral detection advanced, the virus was identified as type-A influenza, and in 1981, avian influenza replaced the term fowl plague.¹⁶⁵

SARS and avian flu overlapped slightly, leading to diagnostic confusion for some time, especially since the diseases had similar symptoms in humans. Around December 2003, eight Asian countries started reporting a strain of the high pathogenicity avian influenza (HPAI) H5N1 virus in humans.¹⁶⁶ In February 2003, two human cases of bird flu (one of them fatal) were reported in Hong Kong.¹⁶⁷ In November 2003, a deadly case of H5N1 occurred in China.¹⁶⁸ Additional non-lethal cases were reported in Vietnam and Thailand.¹⁶⁹ Cases of avian flu continued after 2005, but the virus had mutated.¹⁷⁰ Avian flu was never officially declared contained by the WHO, and it continues to mutate and affect poultry. In some isolated cases, it has crossed over to infect small groups of humans.

Disease transmission of avian flu is tough to combat. According to the CDC, from 2003 to 2005, migrating birds spread HPAI throughout Europe, Africa, and the

¹⁶⁴ “Highlights in the History of Avian Influenza (Bird Flu),” Centers for Disease Control and Prevention, July 8, 2022, para. 1, <https://www.cdc.gov/flu/avianflu/timeline/avian-timeline-background.htm>.

¹⁶⁵ Centers for Disease Control and Prevention, “Highlights in the History of Avian Influenza”; “Information on Avian Influenza,” Centers for Disease Control and Prevention, April 10, 2023, <https://t.cdc.gov/VAY>.

¹⁶⁶ L. D. Sims et al., “Origin and Evolution of Highly Pathogenic H5N1 Avian Influenza in Asia,” *Veterinary Record* 157, no. 6 (August 2005): 159–64, <https://doi.org/10.1136/vr.157.6.159>.

¹⁶⁷ Food and Agriculture Organization of the United Nations, World Organisation for Animal Health, and World Health Organization, *H5N1 Highly Pathogenic Avian Influenza: Timeline of Major Events* (Geneva: World Health Organization, 2014), 1, https://cdn.who.int/media/docs/default-source/influenza/avian-and-other-zoonotic-influenza/h5n1_avian_influenza_update20141204.pdf.

¹⁶⁸ Food and Agriculture Organization of the United Nations, World Organisation for Animal Health, and World Health Organization, 1.

¹⁶⁹ Food and Agriculture Organization of the United Nations, World Organisation for Animal Health, and World Health Organization, 2.

¹⁷⁰ “Highlights in the History of Avian Influenza (Bird Flu) Timeline—2000–2009,” Centers for Disease Control and Prevention, July 8, 2022, <https://www.cdc.gov/flu/avianflu/timeline/avian-timeline-2000s.htm>.

Middle East.¹⁷¹ Before the outbreak, bird flu seemed like a regional threat. That perception changed in 2004 when cases of avian flu appeared in poultry in Canada and the United States.¹⁷² The year 2004 marked the first time in 20 years that the United States had an HPAI outbreak.¹⁷³ The event caused U.S. public health, agriculture, and occupational health officials, along with first responders, to take notice.

Avian flu is complicated. Like most viruses, bird flu has many strains but falls into two groups: low pathogenicity avian influenza (LPAI) and HPAI.¹⁷⁴ LPAI carries minimal clinical signs or symptoms while HPAI causes severe signs and symptoms, including death.¹⁷⁵ HPAI is most concerning because it involves transmission from bird to bird and from birds to other species, such as humans. From 2003 to 2005, bird flu moved from migrating wild birds to domesticated chickens and turkeys to farmworkers and hobby farmers (see Figure 18). When farmworkers became ill, they had the potential to spread the flu to their families and communities. In this way, containing avian flu is tricky because wild birds transit the world.

¹⁷¹ Centers for Disease Control and Prevention.

¹⁷² Centers for Disease Control and Prevention.

¹⁷³ Chang-Won Lee et al., “H5N2 Avian Influenza Outbreak in Texas in 2004: The First Highly Pathogenic Strain in the United States in 20 Years?,” *Journal of Virology* 79, no. 17 (September 2005): 11413, <https://doi.org/10.1128/jvi.79.17.11412-11421.2005>.

¹⁷⁴ “Avian Influenza,” World Organisation for Animal Health, accessed May 7, 2023, <https://www.woah.org/en/disease/avian-influenza/>.

¹⁷⁵ World Organisation for Animal Health.

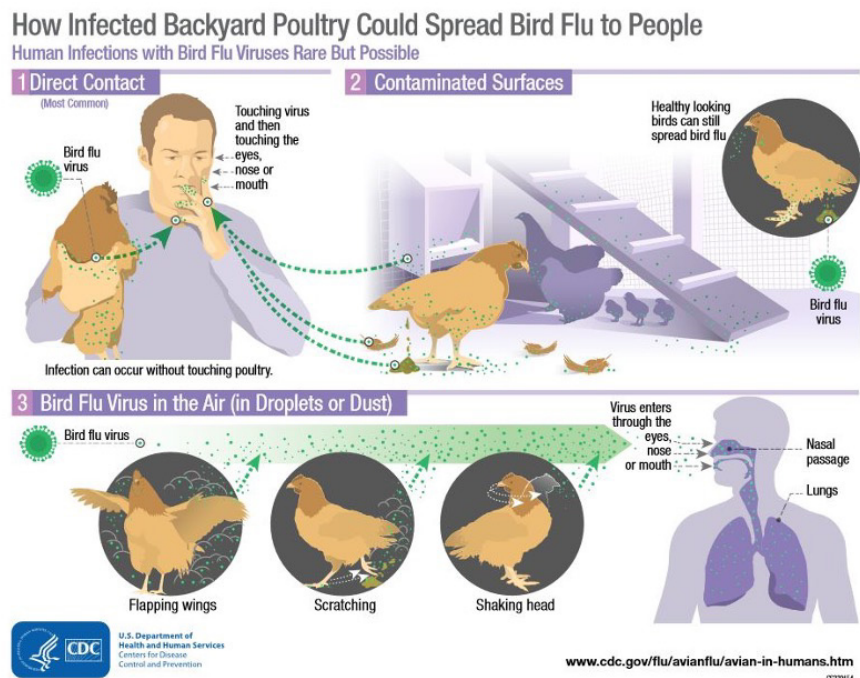


Figure 18. Avian Flu Transmission.¹⁷⁶

The symptoms associated with bird flu are like other flu variations. They include fever, cough, muscle aches, sore throat, and diarrhea.¹⁷⁷ Because the symptoms of bird flu resemble several different viruses, lab testing is necessary to make a definitive diagnosis.¹⁷⁸ With generalized symptoms, people often bypass testing, thus making diagnosing the disease and quarantining people difficult.

1. PPE and First-Responder Vulnerability

Avian flu caused first responders to pay attention to pandemic illnesses. It was the first time American responders started stockpiling PPE and developing pandemic guidelines. EMS officials weighed whether to respond to every medical call during surges of patients while

¹⁷⁶ Source: “How Infected Backyard Poultry Could Spread Bird Flu to People,” Centers for Disease Control and Prevention, May 4, 2022, <https://www.cdc.gov/flu/pdf/avianflu/avian-flu-transmission.pdf>.

¹⁷⁷ National Institute for Occupational Safety and Health, *Protecting Poultry Workers from Avian Influenza (Bird Flu)* (Washington, DC: Department of Health and Human Services, 2008), 10, <https://www.cdc.gov/niosh/docs/2008-128/pdfs/2008-128.pdf?id=10.26616/NIOSH-PUB2008128>.

¹⁷⁸ “Bird Flu Virus Infections in Humans,” Centers for Disease Control and Prevention, May 4, 2022, <https://www.cdc.gov/flu/avianflu/avian-in-humans.htm>.

EMS physicians and chiefs discussed alternate transport decisions, including not sending an ambulance for those with flu-like symptoms and not transporting patients to the emergency room (ER). These considerations represented a drastic shift in EMS philosophy, especially in Minnesota, where state statute requires an ambulance to transport any patient who asks to be taken to an ER, regardless of need. In other words, ambulances cannot deny transport.¹⁷⁹ Before bird flu, the idea of EMS systems' not responding to a request for help or transporting a sick person to the ER was unthinkable.¹⁸⁰ Thus, as with HIV/AIDS, first responders reacted to these threats to their health.

Vaccine distribution was also highly debated. A 2006 article in EMS1, an online trade publication, asserted vaccines should be provided to young, productive adults before the old, sick, and infirm.¹⁸¹ The article weighed the ethical implications of protecting younger populations with more fruitful years of life over the elderly who are not necessarily productive members of society. Ezekiel Emanuel, a medical ethicist at the National Institutes of Health, commented that saving the most lives is not a justifiably ethical approach during pandemics.¹⁸² Emanuel suggested, "Priority should be given instead to three life principles: saving those who still have a life span ahead of them, whose lives have already been invested in and who can maintain public order in a pandemic."¹⁸³ Such ethical debates resurfaced during COVID-19.

Fortunately, protection from bird flu is straightforward. Prevention starts with good hand hygiene, as with most other viruses and infectious diseases. During avian flu outbreaks, farmworkers must use industrial PPE coverings over boots and coveralls; head protection, such as hairnets or bonnets; eye protection; disposable gloves; and, most importantly, an N95

¹⁷⁹ Ambulance Service Requirements, Minn. Stat. § 144E.101 (2023), <https://www.revisor.mn.gov/statutes/cite/144e.101>.

¹⁸⁰ The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author's professional experience, training, and education.

¹⁸¹ Rita Daly, "Study Says to Treat Elderly Last in Pandemic," EMS1, May 12, 2006, <https://www.ems1.com/research-reviews/articles/study-says-to-treat-elderly-last-in-pandemic-e6Scr7jAQkQimlCR/>.

¹⁸² Daly, para. 13.

¹⁸³ Daly, para. 13.

respirator.¹⁸⁴ Emergency responders should protect themselves in the same manner as poultry workers. Donning gloves, gowns, face shields, and N95 respirators will provide adequate protection when treating a human with avian flu. Coughing patients pose a risk to responders as infected droplets enter the air (see Figure 17). There was no indication of a PPE shortage during this outbreak.

2. Economic Impact

The 2002–2005 bird flu outbreak significantly affected the global economy. Poultry accounts for 20 percent of the protein consumed in developing countries.¹⁸⁵ Because avian flu is difficult to diagnose without a lab test, obtaining an accurate count of the sick or dead, specifically during the 2002–2005 outbreak, was difficult. Nonetheless, between 2002 and 2008, there were 379 confirmed cases in 14 countries, of which 239 cases, or 63 percent, were fatal.¹⁸⁶ It was thus considered a highly lethal outbreak.

Culling an entire flock is necessary when a group of birds has suspected bird flu infections. Destroying a farmer's whole poultry flock, however, is financially devastating. Reduced poultry production in the United States means increased chicken, turkey, and egg prices. At the same time, demand for these products falls because of an unwarranted belief that one might contract bird flu from consuming poultry. For example, turkey production was down by 5.3 percent and turkey exports by 19 percent in the first half of 2004.¹⁸⁷ At the same time, egg prices rose by six cents from the previous year, and the cost of feed increased, lowering farmers' profits.¹⁸⁸ In short, culling entire flocks caused an exponential impact on the economy, compounded by the demand for feed and other poultry-related supplies and goods.

¹⁸⁴ National Institute for Occupational Safety and Health, *Protecting Poultry Workers from Avian Influenza*, 8.

¹⁸⁵ Robyn Alders et al., "Impact of Avian Influenza on Village Poultry Production Globally," *Ecohealth* 11, no. 1 (March 2014): 63–72, <https://doi.org/10.1007/s10393-013-0867-x>.

¹⁸⁶ National Institute for Occupational Safety and Health, *Protecting Poultry Workers from Avian Influenza*, 7.

¹⁸⁷ Leland Southard, *Livestock, Dairy, and Poultry Outlook*, LDP-M-122 (Washington, DC: Department of Agriculture, 2004), 11.

¹⁸⁸ Southard, 12.

3. Analysis

SARS and avian flu overlapped and caught the United States by surprise.¹⁸⁹ Because of these overlapping public health emergencies, the international community updated the International Health Regulations, originally adopted in 1951.¹⁹⁰ The goal of these regulations is to “prevent, protect against, control and provide a public health response to the international spread of disease, without unduly interfering with international movement, such as maritime and flight traffic, and trade.”¹⁹¹ Avian flu forced decision-makers to pay attention and update pandemic preparedness and planning, which was beneficial for everyone.

Avian flu had a higher mortality rate at 63 percent than SARS did at 3 percent. Disease transmission was hard to contain because of wild bird migration. In this way, avian flu poses a swifter global spread than with other animal-borne illnesses such as coronaviruses like SARS, swine flu, and MERS. The economic impact of bird flu is tremendous due to the size of poultry farming worldwide, making avian flu a more significant concern than other public health outbreaks.

D. SWINE FLU, 2009–2010

H1N1 swine flu was the next public health outbreak. During the 2009–2010 flu season, swine flu was the new virus to start causing human illness.¹⁹² Swine flu differed from other variants; it broke all the traditional rules. It did not dissipate as the seasons changed to summer, as most flu variants do. It was the first flu pandemic the WHO declared in almost 40 years.¹⁹³ Because swine flu did not follow traditional contagion rules, it was challenging for public health officials and first responders.

¹⁸⁹ Šehović, “SARS and H5N1,” 101.

¹⁹⁰ Šehović, 96.

¹⁹¹ Šehović, 97.

¹⁹² “H1N1 Flu (Swine Flu): Symptoms and Causes,” Mayo Clinic, March 23, 2023, <https://www.mayoclinic.org/diseases-conditions/swine-flu/symptoms-causes/syc-20378103>.

¹⁹³ Fabian Duarte et al., *The Effect of the 2009 Influenza Pandemic on Absence from Work* (Santa Monica, CA: RAND Corporation, 2016), 3, <https://doi.org/10.7249/WR1176>.

Swine flu erupted differently from other flu outbreaks, which typically originate in Asia. In March 2009, parts of Mexico experienced several respiratory infections and influenza-like cases.¹⁹⁴ Swine flu was first discovered in California spanning April 15–17, 2009.¹⁹⁵ The CDC identified two unconnected cases of swine influenza at the time.¹⁹⁶ On April 18, 2009, the CDC reported the infections to the WHO.¹⁹⁷ By May 5, 2009, 642 cases of N1H1 appeared across the United States.¹⁹⁸ In June 2009, the WHO declared a pandemic after 74 countries reported confirmed cases.¹⁹⁹ The WHO declared the pandemic had ended in August 2010.²⁰⁰ In short, N1H1 spread quickly around the globe and almost as quickly died out.

Swine flu quickly gained attention in the public health community due to its dark past. The 2009–2010 N1H1 pandemic was related to the 1918 flu, also known as the Spanish flu.²⁰¹ According to recent research, five of its eight RNA segments indicate the swine flu’s relation to the 1918 Spanish flu.²⁰² The 1918 flu infected around 500 million or one-third of the world’s population, killing over 50 million people worldwide.²⁰³ The connection to the

¹⁹⁴ Renée Johnson, *Potential Farm Sector Effects of 2009 H1N1 “Swine Flu”*: Questions and Answers, CRS Report No. R40575 (Washington, DC: Congressional Research Service, 2010), summary, <https://crsreports.congress.gov/product/pdf/R/R40575/11>.

¹⁹⁵ “2009 H1N1 Flu Pandemic Timeline,” Centers for Disease Control and Prevention, May 8, 2019, https://stacks.cdc.gov/view/cdc/79994/cdc_79994_DS1.pdf?.

¹⁹⁶ Novel Swine-Origin Influenza A (H1N1) Virus Investigation Team, “Emergence of a Novel Swine-Origin Influenza A (H1N1) Virus in Humans,” *New England Journal of Medicine* 360, no. 25 (2009): 2606, <https://doi.org/10.1056/NEJMoa0903810>.

¹⁹⁷ Centers for Disease Control and Prevention, “2009 H1N1 Flu Pandemic Timeline.”

¹⁹⁸ Novel Swine-Origin Influenza A (H1N1) Virus Investigation Team, “Emergence of a Novel Swine-Origin,” 2609.

¹⁹⁹ “Influenza A (H1N1) Pandemic 2009–2010,” World Health Organization, accessed May 28, 2023, [https://www.who.int/emergencies/situations/influenza-a-\(h1n1\)-outbreak](https://www.who.int/emergencies/situations/influenza-a-(h1n1)-outbreak).

²⁰⁰ Mayo Clinic, “H1N1 Flu.”

²⁰¹ Sami Al Hajjar and Kenneth McIntosh, “The First Influenza Pandemic of the 21st Century,” *Annals of Saudi Medicine* 30, no. 1 (2010): 1–10, <https://doi.org/10.4103/0256-4947.59365>.

²⁰² Stacey Knobler et al., eds., *The Threat of Pandemic Influenza: Are We Ready?: Workshop Summary* (Washington, DC: National Academies Press, 2005), 58.

²⁰³ Jeffery K. Taubenberger and David M. Morens, “1918 Influenza: The Mother of All Pandemics,” *Emerging Infectious Diseases* 12, no. 1 (2006): 15, <https://doi.org/10.3201/eid1201.050979>.

1918 flu caused public health officials to act quickly, which likely helped contain the outbreak.

The transmission of N1H1 was different from other flus. Unlike most seasonal cases of flu that infect people during the winter when they spend most of their time indoors, N1H1 caused a high level of infection during the summer.²⁰⁴ The disease affected children and young adults the most because, according to experts, juveniles had not been exposed to previous strains of H1N1.²⁰⁵ By late June 2009, over 30 summer camps experienced H1N1 outbreaks.²⁰⁶ By late June 2009, the CDC estimated at least one million cases of swine flu within the United States.²⁰⁷ By late October 2009, 48 of 50 states reported widespread infections.²⁰⁸ One of the reasons for the speed of transmissions was airline travel.²⁰⁹ By the first decade of the 21st century, the country was more globally connected than ever before, allowing disease to spread with travelers (see Figure 19).

²⁰⁴ World Health Organization, “Influenza A (H1N1) Pandemic 2009–2010.”

²⁰⁵ Al Hajjar and McIntosh, “The First Influenza Pandemic of the 21st Century.”

²⁰⁶ Centers for Disease Control and Prevention, “2009 H1N1 Flu Pandemic Timeline.”

²⁰⁷ Centers for Disease Control and Prevention.

²⁰⁸ Centers for Disease Control and Prevention.

²⁰⁹ Al Hajjar and McIntosh, “The First Influenza Pandemic of the 21st Century.”

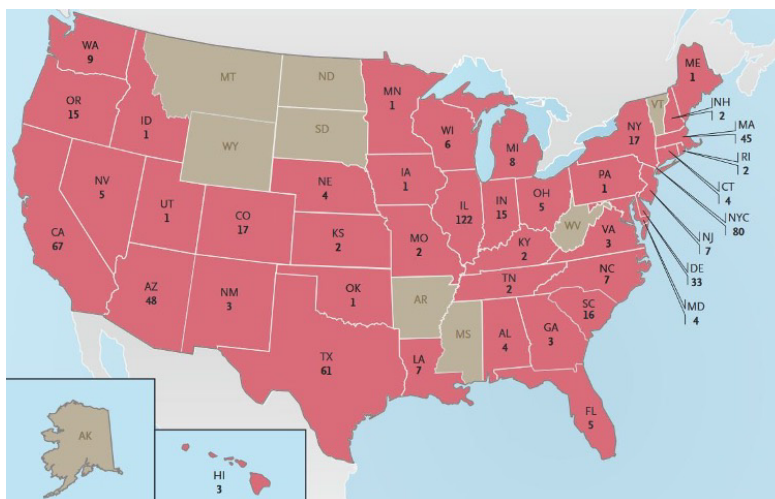


Figure 19. Distribution of Confirmed U.S. Cases of H1N1.²¹⁰

The swine flu outbreak worried public health officials. According to the CDC, because N1H1 was a new strain, very few had any immunity.²¹¹ Only people old enough to have been exposed to the 1918 flu had any immunity to N1H1. This cohort, a decidedly tiny population, would have been over 90 years old when N1H1 emerged. The lack of immunity otherwise found in the population caused the rapid spread of the virus. Because the outbreak started with a novel virus strain, the impact on the population could have been great from a lack of previous exposure or immunity.

The symptoms of N1H1 were like other flu variants. Symptoms developed quickly, including muscle aches, chills and sweats, cough, sore throat, and fatigue.²¹² Such common symptoms made it difficult to detect and isolate.

²¹⁰ Source: Novel Swine-Origin Influenza A (H1N1) Virus Investigation Team, “Emergence of a Novel Swine-Origin,” 2609. There were 642 confirmed U.S. cases of H1N1 from April to May 2009.

²¹¹ “2009 H1N1 Pandemic (H1N1pdm09 Virus),” Centers for Disease Control and Prevention, June 11, 2019, <https://archive.cdc.gov/#/details?url=https://www.cdc.gov/flu/pandemic-resources/2009-h1n1-pandemic.html>.

²¹² Mayo Clinic, “H1N1 Flu.”

1. PPE and First-Responder Vulnerability

N1H1 raised serious concern among health officials. The H1N1 pandemic of 2009 killed an estimated 284,400 people worldwide.²¹³ The H1N1 virus led to higher patterns of death versus other influenza strains, with fatalities concentrated in younger people.²¹⁴ Eighty percent of deaths occurred in people younger than 65.²¹⁵ This pattern differed from the typical seasonal flu, whereby 70 to 90 percent of fatalities are typically of people over 65.²¹⁶ The atypical nature of this flu created fear.

The first-responder community paid close attention to this outbreak. Once again, first-responder agencies nationwide discussed plans for a surge of patients. The CDC issued guidance to EMS systems in August 2009. Although the CDC did not discourage EMS response for H1N1 patients, it stressed the need for medical director (EMS physician) involvement in decision-making.²¹⁷ Ensuring there would be adequate PPE when the 9-1-1 system became overwhelmed with N1H1 flu patients dominated the emergency responders' attention during this outbreak.

Swine flu is spread by contact and droplets. This flu virus can spread through infected pigs' coughing or sneezing, which disperses droplets.²¹⁸ Most of the literature regarding PPE for swine flu is directed at farm workers. However, recommendations that protect farm workers from ill pigs necessarily defend responders from infected people. The CDC recommends wearing gloves, overalls (gowns), eye protection, and N95

²¹³ Mayo Clinic.

²¹⁴ World Health Organization, "Influenza A (H1N1) Pandemic 2009–2010."

²¹⁵ Centers for Disease Control and Prevention, "2009 H1N1 Pandemic."

²¹⁶ Centers for Disease Control and Prevention.

²¹⁷ "Interim Guidance for Emergency Medical Services (EMS) Systems and 9-1-1 Public Safety Answering Points (PSAPs) for Management of Patients with Confirmed or Suspected Swine-Origin Influenza A (H1N1) Infection," Centers for Disease Control and Prevention, August 5, 2009, https://www.cdc.gov/h1n1flu/guidance_ems.htm.

²¹⁸ "Swine Flu in Humans: Key Facts about Human Infections with Variant Viruses," Centers for Disease Control and Prevention, June 30, 2023, <https://www.cdc.gov/flu/swineflu/keyfacts-variant.htm#humansinfected>.

respirators when in contact with known or suspected swine flu cases.²¹⁹ There was no indication of a PPE shortage during this outbreak.

2. Economic Impact

The H1N1 outbreak had global economic impacts consistent with past flu outbreaks.²²⁰ Notably, this outbreak came shortly after the 2008 global recession fueled by financial deregulation. The University of Missouri estimated a loss of \$400 million to the pork industry at the onset of the H1N1 outbreak, as the United States exports over one-quarter of its pork production around the globe.²²¹ Even though the CDC and the WHO confirmed that people could not contract H1N1 by eating properly prepared pork, several countries initiated trade bans on pork.²²² Consequently, the United States lost 13–16 percent of its annual trade due to import bans.²²³ Decreased pork production affected other agricultural sectors as well. The decrease in pork production caused a reduction in prices for corn and soybeans, crops used to feed pigs.²²⁴ This ripple effect thus compounded the economic impact.

H1N1 affected the economies of other countries as well. Internationally, South Korea felt a socioeconomic cost of \$1.09 billion during H1N1.²²⁵ Mexico in 2009 had a trade deficit of \$27 million in pork and lost \$2.8 billion in tourism.²²⁶ Swine flu, although brief, caused significant damage to economies around the world.

²¹⁹ “CDC Interim Guidance for Workers Who Are Employed at Commercial Swine Farms: Preventing the Spread of Influenza A Viruses,” Centers for Disease Control and Prevention, December 23, 2011, <https://www.cdc.gov/flu/swineflu/guidance-commercial-pigs.htm>.

²²⁰ Warwick J. McKibbin, “The Swine Flu Outbreak and Its Global Economic Impact,” Brookings, May 4, 2009, <https://www.brookings.edu/on-the-record/the-swine-flu-outbreak-and-its-global-economic-impact/>.

²²¹ Johnson, *Potential Farm Sector Effects of 2009 H1N1*, 7, 11.

²²² Johnson, summary.

²²³ Johnson, 8.

²²⁴ Johnson, 11.

²²⁵ Yang-Woo Kim, Seok-Jun Yoon, and In-Hwan Oh, “The Economic Burden of the 2009 Pandemic H1N1 Influenza in Korea,” abstract, *Scandinavian Journal of Infectious Diseases* 45, no. 5 (May 2013), <https://doi.org/10.3109/00365548.2012.749423>.

²²⁶ Dunia Rassy and Richard D. Smith, “The Economic Impact of H1N1 on Mexico’s Tourist and Pork Sectors,” abstract, *Health Economics* 22, no. 7 (July 2013), <https://doi.org/10.1002/hec.2862>.

3. Analysis

H1N1 developed into a particularly unusual flu. The outbreak was especially dangerous to the young whereas traditional flu cases are most dangerous to the old. Another interesting factor was that this outbreak spread during the summer whereas other flu variants usually spread over the winter. A summer spread affecting youth made places like summer camps a prime location for “super-spreader” events. H1N1 caused considerable disruptions in global markets, which had not yet recovered from the 2008 recession, fueled by banking deregulation. Swine flu was the last major pandemic before the start of COVID-19.

E. CONCLUSION

The years 1970–2010 were a consequential time in public health outbreaks. HIV/AIDS was the first public health emergency where responders used PPE, including medical exam gloves, gowns, face shields, and both surgical and N95 respirator masks, to protect themselves. Next was SARS, which scholars dubbed the first pandemic of the 21st century.²²⁷ SARS emerged as first responders were focused on terrorism following the 9/11 and Amerithrax attacks. SARS marked the first time N95 respirators were routinely used by responders when treating patients. Then, avian flu proved challenging to contain because of bird migration. The overlap of SARS and the H5N1 avian flu caused governments to take pandemics seriously and start pandemic planning. Finally, swine flu broke traditional flu rules, infecting children during the summer months and creating super-spreader events at summer camps. Each of these outbreaks affected emergency responders.

The next chapter discusses public health outbreaks from 2010 to 2023, highlighting MERS and COVID-19. It further strengthens the argument that basic PPE, such as gloves, gowns, face shields, surgical masks, and N95 respirators, is crucial for protecting the nation’s first responders.

²²⁷ LeDuc and Barry, “SARS, the First Pandemic of the 21st Century.”

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IV. PPE AND U.S. PUBLIC OUTBREAKS, 2010–2023

From 2010 to 2023, two public health outbreaks of concern spread: MERS and COVID-19. MERS occurred a few years after swine flu, and memories were still fresh from that outbreak. Although MERS did not have the global impact of previous outbreaks, such as avian and swine flu, it did represent an outbreak of concern. In June 2013, the HHS secretary declared a significant potential public health emergency for MERS, particularly for U.S. citizens living abroad.²²⁸ Epidemiologists and public health officials had warned about a pandemic like COVID-19 for years—like Chicken Little repeatedly telling the world the sky was falling. It turned out that in the case of COVID-19, they were right. While SARS, MERS, and COVID-19 showed how fear warps the response to a pandemic, it was COVID that taught the absolute need for PPE and the tragic consequences when it is unavailable.²²⁹

A. MERS, 2012

Middle East respiratory syndrome, sometimes called the camel flu, is a coronavirus. The first case of MERS occurred in Jordan in April 2012.²³⁰ It was an unknown disease until its discovery in Saudi Arabia in September 2012.²³¹ From the onset of the outbreak, 27 nations reported confirmed cases.²³² Most of the diagnosed human patients (80 percent) were in Saudi Arabia.²³³ Two confirmed cases appeared in the United States in May 2014; both were healthcare workers who had traveled to Saudi Arabia and returned to the United

²²⁸ Determination and Declaration Regarding Emergency Use of In Vitro Diagnostics for Detection of Middle East Respiratory Syndrome Coronavirus (MERS-CoV), 78 Fed. Reg. 33842 (June 5, 2013).

²²⁹ As with earlier chapters, this chapter also draws from the author’s experience as a paramedic and paramedic supervisor.

²³⁰ “About MERS,” Centers for Disease Control and Prevention, August 2, 2019, <https://www.cdc.gov/coronavirus/mers/about/index.html>.

²³¹ “Middle East Respiratory Syndrome Coronavirus (MERS-CoV),” World Health Organization, August 5, 2022, [https://www.who.int/news-room/fact-sheets/detail/middle-east-respiratory-syndrome-coronavirus-\(mers-cov\)](https://www.who.int/news-room/fact-sheets/detail/middle-east-respiratory-syndrome-coronavirus-(mers-cov)).

²³² World Health Organization.

²³³ World Health Organization.

States ill.²³⁴ The WHO never declared MERS officially contained, so MERS remains an active coronavirus with occasional outbreaks.

MERS is another zoonotic disease, having originated in insects that transmit the illness to insect-eating bats, which bite camels and infect them.²³⁵ Finally, MERS can pass from infected camels to people.²³⁶ Most transmission cases from camels to people involve camel handlers.²³⁷ MERS can spread from person to person when someone is in close contact with an infected person.²³⁸ MERS can also be transmitted through uncooked or undercooked camel meat and milk.²³⁹ Similar to avian flu, people around camels should use good hygiene practices and avoid sick animals.²⁴⁰

According to the CDC, the risk of contracting MERS for the average American is very low because the illness has not spread to the United States.²⁴¹ MERS is less contagious than SARS but more deadly.²⁴² According to the WHO, the 2012 outbreak killed 858 people.²⁴³ MERS has a mortality rate of 35 percent of diagnosed cases.²⁴⁴ For

²³⁴ “Information about Middle East Respiratory Syndrome (MERS),” Centers for Disease Control and Prevention, 2015, https://www.cdc.gov/coronavirus/mers/downloads/factsheet-mers_en.pdf.

²³⁵ Khalaf F. Alsharif et al., “The Prevalence of MERS-CoV among Military Personnel and Their Families: A Single-Center Study,” *Journal of Medical Virology* 93, no. 5 (2021): 2815–19, <https://doi.org/10.1002/jmv.26642>.

²³⁶ “Middle Eastern Respiratory Syndrome (MERS),” American Lung Association, accessed June 4, 2023, <https://www.lung.org/lung-health-diseases/lung-disease-lookup/middle-eastern-respiratory-syndrome-mers>.

²³⁷ World Health Organization, “Middle East Respiratory Syndrome Coronavirus.”

²³⁸ Centers for Disease Control and Prevention, “About MERS.”

²³⁹ Esam I. Azhar et al., “The Qatar FIFA World Cup 2022 and Camel Pageant Championships Increase Risk of MERS-CoV Transmission and Global Spread,” *Lancet Global Health* 11, no. 2 (February 2023): e189–90, [https://doi.org/10.1016/S2214-109X\(22\)00543-5](https://doi.org/10.1016/S2214-109X(22)00543-5).

²⁴⁰ World Health Organization, “Middle East Respiratory Syndrome Coronavirus.”

²⁴¹ Centers for Disease Control and Prevention, “Information about Middle East Respiratory Syndrome (MERS),” 1.

²⁴² Linda Rath, “Coronavirus History: Origin and Evolution,” WebMD, December 31, 2022, <https://www.webmd.com/covid/coronavirus-history>.

²⁴³ World Health Organization, “Middle East Respiratory Syndrome Coronavirus.”

²⁴⁴ World Health Organization.

further comparison, the mortality rate for Ebola has ranged between 25 percent and 90 percent, depending on the outbreak.²⁴⁵

MERS alarmed the U.S. and Saudi governments. During the initial outbreak of MERS in 2012, the United States had a large population of soldiers in Saudi Arabia and throughout the Middle East. The risk of soldiers' contracting MERS, infecting other soldiers, and potentially bringing it stateside alarmed U.S. officials. The Kingdom of Saudi Arabia was concerned about MERS in person-to-person contact in Muslim holy sites throughout the Kingdom. The outbreak caused the Pentagon to study MERS, which led to a vaccine and clinical trial in 2016.²⁴⁶

MERS resurfaces periodically. For example, MERS broke out in 2015 in Korea, infecting 186 and causing 38 deaths.²⁴⁷ It was the first outbreak of MERS outside the Arabian Peninsula.²⁴⁸ The most recent outbreak occurred in November 2022 in Saudi Arabia. Health officials at the time worried about the global spread of MERS because the 2022 outbreak coincided with the FIFA World Cup. Fortunately, the disease did not spread due to precautions to address COVID-19 and a simultaneous monkeypox outbreak. MERS is still a threat that occasionally resurfaces.

MERS is elusive from detection. Symptoms are wide-ranging depending on the severity of the case, causing anything from no symptoms to severe shortness of breath, including pneumonia.²⁴⁹ MERS has similar symptoms to SARS and several other diseases, with one crucial distinction: MERS can cause kidney failure.²⁵⁰ A typical case of MERS

²⁴⁵ "Ebola Virus Disease," Pan American Health Organization, accessed June 4, 2023, <https://www.paho.org/en/topics/ebola-virus-disease>.

²⁴⁶ Cheryl Pellerin, "Army Scientists Begin First MERS Vaccine Clinical Trial," Department of Defense, February 17, 2016, <https://www.defense.gov/News/News-Stories/Article/Article/657176/army-scientists-begin-first-mers-vaccine-clinical-trial/>.

²⁴⁷ "MERS Outbreak in the Republic of Korea, 2015," World Health Organization, accessed June 9, 2023, <https://www.who.int/westernpacific/emergencies/2015-mers-outbreak>.

²⁴⁸ World Health Organization.

²⁴⁹ Hitesh Chopra et al., "MERS-CoV Recently Re-emerged in Qatar, Saudi Arabia, Its Feasible Global Health Risks amid FIFA World Cup 2022 and Salient Counteracting Strategies—an Update," *International Journal of Surgery* 109, no. 2 (February 2023): 153–54, <https://doi.org/10.1097/JS9.0000000000000056>.

²⁵⁰ Rath, "Coronavirus History."

involves fever, cough, and shortness of breath.²⁵¹ These characteristic symptoms, however, could indicate any number of illnesses, making cases difficult to detect. Infected persons could also shrug off symptoms since they might indicate a common illness such as a cold or the flu. A MERS-infected person left untreated or unquarantined will spread the disease.

1. PPE and First-Responder Vulnerability

The best way for first responders to protect themselves from MERS follows the same pattern as other infectious diseases. Responders should use typical PPE to protect against droplets, including N95 respirators, gloves, gowns, and eye protection.²⁵² Standard UPs will protect first responders against MERS.

American first-responder vulnerability was low during the MERS outbreak. With only two confirmed cases in the United States, MERS posed virtually zero threat. First responders had plenty of PPE at the time, thanks to other previous public health emergencies, such as avian flu, which provided the necessary protection if responders encountered a MERS patient, provided they knew the patient had MERS. As a new EMS supervisor, this author recalls hearing about MERS in a public health meeting, and while it was on his responders' radar, it never manifested in their jurisdiction.²⁵³ MERS had great potential to become a global threat but did not spread past the Middle East, meaning it did not pose a significant threat to American first responders.

MERS is a respiratory coronavirus. There is some academic debate on whether bodily fluids from camels can spread MERS. Due to the small number of human cases, the research is incomplete. As a result, MERS falls into the contact, droplet, or splash

²⁵¹ World Health Organization, "Middle East Respiratory Syndrome Coronavirus."

²⁵² Chopra et al., "MERS-CoV Recently Re-emerged in Qatar," 154.

²⁵³ The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author's professional experience, training, and education.

transmission categories. The CDC recommends gloves, a gown, eye protection, and an N95 respirator.²⁵⁴ There has been no indication of a PPE shortage during this outbreak.

2. Economic Impact

Due to this outbreak's limited size and scope, the economic impact is poorly defined.

3. Analysis

The 2012 MERS outbreak ended up as a flash in the pan. It remained localized within the Arabian Peninsula. Although the mortality rate is significant at 35 percent, having few confirmed cases meant it impacted a small sample size. Additional cases of MERS likely emerged in the United States, but because of the mild symptoms, these patients did not seek treatment, and a lab test was not used to confirm a diagnosis. If they had been diagnosed, the mortality rate might have been lower due to a larger sample size.

The disease had minimal impact on the United States; however, the federal government took MERS seriously. Pentagon concerns about MERS infecting troops stationed in the Middle East prompted the development of a vaccine. Fortunately, MERS did not affect American first responders or the broader public on U.S. soil.

B. COVID-19, 2019–2023

In 2019, a historic pandemic emerged in China—coronavirus disease SARS-CoV-2, commonly known as COVID-19. A large group of viruses make up the coronavirus family.²⁵⁵ Coronavirus variants include 22E (the common cold), MERS, and SARS.²⁵⁶ Coronavirus is derived from *coronam*, the Latin word for crown, after the virus's distinctive spikey, crown-like appearance (see Figure 20).²⁵⁷

²⁵⁴ “Interim Infection Prevention and Control Recommendations for Hospitalized Patients with Middle East Respiratory Syndrome Coronavirus (MERS-CoV),” Centers for Disease Control and Prevention, June 2015, <https://www.cdc.gov/coronavirus/mers/infection-prevention-control.html>.

²⁵⁵ Rath, “Coronavirus History.”

²⁵⁶ Jennifer Hulzen, “Why Is It Called Coronavirus?,” Medical News Today, September 29, 2020, <https://www.medicalnewstoday.com/articles/why-is-it-called-coronavirus>.

²⁵⁷ Hulzen.

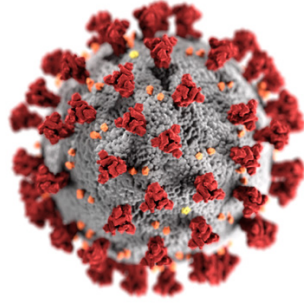


Figure 20. COVID-19 with Its Distinctive Crown-Like Spikes.²⁵⁸

What started in China quickly spread around the world. The first cases of COVID-19 occurred on December 12, 2019, when a group of patients in Hubei Province, China, experienced symptoms of unusual pneumonia that did not respond to conventional treatment.²⁵⁹ The WHO declared a global pandemic on March 11, 2020.²⁶⁰ At that point, 114 countries had COVID-19 infections, with 118,000 cases and 42,291 deaths.²⁶¹ Two days later, on March 13, 2020, the Trump administration declared a national emergency and international travel ban.²⁶² It was the start of a very long, historic, global pandemic.

COVID-19, like many other pandemic outbreaks, including MERS, started as a zoonotic disease linked to bats.²⁶³ The human–bat interaction most likely occurred at an exotic animal wet market in Wuhan, China.²⁶⁴ A wet market is an open-air stall-style market, like an American farmer’s market, where live animals are sold and slaughtered on site.²⁶⁵ They are common throughout China. Less common are wet markets that sell wild

²⁵⁸ Source: Centers for Disease Control and Prevention, “Coronavirus,” Public Health Image Library, 2020, <https://phil.cdc.gov/details.aspx?pid=23312>.

²⁵⁹ Centers for Disease Control and Prevention, “CDC Museum COVID-19 Timeline,” David J. Sencer CDC Museum, March 15, 2023, <https://www.cdc.gov/museum/timeline/covid19.html>.

²⁶⁰ Centers for Disease Control and Prevention.

²⁶¹ Centers for Disease Control and Prevention.

²⁶² Centers for Disease Control and Prevention.

²⁶³ Stanley Perlman, “Another Decade, Another Coronavirus,” *New England Journal of Medicine* 382, no. 8 (2020): 761, <https://doi.org/10.1056/NEJMe2001126>.

²⁶⁴ Perlman, 761.

²⁶⁵ Dina Fine Maron, “‘Wet Markets’ Launched the Coronavirus: Here’s What You Need to Know,” *National Geographic*, April 15, 2020, <https://www.nationalgeographic.com/animals/article/coronavirus-linked-to-chinese-wet-markets>.

animals for butchering. These wild animals include snakes, crocodiles, bats, and many other creatures.²⁶⁶ The prevailing theory is that live bats infected with COVID-19 came in direct contact with humans in the Wuhan wet market, infecting several people. The early COVID-19 cases were connected to the Huanan Seafood Wholesale Market in Wuhan, China.²⁶⁷ This disease is another example of how interactions with animals can transfer a virus to humans.

COVID-19 is a highly contagious respiratory viral infection. According to the CDC, COVID-19 is more contagious than the flu.²⁶⁸ People infected with COVID-19 can spread the virus 2–3 days before the onset of symptoms and be infectious for about eight days after symptom onset.²⁶⁹ Because a person is contagious before symptoms appear, people can unknowingly spread the disease to others before the hosts know they are sick.

COVID-19 can be transmitted in three main ways:

1. By breathing in air carrying droplets or aerosol particles that contain the SARS-CoV-2 virus when close to an infected person or in poorly ventilated spaces with infected persons.
2. By having droplets and particles that contain the SARS-CoV-2 virus land on the eyes, nose, or mouth—especially through splashes and sprays like a cough or sneeze [see Figure 17].
3. By touching the eyes, nose, or mouth with hands with SARS-CoV-2 virus particles on them.²⁷⁰

The nature of the transmission routes explains why governments put mask orders and social distancing rules in place for people when in public. In addition to airborne transmission, COVID-19, like other viruses, can live outside the body and on surfaces for various periods (see Table 2). This latency led to a surge in demand for cleaning products, from disinfectant wipes to spray bottles to hand sanitizer. Interestingly, the fear of contaminated cardboard

²⁶⁶ Maron.

²⁶⁷ Centers for Disease Control and Prevention, “CDC Museum COVID-19 Timeline.”

²⁶⁸ “Similarities and Differences between Flu and COVID-19,” Centers for Disease Control and Prevention, September 28, 2022, <https://www.cdc.gov/flu/symptoms/flu-vs-covid19.htm>.

²⁶⁹ Centers for Disease Control and Prevention.

²⁷⁰ “COVID-19 Overview and Infection Prevention and Control Priorities in Non-U.S. Healthcare Settings,” Centers for Disease Control and Prevention, October 27, 2023, under “Transmission,” <https://www.cdc.gov/coronavirus/2019-ncov/hcp/non-us-settings/overview/index.html>.

boxes, potentially holding PPE or cleaning supplies shipped from China, compounded supply chain disruptions and delays.

Table 2. Viability of COVID-19 on Various Surfaces.²⁷¹

Surface	SARS-CoV-2 (COVID-19) half-life (in hours)
Copper	3.4
Cardboard	8.45
Steel	13.1
Plastic	15.9

Copper and copper alloys, such as bronze and brass, have antimicrobial properties, explaining the short half-life detailed in Table 2.²⁷² While such alloys do not kill viruses like COVID-19, the surface is inhospitable to the virus.²⁷³

Like many other viruses, COVID-19 symptoms vary in patients, from no symptoms to severe respiratory distress. According to the CDC, symptoms can include fever and chills, cough, shortness of breath, body aches, sore throat, fever, and diarrhea.²⁷⁴ The loss of taste or smell differentiated COVID-19 from other ailments like the flu or common cold. No other illnesses during the COVID-19 pandemic had a loss of taste or smell as a symptom.

In the early days of the pandemic, there was no lab test to detect the virus. Officials urged people who felt sick to stay home and self-isolate. Early on, the isolation

²⁷¹ Adapted from: Daniel Hickman, “Coronavirus Stays in Aerosols for Hours, on Surfaces for Days,” *Hospitalist* (blog), March 17, 2020, <https://www.the-hospitalist.org/hospitalist/article/219161/coronavirus-updates/coronavirus-stays-aerosols-hours-surfaces-days/>.

²⁷² Emilie Dauvergne and Catherine Mullié, “Brass Alloys: Copper-Bottomed Solutions against Hospital-Acquired Infections?,” *Antibiotics* 10, no. 3 (March 2021): 286, <https://doi.org/10.3390/antibiotics10030286>.

²⁷³ Nick Guy, “You Don’t Need That Brass Touch Tool You Saw on Instagram,” *Wirecutter* (blog), May 4, 2020, <https://www.nytimes.com/wirecutter/blog/brass-touch-tool-instagram/>.

²⁷⁴ “Symptoms of COVID-19,” Centers for Disease Control and Prevention, October 26, 2022, <https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>.

recommendation was 21 days from the start of symptoms, even if symptoms resolved. Lab-confirmed COVID-19 testing started in February 2020; however, the CDC notes some considered early tests “untrustworthy.”²⁷⁵ The first saliva-based kits were available in May 2020.²⁷⁶ Following federal Disaster Medical Assistance Team (DMAT) deployment, this author’s team members were encouraged to test and wait for negative results before returning to civilian work.²⁷⁷ As of fall 2023, home COVID-19 testing kits are widely available and can detect multiple COVID-19 variants.

Although most people infected with COVID-19 experienced symptoms for a couple of weeks, others had lingering or new (different) symptoms after recovering. HHS characterized the long-term effects from COVID-19 as “long COVID.”²⁷⁸ According to HHS,

Long COVID is broadly defined as signs, symptoms, and conditions that continue or develop after initial COVID-19 or SARS-CoV-2 infection. The signs, symptoms, and conditions are present four weeks or more after the initial phase of infection, may be multisystemic; and may present with a relapsing-remitting pattern and progression or worsening over time, with the possibility of severe and life-threatening events even months or years after infection. Long COVID is not one condition. It represents many potentially overlapping entities, likely with different biological causes and different sets of risk factors and outcomes.²⁷⁹

People experiencing long COVID have dubbed themselves “long-haulers.”²⁸⁰ Long-haulers are in a purgatory-like state. They have not recovered, thus returning to normal, nor have they died. According to Devang Sanghavi of the Mayo Clinic, long COVID or long-haulers fall into three categories:

²⁷⁵ Centers for Disease Control and Prevention, “CDC Museum COVID-19 Timeline.”

²⁷⁶ Centers for Disease Control and Prevention.

²⁷⁷ The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author’s professional experience, training, and education.

²⁷⁸ “What Is Long COVID?,” Department of Health and Human Services, accessed July 7, 2023, <https://www.covid.gov/longcovid/definitions>.

²⁷⁹ Department of Health and Human Services, para. 2.

²⁸⁰ UC Davis Health, “COVID-19 ‘Long-Hauler’ Patients Search for Answers and Help,” BroadcastMed, January 22, 2021, <https://health.ucdavis.edu/coronavirus/news/headlines/covid-19-long-hauler-patients-search-for-answers-and-help/2020/10>.

1. Patients with COVID-19 who do not recover completely and have ongoing symptoms because of direct cell damage from the virus.
2. Patients with symptoms related to chronic hospitalization such as when someone is in the hospital, ICU or is bed bound for weeks.
3. Patients with symptoms that appear after recovery.²⁸¹

Symptoms of long COVID include memory and thinking difficulties, sometimes called “brain fog”; lingering shortness of breath; and general fatigue.²⁸² Because long-haulers have lingering physical symptoms, some cannot return to work or normal activities, affecting their mental and economic well-being.

1. PPE and First-Responder Vulnerability

First responders were particularly susceptible to COVID-19, the leading killer of these public servants in 2020.²⁸³ Police, firefighters, and paramedics interact closely with the public daily. If someone is ill and one’s symptoms escalate beyond the capacity for self-care, the individual may use the 9-1-1 system. First responders interacting with COVID-19 patients were at significant risk of contracting the virus, which was amplified if they did not have proper PPE.

COVID-19 significantly affected police officers. According to a University of Minnesota study, during the first year of the COVID-19 pandemic, 62 percent of police officer deaths were COVID-related, which was higher than all other causes of death for officers combined.²⁸⁴ In 2020, COVID-19 was the leading cause of line-of-duty deaths among police officers. According to the Officer Down Memorial Page, which tracks law enforcement deaths, between 2020 and 2023, at least 862 law enforcement professionals

²⁸¹ Andrea Garcia, “What Is Long COVID?,” American Medical Association, May 12, 2022, para. 7, <https://www.ama-assn.org/delivering-care/public-health/what-long-covid>.

²⁸² Tae Chung et al., “Long COVID: Long-Term Effects of COVID-19,” Johns Hopkins Medicine, June 14, 2022, <https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/covid-long-haulers-long-term-effects-of-covid19>.

²⁸³ Evan Goodenow, “COVID Leading Cause of Death for Police, Firefighters,” *Winchester Star*, March 21, 2023, https://www.winchesterstar.com/winchester_star/covid-leading-cause-of-death-for-police-firefighters/article_141d63be-ceb1-5ef0-ba11-9db5fb3c92b8.html.

²⁸⁴ Mary Van Beusekom, “COVID-19 Was Leading Cause of Duty-Related Police Deaths in 2020,” University of Minnesota Center for Infectious Disease Research & Policy, June 7, 2022, <https://www.cidrap.umn.edu/covid-19-was-leading-cause-duty-related-police-deaths-2020>.

died of COVID-19.²⁸⁵ Medical deaths, primarily from COVID-19, drastically increased, eclipsing all other line-of-duty death causes during the pandemic (see Figure 21).

LODDS BY YEAR

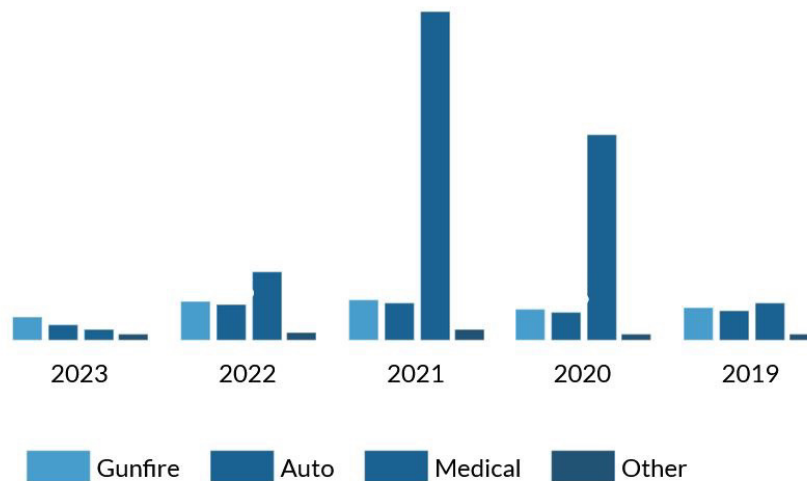


Figure 21. Line-of-Duty Deaths for U.S. Police Officers, 2019–2023.²⁸⁶

Understanding how many firefighters died during COVID-19, in contrast, is complicated. The International Association of Fire Firefighters (IAFF) reported 91 firefighter deaths from COVID-19 in 2022.²⁸⁷ This number is incomplete because the IAFF is a labor union whose count includes only union members. The U.S. Fire Administration also tracks firefighter deaths, reporting 36 deaths from COVID-19 in

²⁸⁵ “Home Page,” Officer Down Memorial Page, accessed September 17, 2023, <https://www.odmp.org/>.

²⁸⁶ Source: Officer Down Memorial Page. Note that the medical category includes COVID-19 and other causes of death (e.g., heart attack and stroke). Image used with permission from the publisher.

²⁸⁷ “IAFF Member COVID-19 Deaths,” International Association of Fire Fighters, April 14, 2022, <https://www.iaff.org/coronavirus/iaff-member-covid-19-deaths/>.

2020.²⁸⁸ An additional 63 COVID-19 deaths occurred in 2021.²⁸⁹ All told, the number of line-of-duty deaths for firefighters during the COVID-19 pandemic is still unknown.

EMS professionals also suffered during COVID-19. EMS in the United States comprises private, fire agency-based, hospital, and third-party agency municipal services. There is no unifying body that reports line-of-duty deaths for EMS. However, some agencies attempted to understand the number of deaths. For example, the Fire Department of the City of New York (FDNY) conducted a study in 2020 of firefighters and department EMS clinicians. It concluded that the fatality risk to EMS clinicians was 14 times that of non-medical firefighters.²⁹⁰ Another study found that EMS workers had a fatality rate of 14 per 100,000 nationwide, slightly higher than firefighters but significantly higher than nurses and physicians, as shown in Figure 22.²⁹¹ EMS workers thus paid the highest price during COVID-19 compared to other first responders and healthcare workers.

²⁸⁸ U.S. Fire Administration, *Firefighter Fatalities in the United States in 2020* (Emmitsburg, MD: U.S. Fire Administration, 2022), 7, <https://www.usfa.fema.gov/downloads/pdf/publications/firefighter-fatalities-2020.pdf>.

²⁸⁹ “Annual Report on Firefighter Fatalities in the United States,” U.S. Fire Administration, August 28, 2023, <https://www.usfa.fema.gov/statistics/reports/firefighters-departments/firefighter-fatalities.html>.

²⁹⁰ Brian J. Maguire et al., “Occupational Fatalities among EMS Clinicians and Firefighters in the New York City Fire Department; January to August 2020,” *Journal of Emergency Medical Services*, November 19, 2020, <https://www.jems.com/coronavirus/occupational-fatalities-among-ems-clinicians-and-firefighters/>.

²⁹¹ Brian J. Maguire et al., “COVID-19 Fatalities among EMS Clinicians,” EMS1, September 25, 2020, <https://www.ems1.com/ems-products/personal-protective-equipment-ppe/articles/covid-19-fatalities-among-ems-clinicians-BMzHbuegIn1xNLrP/>.

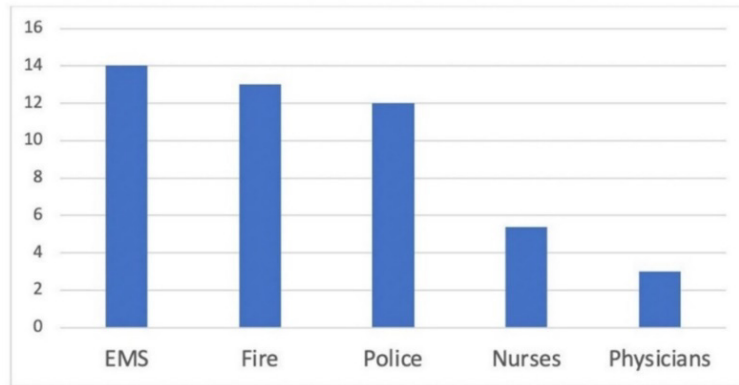


Figure 22. COVID-19 Deaths per 100,000 First Responders and Medical Workers in the United States.²⁹²

PPE shortages constituted part of the reason that first responders died at astronomical rates. First-responder agencies could not secure adequate PPE to protect their responders. The National Fire Protection Association (NFPA) acknowledged the PPE shortage and called on the United States to use the Defense Production Act to increase domestic production. Recent commentary on the matter suggests the U.S. and Chinese governments should look beyond trade disputes and work together to supply PPE.²⁹³ The NFPA saw first responders dying of COVID-19 due to PPE shortages and demanded the federal government do more to equip responders.

COVID-19 stretched and, in some cases, broke the medical supply chain. In the early days of the COVID-19 outbreak, the CDC required gloves, gowns, eye protection, and an N95 respirator.²⁹⁴ However, as demonstrated in Figure 1, the CDC’s PPE recommendations changed in June 2020, partway through the COVID-19 pandemic. Users could substitute an N95 respirator (Figure 6) with a surgical mask (Figure 4). The CDC explained this change as “preferred” and “acceptable.” Significant differences exist

²⁹² Source: Maguire et al. Image used with permission from the publisher.

²⁹³ Meghan Housewright, “The Fire & Life Safety Policy Institute Weighs In on Low Levels of PPE for Responders during COVID-19 Times,” *NFPA Today* (blog), March 25, 2020, <https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2020/03/25/as-a-nation-we-re-failing-the-first-responders-who-are-responding-to-patients-without-proper-ppe>.

²⁹⁴ “Interim Infection Prevention and Control Recommendations for Healthcare Personnel during the Coronavirus Disease 2019 (COVID-19) Pandemic,” Centers for Disease Control and Prevention, May 8, 2023, <https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html>.

between an N95 respirator and a surgical mask (Table 1). While there is limited information explicitly explaining the changes in PPE recommendations, the reasonable conclusion is global N95 respirator shortages. This is a case where the CDC allowed substitutions after an apparent necessity for alternatives.

PPE scarcity was profound during the COVID-19 pandemic for at least the first year and arguably until the COVID-19 vaccine was widely available. N95 respirators, gloves, gowns, and face shields were scarce. As described earlier, the situation for healthcare workers was desperate. In some areas, nurses used trash bags instead of gowns. This author's home agency substituted extrication jackets for gowns. Many first responders simply went without. During COVID-19, this author witnessed countless police officers with no gowns, overalls, or masks.²⁹⁵ It was simply awful seeing officers risk their safety.

It was a strange time to be a first responder. In the early stages of the pandemic, EMTs and paramedics, like healthcare workers, were viewed as heroes. On the one hand, community members donated gift cards, chocolate bars, and PPE to EMS agencies to help the staff. On the other hand, EMTs and paramedics were seen as "unclean" and unwelcome in establishments and at family functions. As the pandemic progressed and became more political, EMTs and paramedics were confronted by anti-maskers and anti-vaccinators as people pushing an agenda. On more than a handful of occasions, patients refused to put masks on in ambulances and before entering hospitals even though they had test-confirmed cases of COVID-19. EMTs and paramedics feared becoming ill or dying.

2. Economic Impact

The global economic impact of the COVID-19 epidemic cannot be overstated. According to the World Bank, the pandemic caused the most significant financial crisis globally in over a century.²⁹⁶ The International Monetary Fund (IMF) agreed, calling the

²⁹⁵ The claims in this paragraph and the next, as with many other statements of fact within this thesis, are based on the author's professional experience, training, and education. During the COVID-19 pandemic, the author served as the EMS logistics chief, responsible for procuring PPE and sanitizing equipment.

²⁹⁶ World Bank, "The Economic Impacts of the COVID-19 Crisis," in *World Development Report 2022* (World Bank, 2022), <https://www.worldbank.org/en/publication/wdr2022/brief/chapter-1-introduction-the-economic-impacts-of-the-covid-19-crisis>.

impact of the “great lockdown” the worst recession since the 1929 Great Depression.²⁹⁷ The IMF also claimed it was far worse than the 2008 global financial crisis, now the second worst economic recession since 1929.²⁹⁸ It will take years, possibly decades, for the economy to recover.

The pandemic created a shock felt around the world. However, various countries’ mitigation policies and strategies reduced or dispersed the economic shock effects.²⁹⁹ According to Reuters, the International Labour Organization found that in the first nine months of 2020, worldwide income dropped by 10.7 percent or \$3.5 trillion.³⁰⁰ Over two years, the United Nations projected an \$8.5 trillion loss from the COVID-19 pandemic.³⁰¹ The Federal Reserve Bank (Saint Louis Branch) reported a decreased world output of 4 percent compared to pre-COVID levels.³⁰² Despite conflicting numbers on the economic impact, COVID-19 disrupted every economy worldwide.

The economy was bleak in the United States, too. According to the Center on Budget and Policy Priorities, in the United States, in April 2020, the unemployment rate increased to levels not seen since the 1930s.³⁰³ Between February 2020 (pre-pandemic) and October 2021, the United States lost 4.2 million jobs, primarily in low-paying industries, accounting for 30 percent of all lost jobs.³⁰⁴ The loss had a devastating effect

²⁹⁷ Gita Gopinath, “The Great Lockdown: Worst Economic Downturn since the Great Depression,” *IMF Blog*, April 14, 2020, <https://www.imf.org/en/Blogs/Articles/2020/04/14/blog-weo-the-great-lockdown-worst-economic-downturn-since-the-great-depression>.

²⁹⁸ Gopinath.

²⁹⁹ Fernando M. Martin, Juan M. Sánchez, and Olivia Wilkinson, “The Economic Impact of COVID-19 around the World,” *Federal Reserve Bank of St. Louis Review* 105, no. 2 (2023): 74, <https://doi.org/10.20955/r.105.74-88>.

³⁰⁰ Stephanie Nebehay, “Pandemic Slashes Worldwide Income from Work by a Tenth: ILO,” Reuters, September 23, 2020, <https://www.reuters.com/article/us-health-coronavirus-ilo-idUSKCN26E1SM>.

³⁰¹ “COVID-19 to Slash Global Economic Output by \$8.5 Trillion over Next Two Years,” United Nations Department of Economic and Social Affairs, accessed July 7, 2023, <https://www.un.org/en/desa/covid-19-slash-global-economic-output-85-trillion-over-next-two-years>.

³⁰² Martin, Sánchez, and Wilkinson, “The Economic Impact of COVID-19 around the World,” 74.

³⁰³ Center on Budget and Policy Priorities, *Tracking the COVID-19 Economy’s Effects on Food, Housing, and Employment Hardships* (Washington, DC: Center on Budget and Policy Priorities, 2021), <https://www.cbpp.org/research/poverty-and-inequality/tracking-the-covid-19-economys-effects-on-food-housing-and>.

³⁰⁴ Center on Budget and Policy Priorities.

on minorities and migrant workers who typically fill low-paying jobs.³⁰⁵ It will take the United States years to dig out from under the economic slump that COVID-19 created.

3. Analysis

COVID-19 was the modern plague that epidemiologists and public health officials had warned about for years. It impacted every U.S. citizen in some way or another. The American people watched millions of people die. Some people became sick; others watched family or friends suffer. In many cases, people could not visit their sick or dying family members, causing them to die alone by a cruel disease. During the COVID-19 pandemic, the term “essential worker” emerged, but this, too, polarized people. For some people, being essential became a badge of honor; for others, it meant having to stay home, unable to work and collect a paycheck.

C. CONCLUSION

MERS and COVID-19 represent two ends of a spectrum from 2010 to 2023. Although concerning in the Middle East, MERS fortunately has not evolved into a global outbreak. Likewise, the 35 percent mortality rate of MERS is alarming, but small sample sizes have hindered discovering the disease’s actual lethality rate. Conversely, COVID-19 has had a tremendous impact worldwide regarding illness and death, exposing the vulnerability of American first responders and creating a lasting effect on the economy, which will take years to recover.

Regarding protections for first responders, all of the diseases covered in Chapters III and IV required the use of similar PPE. Table 3 shows the five pieces of PPE discussed and defined in Chapter II. From looking at the case studies of disease response, it is reasonable to conclude that gloves, masks (simple and N95 respirators), gowns, and face shields should be on hand for the next public health emergency.

³⁰⁵ Center on Budget and Policy Priorities.

Table 3. PPE Required for Various Public Health Emergencies.³⁰⁶

Disease	Disease Transmission	Risk for First Responders	Required PPE
HIV/AIDS	Contact (exchanging bodily fluids)	contact, droplet, or splash	Gloves, mask, gown, eye protection
SARS	Airborne (inhaling particles from coughing, sneeze, breathing, or talking)	droplet	Gloves, N95 mask, gown, eye protection
Avian Flu (H5N1)	Contact & Airborne (contact with bird bodily fluids or inhaling particles from birds or infected people)	contact & droplet	Gloves, gown, eye protection, N95 mask
Swine Flu (N1H1)	Contact & Airborne (contact with pig bodily fluids or inhaling particles from pigs or infected people)	contact & droplet	Gloves, gown, eye protection, N95 mask
MERS	Airborne and possibly Contact (inhaling particles from camels or infected people, possibly from contact with camel bodily fluids)	contact, droplet, or splash	Gloves, gown, eye protection, N95 mask
COVID-19	Airborne	contact & droplet	Gloves, gown, eye protection, N95 mask

Note: Eye protection can involve a face shield, protective eyewear, or both. Protective eyewear and some face shields are reusable.

The next chapter explores federal authority during public health emergencies and the ability to use it to obtain PPE. In some cases, branches of the federal government, specifically FEMA, have the right to intercept and reallocate PPE. Such instances of federal involvement, however, complicate the fragile global supply chain and strengthen the need for anticipating shortages and for local agencies to stockpile supplies.

³⁰⁶ This table is the author's interpretation of facts cited earlier in the thesis.

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V. FEDERAL AUTHORITY FOR OBTAINING PPE

Specific federal laws apply during a pandemic response. This chapter defines key concepts, examines federal statutes, and presents the scholarly debate on the application of federal law during the COVID-19 pandemic. The chapter explores the Public Health Services Act, the Defense Production Act, and the Stafford Act—the three primary federal laws that apply during a public health outbreak. From there, it investigates various executive orders that President Trump and President Biden issued and their consequences, such as competition and interference from FEMA and HHS. The chapter shows varying degrees of success using existing laws and executive orders and possible repercussions. This chapter is also a cautionary tale of how the government can legally interfere with the open market, at times creating hyper-competition, which further stresses an already frail manufacturing and supply chain, thus increasing the risk of PPE shortages for first-responder agencies.

A. TYPES OF FEDERAL AUTHORITY

1. Public Health Services Act of 1944

The Public Health Services Act of 1944 is a federal law under Title 42 of the U.S. Code. This act gives the federal government the legal authority to respond to public health emergencies. It allows HHS to lead federal medical response efforts and gives authority to the federal government to quarantine infected people.³⁰⁷ The act was passed following the 1918 flu pandemic, which lawmakers still had in their memories.³⁰⁸ Lawrence Gostin, a professor of public health at Georgetown University, explains the congressional mindset during the creation of the act:

³⁰⁷ Department of Health and Human Services, “HHS Legal Authorities Related to Disasters and Emergencies,” Public Health Emergency, June 16, 2021, <https://www.phe.gov/Preparedness/planning/authority/Pages/default.aspx>; “History of Quarantine (Port Health),” Centers for Disease Control and Prevention, July 20, 2020, <https://www.cdc.gov/quarantine/historyquarantine.html>.

³⁰⁸ Ari Shapiro, Mallory Yu, and Patrick Jarenwattananon, “The 1944 Law behind the CDC’s Authority,” NPR, April 29, 2022, <https://www.npr.org/2022/04/29/1095642521/the-1944-law-behind-the-cdcs-authority>.

There was a very strong national agreement—Republicans and Democrats alike—that we needed a strong public health agency and that, while most public health powers do reside at the state and local level, what a state or a city can’t do is prevent the spread of diseases across the United States or, in fact, coming from abroad to our nation’s borders.³⁰⁹

Shortly after the passage of the Public Health Services Act, the Centers for Disease Control and Prevention, then called the Communicable Disease Center, opened its doors in Atlanta.³¹⁰ The Public Health Services Act authorizes the HHS secretary

- to lead all Federal public health and medical response to public health emergencies and incidents covered by the National Response Framework;
- to direct the U.S. [public health services] and other components of the Department to respond to a public health emergency;
- to declare a public health emergency (PHE) and take such actions as may be appropriate to respond to the PHE consistent with existing authorities;
- to assist states in meeting health emergencies; to control communicable diseases;
- to maintain the Strategic National Stockpile; to provide for the operation of the National Disaster Medical System;
- to establish and maintain a Medical Reserve Corps; and to potentially provide targeted immunity for covered countermeasures to manufacturers, distributors, certain classes of people involved in the administration of a program to deliver covered treatments to patients, and their employees.³¹¹

The COVID-19 pandemic employed several components of the Public Health Services Act. The first significant outbreak of COVID-19 in the United States occurred on the Grand Princess cruise ship. During the March 2020 voyage, more than 800 passengers and crew tested positive for COVID-19, and 10 died.³¹² American officials became aware of the outbreak while the ship was at sea. During comments on March 6, 2020, while

³⁰⁹ Shapiro, Yu, and Jarenwattananon.

³¹⁰ Centers for Disease Control and Prevention, “Our History—Our Story,” David J. Sencer CDC Museum, April 19, 2023, <https://www.cdc.gov/museum/history/our-story.html>.

³¹¹ Department of Health and Human Services, “HHS Legal Authorities.”

³¹² Minyonne Burke, “10 Dead, over 800 Test Positive in Coronavirus Outbreaks on Princess Cruises, CDC Says,” NBC News, March 25, 2020, <https://www.nbcnews.com/health/health-news/10-dead-over-800-test-positive-coronavirus-outbreaks-princess-cruises-n1167716>.

visiting the CDC, President Trump remarked, “I’d rather have the people stay. . . . I would rather because I like the numbers being where they are. . . . I don’t need to have the numbers double because of one ship that wasn’t our fault,” referring to his desire to keep Grand Princess passengers and crew offshore to avoid increasing confirmed COVID-19 numbers.³¹³ President Trump used the Public Health Services Act to keep the cruise ship from entering a U.S. port, effectively quarantining the vessel’s passengers aboard the boat. This was a stunning move, considering most of the passengers were American.

The U.S. government had to decide how to provide care for the ill while preventing the spread of COVID-19. After waiting days offshore, the ship arrived in Oakland, California, on March 9, 2020. Federally run quarantine centers received the passengers and crew for a mandatory 14-day quarantine.³¹⁴ Many Grand Princess passengers ended up at Travis Air Force Base in Fairfield, California, where members of the National Disaster Medical System’s DMAT Minnesota-1 cared for them.³¹⁵ The U.S. government thus had to create a plan to care for many ill citizens.

The Trump administration’s quarantine authority for the Grand Princess passengers and crew stemmed from the Public Health Services Act. The declaration of a public health emergency for COVID-19, deployment of federal resources for the Grand Princess, and all subsequent COVID-19 responses stemmed from the Public Health Services Act. In other words, the federal government could respond to this public health emergency only because the Public Health Services Act was in place.

³¹³ Phillip Bump, “Which Is Trump More Worried About: Coronavirus Numbers or Coronavirus Patients?,” *Washington Post*, March 7, 2020, <https://www.washingtonpost.com/politics/2020/03/07/which-is-trump-more-worried-about-coronavirus-numbers-or-coronavirus-patients/>.

³¹⁴ Erin McCormick, “Grand Princess Passengers Grapple with Covid Nightmare One Year after Ill-Fated Cruise,” *Guardian*, March 10, 2021, <https://www.theguardian.com/us-news/2021/mar/10/grand-princess-cruise-ship-coronavirus-one-year-later>.

³¹⁵ The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author’s professional experience, training, and education. While this author did not personally deploy on the cruise ship mission, this author’s home team (Minnesota 1) deployed. The team’s knowledge of the deployment mission is reflected here.

2. Defense Production Act of 1950

The Defense Production Act (DPA) is a federal law under Title 50 of the U.S. Code. Its purpose is to ensure that domestic industry can meet the needs of the government during international conflicts, acts of terrorism, or domestic disasters, whether manufactured or natural. The law was passed in response to an external military threat: the Korean War.³¹⁶ As detailed in the DPA,

The President is . . . authorized (1) to require that performance under contracts or orders (other than contracts of employment) which he deems necessary or appropriate to promote the national defense shall take priority over performance under any other contract or order, and, for the purpose of assuring such priority, to require acceptance and performance of such contracts or orders in preference to other contracts or orders by any person he finds to be capable of their performance, and (2) to allocate materials, services, and facilities in such manner, upon such conditions, and to such extent as he shall deem necessary or appropriate to promote the national defense.³¹⁷

The DPA allows the president to allocate materials as he sees fit. The act confers sweeping powers on the chief executive during times of national crisis. The president first must declare a material scarce, critical, or essential through an executive order to trigger the use of the act.³¹⁸ The president can also invoke the DPA to restore critical infrastructure when naming the crisis a domestic disaster.³¹⁹ The DPA then allows the president to act quickly and decisively in times of crisis, both foreign and domestic.

Scholars and politicians criticize the DPA and its uses because it artificially alters the financial market. During a February 9, 2001, senate hearing, Republican Senator Phil Gramm noted, “The Defense Production Act is the most powerful and potentially dangerous American law” because of the broad powers given to the president to influence

³¹⁶ Ariel F. Coto, “Hero and Villain: The Defense Production Act in the Era of COVID-19,” *Southwestern Law Review* 51, no. 1 (Fall 2021): 160.

³¹⁷ Defense Production Act, 50 U.S.C. § 4511(a) (2018), <https://www.govinfo.gov/content/pkg/USCODE-2018-title50/html/USCODE-2018-title50-chap55-subchapI-sec4511.htm>.

³¹⁸ Defense Production Act.

³¹⁹ Defense Production Act.

the private market.³²⁰ Baker agrees with this assertion, likening the use of the DPA to commandeering authority.³²¹ Thus, opponents of the DPA worry that the sweeping executive power it enables could harm the marketplace due to the outsized influence of the federal government.

The DPA is an imperfect law. Coto notes, “The DPA has three significant problems: its evolution, cost, and abuse.”³²² Initially, the DPA set out to quickly bolster the national defense during wartime. Yet, in the early 2000s, the DPA was used to address domestic issues, signaling a significant evolution in the law. In 2001, then-President Clinton applied it for the first time domestically during an energy crisis in California.³²³ Likewise, President Bush used the DPA during recovery efforts in the aftermath of Hurricane Katrina in 2005.³²⁴ In this way, the DPA has evolved from having a national defense purpose in times of war to a broader goal of responding to natural crises.

The second problem with the DPA, as described by Coto, is cost. Coto believes that then-President Trump’s DPA declaration during COVID-19 was disastrous because it created additional artificial shortages of health-related supplies in the market, spiking prices. In an April 2020 report published by the Society for Healthcare Organization Procurement Professionals, the cost of some PPE shot up more than 1,000 percent during the COVID-19 pandemic.³²⁵ Note that this report was issued at the *beginning* of COVID. The challenges of the COVID-19 pandemic occurred all over the country and, in a larger

³²⁰ *The California Energy Crisis and Use of the Defense Production Act: Hearing before the Committee on Banking, Housing and Urban Affairs, United States Senate, 107th Cong.* (2001), 1, <https://www.hsdl.org/c/abstract/?docid=443684>.

³²¹ James E. Baker, “From Shortages to Stockpiles: How the Defense Production Act Can Be Used to Save Lives, Make America the Global Arsenal of Public Health, and Address the Security Challenges Ahead,” *Journal of National Security Law & Policy* 11, no. 1 (2020): 170.

³²² Coto, “Hero and Villain,” 161.

³²³ Frank R. Lindh, “Keeping California’s Pilot Lights Burning: A Rare Exercise of Presidential Powers,” *Natural Resources & Environment* 16, no. 1 (Summer 2001): 320.

³²⁴ Michael J. Littlejohn, “Using All the King’s Horses for Homeland Security: Implementing the Defense Production Act for Disaster Relief and Critical Infrastructure Protection,” *Public Contract Law Journal* 36, no. 1 (2006): 4.

³²⁵ “Analysis of PPE Costs,” Society for Healthcare Organization Procurement Professionals, April 7, 2020, 3, http://cdn.cnn.com/cnn/2020/images/04/16/shopp.covid.ppd.costs.analysis_.pdf.

sense, the world because everyone sought to buy medical supplies simultaneously. When President Trump invoked the DPA, it diverted PPE from the market in the United States. Then, government-ordered PPE production could not ramp up quickly, worsening the limited supply.

Some lawmakers, who would disagree with Coto's cost assertion, demonstrated their position by calling for aggressive use of the DPA during the COVID-19 pandemic. In a letter dated January 19, 2021, 26 Democratic members of the U.S. Senate led by Senator Tammy Baldwin urged President-elect Biden to fully utilize the DPA to build up domestic supplies of PPE.³²⁶ The increased use of the DPA even garnered support from Republican Senator Marco Rubio.³²⁷ All of these senators believed that incentivizing U.S.-made materials would create a patriotic boon for domestic manufacturers.

Abuse from the federal government's use of the DPA during the COVID-19 pandemic affected various industries. President Trump called the DPA a "tremendous hammer" during an April 19, 2020, press conference.³²⁸ A congressional report found, however, that the Trump administration used the DPA during the pandemic as a coercive instrument.³²⁹ Cecire concludes, "The [Trump] Administration employed the DPA selectively, focusing on individual companies (e.g., General Motors, 3M) or industry sub-sectors (e.g., meat processing)."³³⁰ The federal government tapped General Motors to build ventilators, a product it had zero experience producing, rather than contracting with an experienced medical supply company. Such a choice gave the appearance that the president cherry-picked certain companies that were not necessarily the best choices, thereby warping the market. Likewise, FEMA's ability to reallocate PPE supplies from the

³²⁶ Tammy Baldwin et al. to Joseph R. Biden Jr., January 19, 2021, https://www.baldwin.senate.gov/imo/media/doc/2021.01.19%20Letter%20to%20PEOTUS%20Biden%20on%20DPA%20for%20medical%20supplies_final.pdf.

³²⁷ Anshu Siripurapu, *What Is the Defense Production Act?* (Washington, DC: Council on Foreign Relations, 2021), 6, <https://www.jstor.org/stable/resrep29863>.

³²⁸ Alice Miranda Ollstein, "Trump Invokes DPA for Testing Swabs, Weeks after Reported Shortages," *Politico*, April 19, 2020, <https://www.politico.com/news/2020/04/19/trump-dpa-testing-swabs-reported-shortages-195721>.

³²⁹ Cecire et al., *COVID-19 and Domestic PPE Production and Distribution*, 31.

³³⁰ Cecire et al., 30.

DPA can cause a shortfall for healthcare workers. This author's EMS agency experienced such firsthand abuse of this power when FEMA, under the DPA, intercepted and reallocated an order of high-efficiency particulate air (HEPA) filters intended for intubation (breathing) tubes during COVID-19 and sent it elsewhere, which left paramedics at risk.³³¹

Coto explains how states consequently had to compete for scarce resources creatively. In several situations, Nguyen notes, states had to circumvent the DPA to acquire enough PPE to protect first responders. In one extreme case, Massachusetts Governor Charlie Baker and Robert Kraft, the owner of the New England Patriots, sent the football team's private jet to fly PPE to Massachusetts, so the federal government would not find out.³³² Coto argues that the abuse of the DPA made this kind of state-sponsored smuggling necessary.³³³ States should not have to fight the federal government for lifesaving supplies. Instead, the federal government should have used the DPA to acquire resources and distribute them to states for their COVID-19 response.

Scholars and congressional agencies concur that DPA implementation was irregular and reactive during the COVID-19 pandemic. Baker criticizes the DPA's use as episodic instead of systemic because the Trump administration followed no strategic process to mobilize the supply chain or manufacturers.³³⁴ Siripurapu agrees with this assertion, believing the Trump administration needed to go further to secure adequate PPE, specifically masks, than it did.³³⁵ For example, Trump replenished the SNS slowly instead of rapidly generating medical supplies using the DPA.³³⁶ As discussed in Chapter II, the SNS is a system administered by HHS containing lifesaving medications and supplies

³³¹ The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author's professional experience, training, and education.

³³² Terry Nguyen, "The Trump Administration Has Made Getting Necessary Medical Equipment Difficult," Vox, April 4, 2020, <https://www.vox.com/2020/4/4/21208122/ppe-distribution-trump-administration-states>.

³³³ Coto, "Hero and Villain," 168.

³³⁴ Baker, "From Shortages to Stockpiles," 167.

³³⁵ Siripurapu, *What Is the Defense Production Act?*, 5.

³³⁶ Baker, "From Shortages to Stockpiles," 158.

intended as a stopgap when medical materials are otherwise unavailable.³³⁷ Baker goes on to characterize the administration's actions as reactive, not proactive.³³⁸ Likewise, a congressional report criticizes the Trump administration's application of the DPA as narrow in use and biased toward the defense industrial base over PPE manufacturing or the medical supply sector.³³⁹ Critics chided Trump, again, for handpicking military manufacturers instead of medical supply producers to address pandemic supply chain issues. While the manner in which the DPA was used during the COVID-19 response was innovative, it was bogged down by complexity and insufficiently trained staff.³⁴⁰

3. Stafford Act of 1988

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) is another federal law under Title 42 of the U.S. Code. The Stafford Act of 1988 replaced the Disaster Relief Act of 1974 (42 U.S.C. § 68). The law authorizes the president to use federal funds to assist state, local, and tribal governments in providing aid to citizens.³⁴¹ The law defines the process of declaring a federal disaster, determines the type of federal assistance, and arranges cost-sharing between local, state, and federal governments.³⁴² It also gives FEMA the responsibility of coordinating government-wide response and relief efforts.³⁴³ Invoking the Stafford Act provides disaster preparedness and mitigation assistance. The act dictates how to declare a major disaster and how the government will respond and triggers access to major disaster assistance programs, emergency assistance programs, and emergency preparedness funding.

³³⁷ "Strategic National Stockpile," Administration for Strategic Preparedness and Response, April 3, 2023, <https://aspr.hhs.gov/443/SNS/Pages/default.aspx>.

³³⁸ Baker, "From Shortages to Stockpiles," 165.

³³⁹ Cecire et al., *COVID-19 and Domestic PPE Production and Distribution*, 29.

³⁴⁰ Federal Emergency Management Agency, *Pandemic Response to COVID-19*, 69.

³⁴¹ Mitchell Moss, Charles Schellhamer, and David A. Berman, "The Stafford Act and Priorities for Reform," *Journal of Homeland Security and Emergency Management* 6, no. 1 (2009): 1, <https://doi.org/10.2202/1547-7355.1538>.

³⁴² Moss, Schellhamer, and Berman, abstract.

³⁴³ Moss, Schellhamer, and Berman, 1.

One of the challenges of the Stafford Act is its complexity in combination with other federal laws. Moss, Schellhamer, and Berman, experts on law and policy, point out the many layers of laws and regulations that may involve the use of the Stafford Act, such as the Homeland Security Act of 2002, the Post-Katrina Emergency Management Reform Act of 2006, and the National Response Framework known as the Incident Command System. The authors further assert that an event could be declared an incident of national significance, a catastrophic incident, or a major disaster, each carrying different response provisions.³⁴⁴ In responding to an incident while navigating all these laws, confusion occurs when applying various sets of rules. Confusion is the last thing responders need during times of crisis.

One area where the Stafford Act worked well during the COVID-19 outbreak was in public assistance (PA). FEMA administers PA, the most extensive grant program to assist communities recovering from a presidentially declared disaster.³⁴⁵ Before the COVID-19 pandemic, no president had used PA to respond to an infectious disease outbreak.³⁴⁶ On March 22, 2020, President Trump relied on the act to sign a memorandum providing federal support to governors, so they could use the National Guard to respond to COVID-19.³⁴⁷ Citing the Stafford Act, the federal government would fund 100 percent of emergency assistance in responding to COVID-19 for California, New York, and Washington. At the time of the memo, the three states were experiencing a surge in COVID-19 illness.

In a February 2022 congressional report, Lee praised the Trump and Biden administrations for increasing PA from the statutory floor of 75 to 100 percent for all jurisdictions nationwide during COVID-19 for costs and supplies needed for reopening

³⁴⁴ Moss, Schellhamer, and Berman, 1.

³⁴⁵ “Public Assistance Fact Sheet,” Federal Emergency Management Agency, October 2019, 1, https://www.fema.gov/sites/default/files/2020-07/fema_public-assistance-fact-sheet_10-2019.pdf.

³⁴⁶ Erica A. Lee, *FEMA’s Role in the COVID-19 Federal Pandemic Response*, CRS Report No. R47048 (Washington, DC: Congressional Research Service, 2022), 27, <https://crsreports.congress.gov/product/pdf/R/R47048/2>.

³⁴⁷ Donald J. Trump, “Providing Federal Support for Governors’ Use of the National Guard to Respond to COVID–19” (official memorandum, Washington, DC: White House, 2020), ProQuest.

facilities.³⁴⁸ These included supplies like PPE and cleaning supplies. Before this change, states, municipal governments, eligible healthcare organizations, and some nonprofits had to provide their share (25 percent) up front.³⁴⁹ The increase helped with already-tight budgets to cover rapidly growing unexpected costs. The Trump memorandum is an example of the federal government's using statutes appropriately and promptly; unfortunately, the use did not apply to all states.

4. Executive Orders

Mary Woodward, an expert on executive orders (EOs), defines them as “a formal means through which the President of the United States prescribes the conduct of business in the Executive Branch.”³⁵⁰ Put another way, an EO is a written presidential directive that manages the federal government's operation. It is an internal directive to federal employees. The U.S. Constitution does not specify the president's authority to issue EOs; Article II, Section 3, of the Constitution, which gives the president executive powers, implies that right. It requires that the president “take Care that the Laws be faithfully executed.”³⁵¹ Once issued, EOs remain valid until they are revoked, canceled, or determined unlawful, or expire. EOs are subject to legal review, meaning they can be determined unlawful by the judicial branch.³⁵² Modern EOs (i.e., EOs issued after 1936) must be filed in the Federal Register and the Code of Federal Regulations.³⁵³

³⁴⁸ Lee, *FEMA's Role in the COVID-19 Federal Pandemic Response*, 28.

³⁴⁹ Lee, 28.

³⁵⁰ Mary Woodward, “Executive Orders: A Journey,” *Legal Reference Services Quarterly* 10, no. 3 (1990): 125, https://doi.org/10.1300/J113v10n03_07.

³⁵¹ National Constitution Center, “Executive Orders 101: What Are They and How Do Presidents Use Them?,” *Constitution Daily* (blog), January 23, 2017, para. 5, <https://constitutioncenter.org/blog/executive-orders-101-what-are-they-and-how-do-presidents-use-them>.

³⁵² “Executive Order,” History Channel, February 4, 2021, <https://www.history.com/topics/us-government-and-politics/executive-order>.

³⁵³ Barbara Bavis, “Executive Orders: A Beginner's Guide: Executive Order, Proclamation, or Executive Memorandum?,” Library of Congress, accessed August 24, 2023, <https://guides.loc.gov/executive-orders/order-proclamation-memorandum>.

Some consider EOs the executive's most powerful tool, enabling a president to create a legally enforceable policy without congressional approval.³⁵⁴ The circumventing of congressional approval can make EOs controversial. Every president except William Henry Harrison has issued EOs.³⁵⁵ Harrison issues no EOs simply because his presidency lasted 31 days.³⁵⁶ Since Ronald Reagan, presidents from both political parties have increasingly relied on EOs to control policymaking.³⁵⁷ EOs, while at times contentious, are a part of modern presidencies.

Presidential proclamations are another type of presidential edict. Proclamations tend to be less formal and are typically celebratory.³⁵⁸ Proclamations are external, involve private citizens, and are not legally enforceable.³⁵⁹ A presidential order to lower the U.S. flag to half-staff to honor someone is usually delivered by proclamation.³⁶⁰ Proclamations occur frequently, and because they are generally ceremonial, they tend to be inconsequential.

During COVID-19, President Trump and President Biden issued several EOs to aid the country in navigating the pandemic. These orders ranged from a proclamation declaring COVID-19 a federal emergency to one requiring federal workers to get the COVID-19 vaccine. Some orders had minimal effect while others set huge course adjustments for the federal government.

³⁵⁴ Woodward, "Executive Orders."

³⁵⁵ Gerhard Peters and John T. Wooley, *Executive Orders* (Santa Barbara, CA: American Presidency Project, 2023), <https://www.presidency.ucsb.edu/node/323876>.

³⁵⁶ White House Historical Association, "William Henry Harrison," White House, accessed August 22, 2023, <https://www.whitehouse.gov/about-the-white-house/presidents/william-henry-harrison/>.

³⁵⁷ Lisa Manheim and Kathryn A. Watts, "Reviewing Presidential Orders," *University of Chicago Law Review* 86, no. 7 (November 2019): 1743.

³⁵⁸ "Government Information: Executive Orders and Proclamations," University of Massachusetts Amherst Libraries, December 14, 2022, <https://guides.library.umass.edu/govinfo/exec/orders>.

³⁵⁹ Bavis, "Executive Order, Proclamation, or Executive Memorandum?"

³⁶⁰ Julie Percha, "Your Cheat Sheet for Executive Orders, Memorandums and Proclamations," PBS NewsHour, July 11, 2019, <https://www.pbs.org/newshour/politics/cheat-sheet-executive-orders-memorandums-proclamations>.

a. Donald J. Trump (2017–2021)

President Trump’s first COVID-19 directive was Proclamation No. 9994 of March 13, 2020. Proclamation No. 9994 declared COVID-19 a federal emergency and allowed the HHS secretary to modify healthcare laws, including the Health Insurance Portability and Accountability Act (HIPAA).³⁶¹ Nass, Levit, and Gostin explain that HIPAA was created in 1996 to increase the number of Americans with health insurance and make healthcare more efficient.³⁶² The lasting and most consequential part of HIPAA is standardized electronic health information, including security and privacy standards.³⁶³ Proclamation No. 9994 allowed the relaxation of the privacy rights of individuals so that emergency management agencies could obtain certain protected health information.³⁶⁴ The information otherwise kept from dissemination by HIPAA was used by emergency managers to generate data analytics for public safety.

An emergency declaration also allowed Stafford Act money to flow. While the Stafford Act was not specifically intended for public health emergencies, Trump said in a letter that he believed the pandemic was a “disaster . . . of such severity and magnitude nationwide that requests for a declaration of a major disaster as set forth in section 401(a) of the Stafford Act [might] be appropriate.”³⁶⁵ In a report dated September 21, 2021, the Department of Homeland Security (DHS)’s Office of Inspector General (OIG) called Trump’s declaration “unprecedented” because it applied to all 50 states, the District of Columbia, all U.S. territories, and all tribal nations.³⁶⁶ Trump’s letter, a proclamation, was

³⁶¹ Proclamation No. 9994, 85 Fed. Reg. 15337 (March 18, 2020).

³⁶² Sharyl J. Nass, Laura A. Levit, and Lawrence O. Gostin, eds., *Beyond the HIPAA Privacy Rule: Enhancing Privacy, Improving Health through Research* (Washington, DC: National Academies Press, 2009), 63, <https://www.ncbi.nlm.nih.gov/books/NBK9576/>.

³⁶³ Nass, Levit, and Gostin, 63.

³⁶⁴ Stacey A. Tovino, “COVID-19 and the HIPAA Privacy Rule: Asked and Answered,” *Stetson Law Review* 50, no. 3 (2021): 367.

³⁶⁵ Donald J. Trump to Chad F. Wolf, Steven T. Mnuchin, Alex M. Azar II, and Pete T. Ganor, March 13, 2020, <https://trumpwhitehouse.archives.gov/briefings-statements/letter-president-donald-j-trump-emergency-determination-stafford-act/>.

³⁶⁶ Department of Homeland Security, Office of Inspector General, *Lessons Learned from FEMA’s Initial Response to COVID-19*, OIG-21-64 (Washington, DC: Department of Homeland Security, 2021), 1, <https://www.oig.dhs.gov/sites/default/files/assets/2021-09/OIG-21-64-Sep21.pdf>.

an essential first step in the federal response to COVID-19. The choice of a proclamation instead of an EO for the first step is curious, especially considering the scope of the topic. However, there is little academic debate on the point. Trump most likely used a proclamation instead of an EO because President Obama used Proclamation 8443 to declare a national emergency during the 2009 H1N1 outbreak.³⁶⁷ That Trump followed Obama's lead is the most likely conclusion.

Trump's next EO was 13909, prioritizing and allocating health and medical resources to the COVID-19 response.³⁶⁸ In this critical order, the president recognized the importance of PPE for the first time. The order designated the HHS secretary to prioritize and allocate medical resources—including those in the civilian market. This EO allowed the federal government to reallocate PPE supplies purchased through civilian supply chains. On the one hand, the EO recognized the importance of PPE in fighting COVID-19. Still, it allowed the federal government to usurp critical supplies and disrupt an already stressed supply chain.

Trump also issued EO 13910 early in the pandemic, on March 23, 2020, to address hoarding medical supplies related to COVID-19.³⁶⁹ This EO directed the HHS secretary to work with the FEMA administrator to adopt and revise rules to prevent hoarding. It also allowed the HHS secretary to deem any relevant material as scarce, such as PPE or HEPA filtering material.³⁷⁰ The EO also directed federal agencies to make rules to prevent hoarding COVID-19 supplies and materials. This EO was thus important for two reasons. First, the president recognized PPE as a scarce resource for the first time, and second, it made PPE price-gouging a crime.

³⁶⁷ L. Elaine Halchin and Elizabeth M Webster, *Presidential Declarations of Emergency for COVID-19: NEA and Stafford Act*, CRS Report No. IN11264 (Washington, DC: Congressional Research Service, 2020), 1, <https://crsreports.congress.gov/product/pdf/IN/IN11264>.

³⁶⁸ Exec. Order 13909, 85 Fed. Reg. 16227 (March 23, 2020).

³⁶⁹ Exec. Order 13910, 85 Fed. Reg. 17001 (March 26, 2020).

³⁷⁰ HEPA is a pleated air filter that removes at least 99.97 percent of dust, mold, bacteria, or airborne particles. "What Is a HEPA Filter?," Environmental Protection Agency, March 13, 2023, <https://www.epa.gov/indoor-air-quality-iaq/what-hepa-filter>.

As a result of EO 13910, the Department of Justice (DOJ) charged at least two people with hoarding and price gouging in the New York area. In one case, a Long Island man was accused of selling COVID-19 PPE at inflated prices.³⁷¹ In another, the DOJ accused a licensed pharmacist of hoarding, gouging, and healthcare fraud.³⁷² Headlines about the cases spread nationwide during the early days of the COVID-19 pandemic. It appears that in making an example of the two individuals, the DOJ had hoped to deter others.

Trump also penned two EOs for COVID-19 that cite the DPA. EO 13911, dated March 27, 2020, delegated the HHS and DHS secretaries to work with other executive departments to respond to COVID-19.³⁷³ It also directed expanding domestic production of healthcare supplies, including PPE and ventilators. This vital EO allowed various federal agencies to increase the production of PPE by partnering with private industry. EO 13922, issued in May 2020, allowed the Development Finance Corporation to loan funds to increase domestic production of resources necessary for the COVID-19 response and to strengthen domestic supply chains.³⁷⁴ In short, the second EO helped fund the production of domestic supplies to carry out the COVID-19 response.

b. Joseph R. Biden Jr. (2021–Present)

Minutes into the Biden presidency, the president issued a flurry of EOs. His first order was issued just over a year after the start of the COVID-19 outbreak. EO 13991, issued on January 20, 2021, required federal employees to wear masks and socially distance while at work.³⁷⁵ On the same day, Biden also issued EO 13987, which designated a

³⁷¹ U.S. Attorney’s Office, Eastern District of New York, “Long Island Man Charged under Defense Production Act with Hoarding and Price-Gouging of Scarce Personal Protective Equipment,” Department of Justice, April 24, 2020, <https://www.justice.gov/usao-edny/pr/long-island-man-charged-under-defense-production-act-hoarding-and-price-gouging-scarc-0>.

³⁷² U.S. Attorney’s Office, Southern District of New York, “Licensed Pharmacist Charged with Hoarding and Price Gouging of N95 Masks in Violation of Defense Production Act,” Department of Justice, May 26, 2020, <https://www.justice.gov/usao-sdny/pr/licensed-pharmacist-charged-hoarding-and-price-gouging-n95-masks-violation-defense>.

³⁷³ Exec. Order 13911, 85 Fed. Reg. 18403 (April 1, 2020).

³⁷⁴ Exec. Order 13922, 85 Fed. Reg. 30583 (May 19, 2020).

³⁷⁵ Exec. Order 13991, 86 Fed. Reg. 7045 (January 25, 2021).

COVID-19 response coordinator who reported directly to the president.³⁷⁶ Jeff Zients took this position and was dubbed the “COVID-19 czar.”³⁷⁷ Biden appointed Anthony Fauci as the White House chief medical advisor.³⁷⁸ These actions signaled that the Biden administration would approach the COVID-19 pandemic differently from its predecessor, including a greater focus on PPE. Directing social distancing could reduce contact with infected persons, which could mean fewer sick people and reduced PPE consumption, leaving the vital commodity for first responders and medical professionals.

The next day, on January 21, 2021, Biden issued several more EOs relating to COVID-19: 13994–13999 and 14001–14002.³⁷⁹ Of those orders, two were relevant to supply chains and PPE production. The first was EO 13999, designed to protect workers’ health and safety and vaguely touched on workplace masking. The second was EO 14001, which sought to achieve sustainability in the health goods supply chain, including securing PPE. These orders showed how important President Biden viewed the COVID-19 pandemic during the first hours of his presidency (see Figure 23).

³⁷⁶ Exec. Order 13987, 86 Fed. Reg. 7019 (January 25, 2021).

³⁷⁷ Kiran Stacey and Hannah Kuchler, “Jeff Zients, the ‘Mr. Fix It’ Biden Put in Charge of Tackling the COVID-19 Crisis,” *Los Angeles Times*, January 20, 2021, <https://www.latimes.com/world-nation/story/2021-01-20/joe-biden-jeff-zients-covid-19-crisis>.

³⁷⁸ Matthew Choi, “Biden Asks Fauci to Stay on Covid Team, Become Chief Medical Adviser,” *Politico*, December 3, 2020, <https://www.politico.com/news/2020/12/03/biden-fauci-covid-team-442739>.

³⁷⁹ National Archives, “2021 Joseph R. Biden Jr. Executive Orders,” *Federal Register*, December 31, 2021, <https://www.federalregister.gov/presidential-documents/executive-orders/joe-biden/2021>.

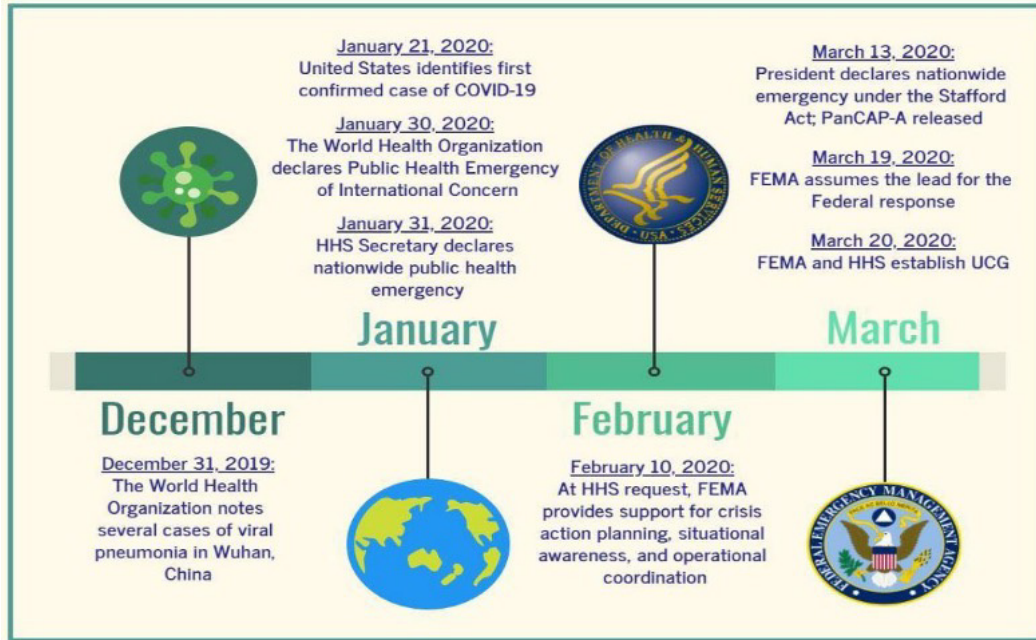


Figure 23. Timeline of the COVID-19 Pandemic and Federal Response during the Early Months.³⁸⁰

B. CONSEQUENCES OF USING FEDERAL AUTHORITY

There were many consequences from federal interference. PPE and sanitization supplies were already limited commodities. Federal involvement of FEMA, HHS, and the SNS created a hyper-competitive environment for such medical supplies. While FEMA attempted to secure PPE to distribute to agencies nationwide, it did not have a robust ordering system that cataloged and tracked supplies, which sometimes meant the agency lost valuable lifesaving equipment. The federal efforts caused a disjointed response, putting first responders at risk.

1. Competition

Competition is a cornerstone of any free-market economy. Supply and demand are what set the price of a good. In a free market, the government does not interfere with that process. During the COVID-19 pandemic, Americans experienced supply shortages,

³⁸⁰ Source: Department of Homeland Security, Office of Inspector General, *Lessons Learned from FEMA's Initial Response to COVID-19*, 2.

leading to hyper-competition, price gouging, counterfeits, and sometimes government interference. It was the worst possible scenario for first-responder agencies trying to buy enough PPE to protect their employees. The federal government altered the free-market system using the DPA and EO 13909, which increased shortages by reallocating supplies like PPE.

Nearly every healthcare system and first-responder agency experienced shortages of PPE during COVID-19. A September 2020 GAO report explains that PPE shortages during the pandemic were “due to limited U.S. manufacturing and high global demand.”³⁸¹ Everyone worldwide was trying to get the same supplies, and manufacturing capabilities could not keep up. Writing for the University of Minnesota’s Center for Infectious Disease Research and Policy, Chris Dall describes the cascading effects of competition for PPE: “A global surge in demand for protective gear that was outstripping supply, a lack of adequate supplies in the Strategic National Stockpile, which is intended to supplement state and local supplies during public health emergencies, and a response that lacked any federal coordination.”³⁸²

The instances of PPE shortages across the United States were endless. In March 2020, a photo of nurses from New York City’s Mount Sinai Hospital using trash bags as makeshift isolation gowns surfaced.³⁸³ Nada Sanders, a professor of supply chain management at Northeastern University, categorized the PPE market during COVID-19 as a “free-for-all.”³⁸⁴ Furthermore, a January 2021 DHS report on FEMA’s initial response to COVID-19 describes how “FEMA purchased 220 million respirators using a priority

³⁸¹ A. Nicole Clowers, *COVID-19 Federal Efforts Could Be Strengthened by Timely and Concerted Actions*, GAO-20-701 (Washington, DC: Government Accountability Office, 2020), 14, <https://www.gao.gov/assets/710/709492.pdf>.

³⁸² Chris Dall, “As Pandemic Rages, PPE Supply Remains a Problem,” University of Minnesota Center for Infectious Disease Research and Policy, July 29, 2020, <https://www.cidrap.umn.edu/covid-19/pandemic-rages-ppe-supply-remains-problem>.

³⁸³ Justine Coleman, “Photo Shows NY Hospital Staff Using Trash Bags as Protective Gear,” *Hill*, March 26, 2020, <https://thehill.com/policy/healthcare/489622-photo-shows-staff-using-trash-bags-as-protective-gear-in-hospital-system/>.

³⁸⁴ Daniella Diaz, Geneva Sands, and Christina Alesci, “Protective Equipment Costs Increase over 1,000% amid Competition and Surge in Demand,” CNN, April 16, 2020, <https://www.cnn.com/2020/04/16/politics/ppe-price-costs-rising-economy-personal-protective-equipment/index.html>.

contract.”³⁸⁵ That meant the federal government usurped masks intended to go to first responders and healthcare workers. Increased competition caused chaos as agencies nationwide scrambled to find and obtain PPE.

The United States is a nation of scale. Larger agencies, organizations, and businesses thrive because they have purchasing power. Buying in large quantities typically gives the purchaser a reduction in unit price, commonly called a bulk discount. One way to think about this is that the more one buys, the more one saves. Large purchasing agencies like the U.S. government, large hospital systems, and local governments buy in bulk and rarely pay retail prices. Frequently, the ability to buy in mass provides the purchaser preferential treatment with a seller. For example, the bulk buyer’s order is often filled first. When scarcity occurs, the bulk buyer’s orders may be filled, but orders for purchasers of small quantities or infrequent transactions might not be. In such situations, the small purchaser loses. For example, a small clinic in Aledo, Texas, which served around 600 patients a month, received only 10 gowns and zero N95 respirators from a medical supplier the clinic had used for over 10 years.³⁸⁶ For first responders, a small department might have been unable to purchase one or two boxes of medical gloves simply because the order was too small. At this author’s home agency, weeks were spent trying to source two boxes of extra-small medical exam gloves for one petite paramedic.³⁸⁷ These examples demonstrate that increased competition made finding small quantities of PPE nearly impossible.

Scarcity also impacted first responders in departments of a larger size. Dall, a journalist at the University of Minnesota’s Center for Infectious Disease Research and Policy, discusses the FDNY’s experience, which also involved PPE shortages during COVID-19. The department advised EMTs to wear protective surgical masks instead of N95 respirators, and fewer of them. The scarcity of PPE was described this way: an

³⁸⁵ Federal Emergency Management Agency, *Pandemic Response to COVID-19*, 69.

³⁸⁶ Dall, “As Pandemic Rages, PPE Supply Remains a Problem.”

³⁸⁷ The claims in this paragraph, as with many other statements of fact within this thesis, are based on the author’s professional experience, training, and education. During the COVID-19 pandemic, the author served as the EMS logistics chief, responsible for procuring PPE and sanitizing equipment.

anonymous EMT told Dall that “the patient compartment of an ambulance is compact, and even though in theory there is a vent to circulate air, [you are] definitely breathing shared air for 10–15 minutes. . . . [I] definitely don’t feel safe using a surgical mask on COVID calls” (brackets in the original).³⁸⁸ Even EMTs in a massive department like the FDNY felt the squeeze of PPE shortages and felt less protected with the provided substitution.

2. FEMA

FEMA is the lead federal agency helping the nation before, during, and after disasters.³⁸⁹ FEMA can trace its roots back to 1803 when the U.S. government provided relief to the citizens of Portsmouth, New Hampshire, following a fire that destroyed large parts of the city’s port.³⁹⁰ On April 1, 1979, FEMA became a stand-alone agency when President Carter signed EO 12127.³⁹¹ Since its creation, FEMA has become the nation’s natural disaster responder.

During disasters, FEMA has 15 emergency support functions (ESFs). An ESF groups similar resources and capabilities into functional areas most frequently needed during a disaster.³⁹² FEMA’s ESFs range from transportation (ESF #1) to agriculture and natural resources (ESF #11) to infrastructure (ESF #14). Public health and medical services fall under ESF #8. Although FEMA has a listed ESF for public health and medical needs, HHS is the lead agency.³⁹³ The agency’s organization means that while FEMA addresses medical conditions, HHS must provide the resources, equipment, and responders for FEMA to do so.

³⁸⁸ Dall, “As Pandemic Rages, PPE Supply Remains a Problem,” under “Forced to Adapt.”

³⁸⁹ “About FEMA,” Federal Emergency Management Agency, May 4, 2023, <https://www.fema.gov/about/strategic-plan/about-fema>.

³⁹⁰ “History of FEMA,” Federal Emergency Management Agency, January 4, 2021, <https://www.fema.gov/about/history>.

³⁹¹ Federal Emergency Management Agency.

³⁹² Department of Homeland Security, *National Response Framework*.

³⁹³ Federal Emergency Management Agency, “Appendix F: Emergency Support Functions (ESFs),” in *Key Planning Factors and Considerations for Response to and Recovery from a Chemical Incident* (Washington, DC: Federal Emergency Management Agency, 2022), 281–83, https://www.fema.gov/sites/default/files/documents/fema_chemical-incident-kpf-2022.pdf.

a. HHS

Medical responders and healthcare supplies currently fall under the ASPR, a subsection of HHS. Medical responders also fall under the National Disaster Medical System (NDMS) while medical supplies fall within the SNS. The NDMS has had a winding and bumpy path. The NDMS was formed under the HHS umbrella in 1984 as part of the Public Health Service.³⁹⁴ In 2003, the NDMS was moved from HHS to the newly created DHS as part of the Homeland Security Act of 2002 following the 9/11 terrorist attacks.³⁹⁵ The idea then was to move all non-military federal responders under DHS.

The NDMS moved back under the HHS secretary in 2006 following criticism of the former's response to hurricanes in 2004 and 2005.³⁹⁶ The move resulted from the Pandemic and All-Hazards Preparedness Act of 2006.³⁹⁷ Rear Admiral W. Craig Vanderwagen, the HHS chief preparedness officer, explained the thought process: "We're doctors talking to doctors, nurses talking to nurses, EMTs talking to EMTs."³⁹⁸ Having the medical responders of the NDMS report to HHS, which speaks the same language, made sense.

b. FEMA, HHS, and the COVID-19 Response

When COVID-19 hit, the public heavily criticized FEMA and HHS. HHS was designated the lead agency in the Pandemic Crisis Action Plan of January 2018.³⁹⁹ However, when President Trump issued Proclamation No. 9994, declaring a federal

³⁹⁴ Committee on Government Reform, Minority Staff, *The Decline of the National Disaster Medical System* (Washington, DC: House of Representatives, 2005), 3, <https://www.hsdl.org/c/view?docid=463751>.

³⁹⁵ Committee on Government Reform, Minority Staff, 5.

³⁹⁶ Zack Phillips, "The Emergency Medical System Returns Home, Hopefully to Better Health," *Government Executive*, February 21, 2007, <https://www.govexec.com/management/2007/02/geographic-cure/23771/>.

³⁹⁷ Pandemic and All-Hazards Preparedness Act, Pub. L. No. 109–417, 120 Stat. 2831 (2006), <https://www.congress.gov/bill/109th-congress/senate-bill/3678/text>.

³⁹⁸ Phillips, "The Emergency Medical System Returns Home."

³⁹⁹ Department of Homeland Security, Office of Inspector General, *Lessons Learned from FEMA's Initial Response to COVID-19*, 1.

disaster citing the Stafford Act, the responsibility shifted to FEMA.⁴⁰⁰ The change in the chain of command led to confusion within the federal government and impacted the response to the pandemic. In the early days of COVID-19, FEMA reacted as though it were responding to a traditional natural disaster, using the “all emergencies are local” mentality.⁴⁰¹ However, the nature of the unique public health emergency necessarily involved every municipality across the entire nation. The effort eventually involved 57 presidentially declared disasters, making it unprecedented.⁴⁰²

In addition to COVID-19, FEMA was involved in responding to 41 declared emergencies across the United States—seven hurricanes, three wildfires, five floods, 23 severe storms/tornadoes, two earthquakes, and one broken dam—between January 1 and September 30, 2020.⁴⁰³ Figure 24 depicts presidentially declared non-COVID-19 emergencies. The scope of COVID-19, however, meant that the emergency was too large for FEMA to manage using traditional methods.

⁴⁰⁰ Proclamation No. 9994.

⁴⁰¹ Department of Homeland Security, Office of Inspector General, *Lessons Learned from FEMA's Initial Response to COVID-19*, 2.

⁴⁰² Federal Emergency Management Agency, *Pandemic Response to COVID-19*, 22.

⁴⁰³ Federal Emergency Management Agency, 20.

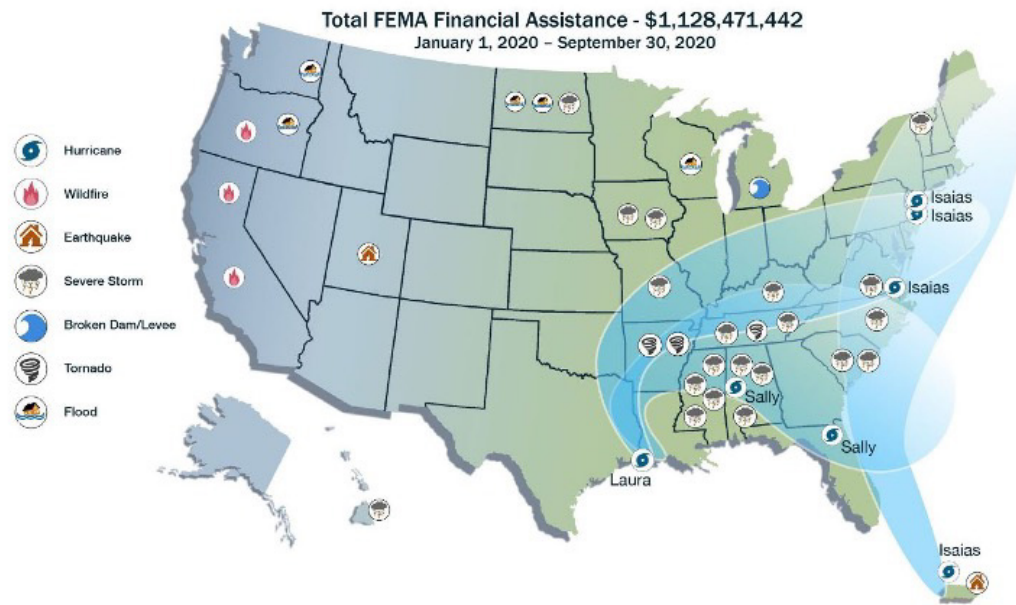


Figure 24. Presidentially Declared Emergencies from January 1, 2020, to September 30, 2020.⁴⁰⁴

In addition, FEMA’s response to COVID-19 evolved in unexpected ways. On April 14, 2020, the American Medical Association called on FEMA to act as a nationwide distribution point for PPE because all levels of government were competing against each other.⁴⁰⁵ The American Medical Association suggested that FEMA become a central distribution point for PPE to reduce competition on the open market. Not only would this reduce competition, but it would also control pricing, which would eliminate exorbitant price hikes. While a good idea in theory, FEMA was not equipped to handle that logistical lift at the time due to factors like capacity, resource typing, and outdated software. FEMA’s resource-typing library has formed the basis of its inventory and request software, comprising 590 item-specific equipment and personnel resources, from ambulance operators to wildland firefighters.⁴⁰⁶ However, the resource types are disaster oriented, not public-health focused, thus making the tool useless for a pandemic response.

⁴⁰⁴ Source: Federal Emergency Management Agency, 20.

⁴⁰⁵ Diaz, Sands, and Alesci, “Protective Equipment Costs Increase over 1,000%.”

⁴⁰⁶ “Resource Typing Library Tool,” Federal Emergency Management Agency, accessed August 29, 2023, <https://rtlt.preptoolkit.fema.gov/Public>.

An OIG audit issued on September 21, 2021, six months into the U.S. response to COVID-19, found deficiencies in FEMA's software program and made three recommendations. First, it needed to improve the reliability of the current software system to track requests better.⁴⁰⁷ In the early days of the pandemic response, FEMA's management software did not handle medical supplies such as masks and gloves. The gap sometimes meant specific supplies like N95 masks were incorrectly classified, leading to lost supplies in the system.⁴⁰⁸ Moreover, the software could not process a partial order, leading to confusion when a state received its requested supplies. In other cases, however, states received no supplies. COVID-19 exposed that FEMA did not understand the resources needed to address the pandemic and its software's limitations. Even worse, FEMA caused significant delays as it manually processed requests.⁴⁰⁹ In short, FEMA's resource-typing system caused inefficiencies, partial orders, and lost supplies.

The second recommendation in the September 21, 2021, OIG report involved cooperation between FEMA and HHS. The OIG report suggested improving HHS and FEMA's coordination in public health emergencies by formally documenting policies and procedures for allocating equipment and resources.⁴¹⁰ Third, the OIG recommended that FEMA and HHS better define their roles and responsibilities during a Stafford Act declaration.⁴¹¹ COVID-19 revealed that FEMA had innovative but insufficient protocols and policies to address a public health emergency. Despite these challenges, FEMA shipped over 46.7 million face shields, 1.1 billion surgical masks, and 249 million N95 respirators within the first nine months of the pandemic. Figure 25 shows the volume of PPE that FEMA delivered in the early days of the pandemic.

⁴⁰⁷ Department of Homeland Security, Office of Inspector General, *Lessons Learned from FEMA's Initial Response to COVID-19*, 13.

⁴⁰⁸ Department of Homeland Security, Office of Inspector General, 7.

⁴⁰⁹ Federal Emergency Management Agency, *Pandemic Response to COVID-19*, 48.

⁴¹⁰ Department of Homeland Security, Office of Inspector General, *Lessons Learned from FEMA's Initial Response to COVID-19*, 13.

⁴¹¹ Department of Homeland Security, Office of Inspector General, 13.

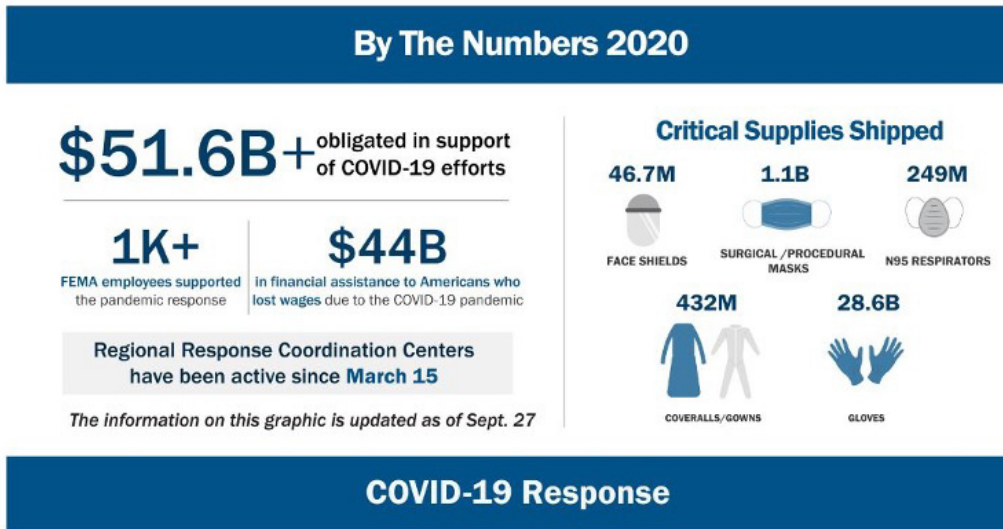


Figure 25. FEMA’s COVID-19 Response from January 1, 2020, to September 27, 2020.⁴¹²

According to a report detailing FEMA’s COVID-19 response, in the first nine months of the response, the agency “executed an unprecedented number of mission assignments to federal partners in innovative ways to support state, tribal, and territorial requirements, but the nature of the incident revealed insufficient policies and procedures for handling the duration and complexity of the operations.”⁴¹³ In this way, FEMA did the best it could under impossible circumstances.

C. CONCLUSION

The federal response to COVID-19 was insufficient in dealing with the nature of the emergency. Laws such as the Public Services Act were stretched in all directions as the administration tried to manage the pandemic and slow its spread. Likewise, the DPA, intended for wartime use, was used innovatively during COVID-19 to compel domestic industry to increase the production of PPE and other critical medical supplies—a few legal mechanisms worked as intended. The Stafford Act, the primary federal emergency management law, provided a means for funding the COVID-19 response. Finally, EOs

⁴¹² Source: Federal Emergency Management Agency, *Pandemic Response to COVID-19*, 9.

⁴¹³ Federal Emergency Management Agency, 57.

filled in gaps where existing laws were lacking, including addressing issues like hoarding and price gouging.

The federal implementation of the Public Health Services Act, the DPA, and EOs had far-reaching consequences. Competition for medical supplies, including vital PPE, increased, leading to a hyper-competitive environment, which Sanders has categorized as a free-for-all. The hyper-competitive environment made it nearly impossible for small first-responder agencies of any size to get small quantities of supplies because they needed more buying power. In some cases, FEMA made the situation worse by intercepting PPE and removing it from the usual market flow. FEMA and HHS were woefully underprepared for a disaster of this scope. Citizens expect the federal government to respond to emergencies. However, while the U.S. government responded, it was a disjointed, complicated, and incomplete effort.

The next chapter concludes the thesis by exploring findings and recommendations based on earlier chapters. These recommendations are framed at the federal and state/local levels with the intent of providing realistic suggestions so that first-responder agencies may prepare for the next public health crisis.

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VI. FINDINGS AND RECOMMENDATIONS

This thesis has demonstrated the importance of PPE for first responders and the challenges of providing it to individuals facing various exposure risks during even the most routine service calls. Because of the nature of modern supply chains, public health emergencies—including pandemics and other mass-casualty events—serve as warnings about the inadequacies of existing resource management policies and industrial capacity to guarantee that first responders have what they need during emergencies. Several specific examples of PPE supply chain problems in these pages highlight two important points: these supply chains are neither redundant nor resilient, and, collectively, first responders and different levels of government have not necessarily learned from the past.

During the COVID-19 pandemic, perhaps the first truly global public health crisis in over 100 years, public safety agencies did not have adequate PPE to protect their first responders. The already frail supply chain had unprecedented disruptions at all levels, causing PPE shortages. These shortages put responders at risk, and in some cases, under-protected first responders became ill, and a few died. Emergency services in the United States have not yet fully recovered from the COVID crisis, as recruitment and retention for police, fire, and EMS are down nationwide, making first responders a scarce resource. The fact that PPE supply chains were taxed during the pandemic is no secret, and this fact has likely contributed to the slowness of post-COVID agency recovery. Indeed, various sources of disruption brought to light the shortcomings of the modern supply chain.

By exploring past public health emergencies, from HIV/AIDS to pandemic flu to COVID-19, this thesis showed that adequate medical exam gloves, face shields, isolation gowns, and N95 respirators can protect first responders from most pathogens. As a result, first-responder agencies should ensure they have adequate amounts of these PPE types as a “layered defense”—a concept familiar to all who work in emergency services. A layered defense is one with multiple barriers before entry. For first responders like firefighters, paramedics, and police officers, a layered defense means layers of protection, or PPE. The first—or outer—layer for firefighters is protective turnout gear. The second layer is their duty uniform; the third could be medical exam gloves; and the final layer is intact skin. A

similar comparison for law enforcement is a ballistic vest, uniform, exam gloves, and intact skin. This thesis focused on disposable PPE, consumed at an increased rate during public health emergencies.

The layered defense metaphor should apply to the management of PPE stocks, as this framing would help practitioners prepare for the next public health emergency by ensuring that first responders have adequate protective gear. Such a philosophy would entail layering physical supplies, such as multiple layers of gloves, as well as creating sourcing or purchasing redundancies. By creating layers of supply and storage, public health and emergency service agencies—especially those staffed by first-responder personnel who interact with the public—will have redundancies available to them to ensure uninterrupted service in the event of another crisis that strains supply chains.

A. EXPECTED CHANGE/IMPACT

Having a layered defense should reduce illness and death among first responders as stockpiling and having multiple supply chains are means of quickly acquiring sufficient amounts of quality PPE to protect responders during the next public health crisis. Forecasting is challenging, but using lessons learned from COVID-19 is a reasonable starting point. Agencies must assume disruptions in the supply chain during a global pandemic and plan supplies accordingly.

The recommended layered defense builds layers of resiliency along with layers of physical PPE. This strategy requires agencies to have multiple vendors in different industries. For example, an agency should use a medical vendor as a primary source of isolation gowns and a backup vendor in the chemical or meat-processing industry for equally suitable gowns. When sourcing exam gloves, the primary vendor should be a medical supplier, but an auto parts supplier might also be considered a source for mechanic's gloves made of the same material. To bolster resiliency, these layers must occur at the federal, state, and local levels.

B. FEDERAL CONSIDERATIONS

The federal government may bring to bear broad powers during emergencies, but as the ancient adage goes, “with great power comes great responsibility.”⁴¹⁴ The federal government must balance authority with repercussions and unintended consequences. During the global COVID-19 pandemic, FEMA’s ability to usurp already-purchased supplies and reallocate this equipment left agencies without. Although it might have made sense to restrict PPE purchases in areas with zero infections, COVID-19 spread from state to state quickly, and everyone needed PPE.

1. Strategic National Stockpile

The first step the federal government must take is to fund the SNS fully. The public’s expectations have evolved since the stockpile’s inception in 1999, when the National Pharmaceutical Stockpile was created to amass vaccines and pharmaceuticals, though never intended as the sole solution.⁴¹⁵ It evolved into the SNS in response to the 9/11 terrorist attacks.⁴¹⁶ The stockpile must evolve further to have the appropriate supplies and quantities for CBRN attacks, medical supplies, and PPE to defend the nation during a global outbreak. Public health officials from HHS and emergency managers from FEMA should work together to create a supply list, establish appropriate quantities, and then push politicians to fully fund the endeavor.

2. Purchasing

The federal government possesses tremendous purchasing power, which allows it to receive a deep discount from suppliers. This buying power gives it leverage, meaning the federal government’s orders ship first. The federal government also pays its bills, making it a good customer.

⁴¹⁴ Robert Deis, “With Great Power Comes Great Responsibility,” *Quote/Counterquote* (blog), July 5, 2012, <http://www.quotecounterquote.com/2012/07/with-great-power-comes-great.html>.

⁴¹⁵ Omnibus Consolidated and Emergency Supplemental Appropriations Act.

⁴¹⁶ Gottron and Wyatt, *The Strategic National Stockpile*, 1.

3. Federal Supply Schedule

Another federal-level consideration involves allowing states to use the federal supply schedule (FSS), which provides federal agencies with a purchasing process for commercial supplies at volume discounts.⁴¹⁷ By allowing states to use the federal supply program, states would have access to a new supply chain separate from the open market. Buying from the FSS will increase buying power, decrease pressure on the open market, and save taxpayer dollars with purchases at a discount.

4. Laws

One topic that needs further analysis is expiration dates and agency liability when using expired products. As previously discussed, disposable medical equipment, including PPE, has an expiration date. In the United States, organizations that decide to use something past its expiration date face legal liability and sanctions.

Although the public understands products should not be used after the expiration date, some circumstances, particularly during supply shortages, merit using an expired product instead of going without. Is it better to use an expired mask or a different product that provides lesser protection? For example, is an expired but intact N95 respirator better than a handmade cloth mask? If given the choice, the author would choose the expired N95 mask, which would still provide superior protection to a handmade mask.⁴¹⁸ Risk is involved for both the user and the employer, but changing federal and state laws around expiration dates during public health emergencies will better protect responders.

One solution is to change indemnification laws during public health emergencies to relieve agencies from lawsuits in cases where they have appropriate but expired PPE for their employees. Eliminating employer liability under specific circumstances during a declared public health emergency when there are national supply chain shortages could

⁴¹⁷ FAR 38.000–38.201 (2023), <https://www.acquisition.gov/far/part-38>.

⁴¹⁸ The opinion in this paragraph, as with many other statements of fact within this thesis, is based on the author's professional experience, training, and education. During the COVID-19 pandemic, the author served as the EMS logistics chief, responsible for procuring PPE and sanitizing equipment.

reduce employers' hesitation to issue expired supplies in favor of lesser-quality substitutions.

5. Federal Laws and Overreach

Chapter IV discussed federal laws relating to public health outbreaks. During COVID-19, the government overreached in using the DPA, the Stafford Act, and EOs. Although federal laws allow tremendous emergency powers in times of crisis, they can worsen things without careful consideration. These overreaches hurt first responders by warping the free market in several ways, making it harder to obtain essential PPE.

In applying the DPA, President Trump described the act as a “tremendous hammer.”⁴¹⁹ However, a congressional report found Trump's actions coercive instead of thoughtful. Critics pointed out that Trump chose individual companies like General Motors, which had zero experience creating ventilators, instead of reaching out to medical supply producers. These choices reeked of favoritism over sound decision-making. The DPA requires systematic and strategic use in the future, finding the best-suited manufacturers instead of favoritism.

The Stafford Act needs revision. Chapter III mentioned that the Stafford Act is complex and sometimes directly conflicts with other laws. The Stafford Act, the Homeland Security Act of 2002, the Post-Katrina Emergency Management Reform Act, and the National Response Framework need to mesh instead of conflict. Members of Congress need to revise current laws to eliminate overlaps and contradictions. For example, Moss, Schellhamer, and Berman, who are law and policy experts, assert that an event could be declared an incident of national significance, a catastrophic incident, or a major disaster, all with different rules and laws, which lead to confusion.⁴²⁰ Amending laws would benefit the American people and first responders by reducing confusion during emergencies.

Finally, EOs must be used sparingly. EO 13909 allowed the HHS secretary and FEMA to prioritize and allocate medical supplies. This order permitted officials within the

⁴¹⁹ Ollstein, “Trump Invokes DPA for Testing Swabs,” para. 4.

⁴²⁰ Moss, Schellhamer, and Berman, “The Stafford Act and Priorities for Reform,” 1.

federal government to take critical supplies like PPE from the open market—even already-purchased products—and reallocate them as the officials saw fit, which heightened an already competitive market, further stressing the strained supply chain.

6. Storage

The federal government has ample storage and easily locates, secures, pays for, and staffs warehouse space across the United States and its territories. In a 2014 GAO report, author David Wise reports the U.S. government owns over 19,000 non-military warehouses with over 89 million square feet of space.⁴²¹ Several federal agencies, including the General Services Administration, FEMA, the Department of Defense, and HHS, excel at storing goods. Storage is a non-issue for the federal government.

C. STATE AND LOCAL RECOMMENDATIONS

As explained earlier, small agencies requiring small amounts of PPE are susceptible to unfulfilled orders due to a hyper-competitive environment or usurping from federal agencies such as FEMA. This situation occurred repeatedly during the COVID-19 pandemic, primarily because of the DPA.

For this thesis, state and local levels are combined because of population considerations. For example, the City of New York has roughly the same population as Wyoming, Montana, Utah, North Dakota, South Dakota, and Idaho combined.⁴²² For this reason, no one-size-fits-all solution exists. Local and state-level officials must make decisions that maximize buying power while providing cost-effective storage with reasonable access for agencies needing PPE.

⁴²¹ David Wise, *Federal Real Property: Strategic Focus Needed to Help Manage Vast and Diverse Warehouse Portfolio*, GAO-15-41 (Washington, DC: Government Accountability Office, 2014), 8, <https://www.gao.gov/assets/gao-15-41.pdf>.

⁴²² “US States—Ranked by Population 2023,” World Population Review, accessed November 8, 2023, <https://worldpopulationreview.com/states>.

1. Laws

Like federal laws, states should revise laws that allow the most flexibility during a declared public health emergency for first responders. States should follow a similar process as recommended in the federal law subsection of this chapter, particularly on expiration dates and indemnification.

2. Purchasing

Public safety agencies vary in size and scope. Some large agencies, such as New York City or Los Angeles County, already possess significant purchasing power. Smaller departments like the Centennial Lakes Police in Minnesota, a 20-member department; Bluewater Village Fire District in New Mexico; or even rural counties like Rolette County, North Dakota, stand little chance of getting essential PPE supplies when making purchases. Small- to middle-sized agencies must band together to increase purchasing power.

Americans understand the idea of purchasing power and buying in bulk. Stores like Costco and Sam's Club cater to consumers and businesses that understand the savings involved in larger quantities. Other companies, like GovX, cater to a specific population segment. GovX is an e-commerce site that provides "savings for those who serve," including military, police, fire, EMS, medical, and government.⁴²³ GovX provides savings in thousands of products and services ranging from clothing to sporting events to travel. Vetting occurs before free membership is issued. GovX claims to have seven million users, thus creating incredible purchasing power.⁴²⁴ These are a few examples of how consumers (including public safety agencies) can save by buying in bulk or participating in purchasing clubs.

Increasing purchasing power could involve forming a cooperative purchasing group for first-responder agencies. One such public safety purchasing group is the Minnesota-based Savvik Buying Group, formerly the North Central EMS Corporation.⁴²⁵

⁴²³ "Home Page," GovX, accessed October 28, 2023, <https://www.govx.com/>.

⁴²⁴ "About," GovX, accessed October 28, 2023, <https://govxinc.com/about/>.

⁴²⁵ "A Note from a Founding Father," Savvik Buying Group, accessed October 28, 2023, <https://www.savvik.com/a-note-from-a-founding-father/>.

Savvik is a free membership-based cooperative with 16,000 agencies.⁴²⁶ Another option is for neighboring agencies to band together on a county or regional basis. Likewise, associations of fire chiefs or fire marshals would be natural purchasing groups.

The management of the proposed purchasing groups has a variety of options. A statewide program might make the most sense in sparsely populated states like Wyoming. Likewise, a geographically small state with dense populations like Rhode Island might choose a statewide program. In larger states like California, a regional or county approach could work. A nonprofit or a special district administrator could be the purchasing authority in smaller areas.

3. Storage

State and local agencies may struggle with storage solutions. This thesis has shown that JIT is an unreliable method for purchasing critical PPE for first responders. In addition to group buying, storage options are essential. Warehousing is expensive. Fortunately, PPE is shelf-stable and does not require costly refrigeration. This situation is another opportunity for first-responder agencies to work together to store PPE. Storage recommendations should follow the purchasing recommendations described in the previous subsection. Although warehousing supplies is expensive, having insufficient PPE to protect first responders brings with it a graver consequence and cost in the form of ill or dead employees.

D. POTENTIAL CHALLENGES

The biggest challenge with these recommendations is funding. Every proposal in this policy requires additional funds. This need is a monumental lift for agencies that struggle to keep the lights on. Disposable PPE has expiration dates. If not used, it will expire, causing more complications.

To get past funding, agency leaders must prioritize protecting their staff by buying PPE. The COVID-19 pandemic turned into a politically charged event, and there are

⁴²⁶ “Home Page,” Savvik Buying Group, accessed October 28, 2023, <https://www.savvik.com/>.

countless examples of COVID-19 deniers in leadership roles. If agency heads do not believe a near-future public health crisis will occur and endanger their staff, the agency will not purchase enough PPE for future use, causing history to repeat itself.

Another challenge is cooperation. This recommendation will only work if multiple agency heads can agree. The days of handshake deals are long gone. As a result, a memorandum of understanding (MOU) must be written and signed by the participating agencies. The MOU must include details such as how much each agency is purchasing, what percentage of warehouse space each agency has, and who will oversee the program.

E. TIMELINE WITH MILESTONES

Because these solutions are layered, timelines and milestones vary. For example, at the federal level, Congress can fully fund the SNS during the next spending bill. From there, the purchasing process depends on suppliers, but with large orders, the request could move to the front of the line and be completed within a year.

At the local level, the co-op plan involves multiple agencies and their governing bodies working together. MOUs take time. Various agency heads, city councils, and lawyers must approve the agreements. Storage space must be acquired from there, which might require hiring or reallocating staff to oversee the program. Once all these pieces are in place, the last step is purchasing the actual supplies, which should be the easiest step if no scarcity issues surface at the time of the purchase. Based on the complexities, a year is the quickest this could happen.

F. COMMUNICATION PLAN

Agency heads such as police and fire chiefs are usually tightly networked. Leaders tend to know each other. Organizations such as county-wide police or fire chief associations are standard nationwide. Therefore, it makes sense for these associations to talk among themselves to start working on a group buying and storage plan. Perhaps one agency has a storage surplus and could house the cooperatively bought PPE. Having these talks can help influence city or county councils. For example, if five of the county's fire

departments meet and agree that purchasing should occur, the individual chiefs would have a stronger message for their respective city councils.

A mix of anecdotal and statistical information could help show the need for PPE stockpiling. For example, an EMS chief's experience of running out of PPE during the COVID-19 pandemic and subsequently reusing single-use supplies is a helpful illustration. Another powerful way to tell the story is to show how many employees became sick with COVID-19 because of work-related exposure and the resulting quarantine, correlating illness prevention with PPE.

G. RISK ASSESSMENT

This thesis demonstrated the disastrous consequences when first responders do not have adequate PPE. Agencies must perform a risk assessment to weigh the cost of employee absenteeism due to illness during public health outbreaks. Agency heads should ask themselves whether the agency can afford to have a third of its staff in quarantine for weeks at a time and still meet the mission, Worse yet, can a department withstand a death in the agency, which not only creates a hole in the roster but a hole in the soul of the agency? Each agency has tolerances built into its roster to account for various forms of leave, such as vacation, injury, and personal time off, but in contemplating the next contagious disease, each agency must weigh the benefits and costs of keeping surplus PPE against the potential human loss.

H. FINAL THOUGHTS

The global COVID-19 pandemic affected every U.S. citizen. Over 100 million people contracted the disease, and over one million died.⁴²⁷ Stay-at-home orders and supply chain shortages of everyday items like toilet paper and cleaning supplies impacted many more. COVID-19 was an event that will be etched in our memories for years to come.

First responders were disproportionately affected by COVID-19. Shortages of PPE put responders at risk, causing some to become ill and others to die. With the proper

⁴²⁷ "WHO Coronavirus Disease (COVID-19) Dashboard," World Health Organization, accessed October 28, 2023, <https://covid19.who.int>.

protective equipment, many of these deaths could have been prevented. As a nation, the United States must do better.

This thesis asserts the COVID-19 response was imperfect, and the likelihood of a future pandemic is high. By looking at COVID-19, along with other past outbreaks like HIV/AIDS and pandemic flu, the nation can forecast the specific types of equipment its first responders will require and can plan accordingly.

There is no crystal ball forecasting when, where, and what the next pandemic will be, but only the naive believe it will not happen again. The United States must take past lessons; understand current conditions, such as the frailty of modern manufacturing and the global supply chain; and prepare for the next public health outbreak. Preparing now is the best way to protect our future.

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