A 10% Lethal Synthetic Virus Could Cause Societal Collapse to a Pre-Industrial Civilization[1]

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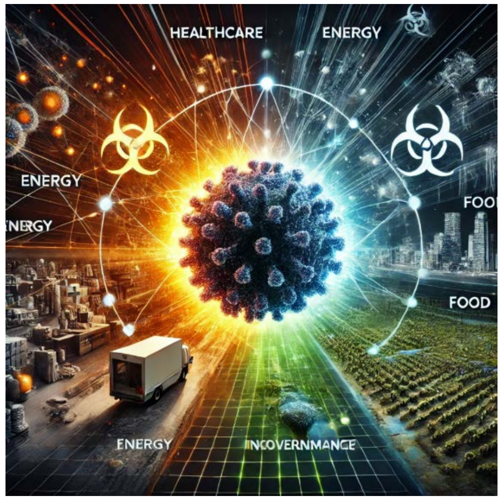

Abstract. In 2021 I and three academic colleagues, with substantial forensic bioinformatics skills, published a pre-print[3] describing the detection of Nipah virus sequences in an infectious clone format, a BSL4-level pathogen and CDC-designated Bioterrorism Agent. These sequences were inadvertent contamination in raw RNA-Seq sequencing reads from the BSL-2 laboratories of the Wuhan Institute of Virology (WIV). The specimens were taken from five patients infected with SARS-CoV-2 and hospitalized in December 2019. Given that the Nipah virus is 40-75% lethal, the prospect of a pandemic with a pathogen significantly more deadly than SARS-CoV-2 needs to be considered.

Using the case fatality rate for the 1918 influenza at 2.5% to 9.7%[4] suggests an upper limit of about 10% for a society changing pandemic. In addition, the historical estimates of lethality for four epidemics, dating from 430 BC to the 16th century that changed the course of history, all clustered at about a 10% case fatality rate.[5]

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[1] This work utilized OpenAI's ChatGPT to assist with drafting, editing, and enhancing the narrative. Final revisions and interpretations were conducted by the author.

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[3] https://arxiv.org/abs/2109.09112 Nipah virus vector sequences in COVID-19 patient samples sequenced by the Wuhan Institute of Virology. SC Quay, D Zhang, A Jones, Y Deigin

[4] Taubenberger JK, Morens DM. 1918 Influenza: the mother of all pandemics. Emerg Infect Dis. 2006 Jan;12(1):15-22. doi: 10.3201/eid1201.050979. PMID: 16494711; PMCID: PMC3291398.

[5] The oldest of these four pandemics was the Plague of Athens (430 BC). While its cause is unknown, it was possibly caused by typhoid fever or viral hemorrhagic fever. The estimated CFR of around 10%–15% was based on historical records. The impact was the death of about 25% of Athens' population, significantly affecting the Peloponnesian War. The next pandemic was the Antonine Plague (165–180 AD), which was suspected to be caused by either smallpox or measles. It also had an estimated CFR of around 10% in affected populations. The impact was an estimated 5 million deaths in the Roman Empire, including

I will therefore use a CFR of 10% for a hypothetical synthetic virus as the base case to estimate its impact on modern society. I conclude:

- The potential is high for a synthetic virus with a 10% fatality rate to cause societal collapse, using historical pandemics as context.
- Cascading failures in healthcare, energy, food supply, and governance will lead to widespread instability.
- The fragility of interconnected systems and the amplified risks in a globalized society is substantial. The knock-on societal fragmentation and economic collapse is likely to result from such a crisis.
- Important strategies need to be put in place to mitigate risks, including decentralized infrastructure, robust preparedness, and regulation of synthetic biology.

emperors and soldiers. The Antonine Plague is often considered one of the early markers of the Roman Empire's slow decline. While Rome would recover in the short term, the vulnerabilities exposed by the plague set the stage for later crises. Next was the Plague of Justinian (541–542 AD), caused by Yersinia pestis (bubonic plague). The plague killed an estimated 25–50 million people across the Mediterranean, including a large portion of the Byzantine population. This demographic collapse severely reduced the empire's tax base and labor force. The empire faced severe economic consequences, with trade networks disrupted and agricultural production plummeting. This led to food shortages, inflation, and a strain on state finances. Justinian raised taxes to address the financial shortfall, further alienating an already suffering population. Widespread death and suffering led to social unrest, as people questioned the legitimacy of the emperor and turned to religious or superstitious explanations for the disaster. The plague marked the beginning of a period of contraction for the Byzantine Empire. While Justinian's reign saw temporary successes, the empire's weakened state left it vulnerable to subsequent invasions and internal crises. The demographic and economic decline contributed to a shift in the balance of power in Europe and the Mediterranean, enabling the rise of new political entities, such as the Islamic Caliphates, in the following centuries. Finally, the Cocoliztli Epidemics in the 16th century in Mexico, likely caused by a hemorrhagic fever virus exacerbated by environmental factors and introduced diseases. The estimated CFR was approximately 10% or higher in indigenous populations. The impact was to devastate the Aztec population, with millions perishing.

Introduction: Fragile Civilization

Civilization today balances precariously on the scaffolding of interconnected systems. From energy grids to food supply chains, from healthcare infrastructure to governance, the seamless functionality of our modern world depends on a finely tuned and deeply interdependent machine. We've built societies capable of sustaining billions, feeding cities of millions, and coordinating global economies. Yet, beneath this sophistication lies a terrifying fragility. A disruption in one critical sector can ripple through others, igniting cascading failures capable of bringing even the most advanced nations to their knees.

Now imagine a pathogen designed with precision—a synthetic virus engineered to spread with the efficiency of the common cold and the lethality of smallpox. This isn't the stuff of science fiction but a conceivable outcome of advances in synthetic biology. Such a virus, with a modest yet catastrophic 10% fatality rate, could wreak havoc on an interconnected world, unraveling its tightly wound systems.

This essay examines how such a synthetic virus would likely lead to societal collapse. By exploring vulnerabilities in healthcare, energy, food supply chains, and governance, and incorporating historical precedents and modern system dynamics, I will argue that a 10% fatality rate could be the tipping point to push civilization back to a pre-industrial state—a collapse not measured in months or years but potentially in centuries.

The Synthetic Threat: A New Pandemic Era

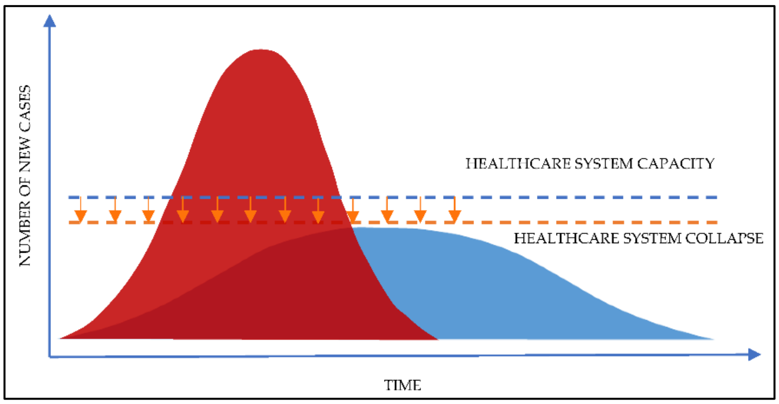
Synthetic biology is often hailed as one of humanity's greatest scientific achievements. Through advanced tools like CRISPR and gene synthesis, we've entered an era where creating new life forms is possible. This has opened extraordinary doors for curing diseases, engineering crops, and solving environmental challenges. But with these advancements comes a dark potential—the creation of synthetic viruses capable of catastrophic destruction.

A synthetic virus, designed to kill 10% of those it infects, could combine the most devastating traits of history's deadliest pathogens. While natural viruses evolve with constraints, a synthetic pathogen can be engineered to bypass these limits entirely. For example, it could be airborne like influenza, resilient to treatment like multidrug-resistant tuberculosis, and prolonged in asymptomatic transmission like HIV and SARS-CoV-2. This trifecta of traits would make such a virus nearly impossible to contain.

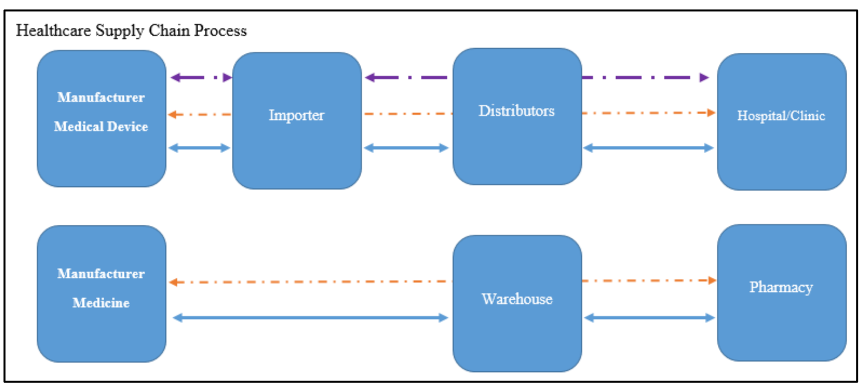
Even with its "modest" lethality, the consequences of a 10% mortality rate would be staggering. Historical pandemics such as the Black Death killed 30–50% of the population in affected regions, leading to profound societal upheaval (Benedictow, 2004). Similarly, the 1918 influenza pandemic—with a mortality rate of just 2-3%—caused 50 million deaths and widespread disruption (Taubenberger & Morens, 2006). Modern globalization and interdependence amplify these risks exponentially, creating a situation where a synthetic virus could far outstrip these historical catastrophes in impact.

Healthcare Collapse: The First Domino

The healthcare system is often the first line of defense against pandemics, but it is also one of the most fragile. During the COVID-19 pandemic, with a global mortality rate under 1%, healthcare systems in developed countries buckled under the strain. Hospitals ran out of ICU beds, ventilators, and even basic personal protective equipment (PPE). A 10% lethal virus would not just strain these systems; it would break them entirely. In Brazil, the healthcare system collapsed in 45 days (Lemos, DRQ, 2020). The public health goal with COVID was to slow the cases enough that the healthcare system could cope. This so-called flattening the curve via mitigation efforts is illustrated with this figure.



Hospitals worldwide operate on just-in-time supply chains, keeping only as much inventory as necessary for normal operations. To complicate matters, the supply chain is usually international, with many supplies being sourced out of Asia, leading to additional parties in the chain, as shown here.



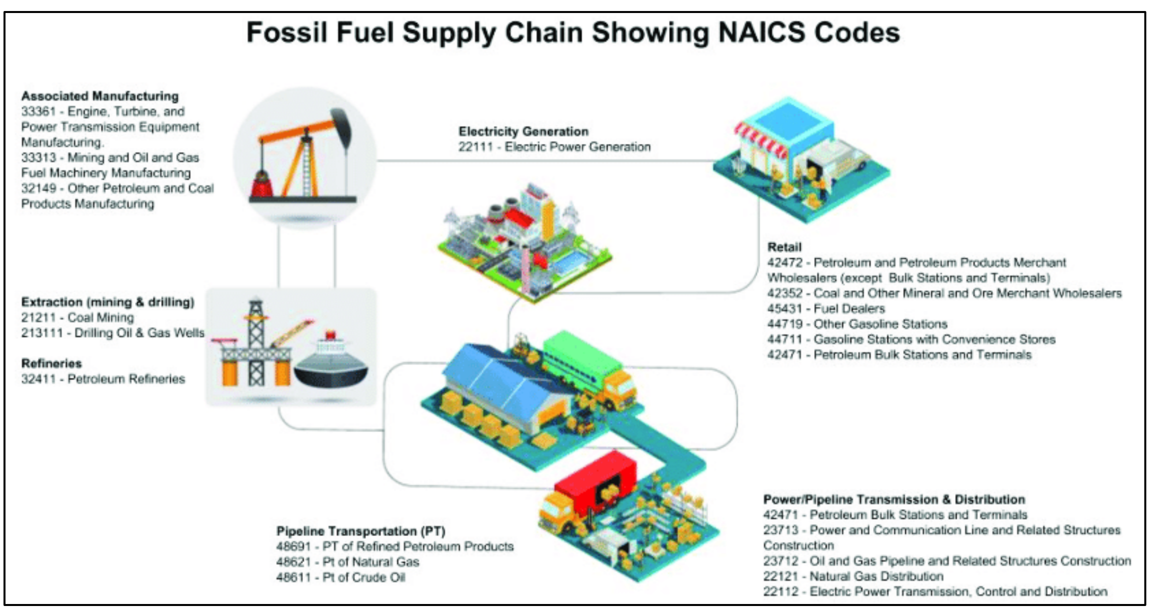
Any significant surge in critically ill patients overwhelms this delicate balance. During COVID-19, the healthcare system in Italy's Lombardy region collapsed within weeks. Doctors were forced to triage patients, denying care to the elderly or those less likely to survive (Remuzzi & Remuzzi, 2020). A synthetic virus killing 10% of its victims would render such measures futile, as the number of patients requiring care would exceed capacity many times over.

Compounding this crisis would be the loss of healthcare workers themselves. Frontline medical staff are at the highest risk of exposure during pandemics. With a 10% fatality rate, many doctors, nurses, and technicians would succumb to the virus, leaving hospitals even more short-staffed. Survivors would face unbearable workloads, psychological trauma, and burnout, leading to further attrition (Shanafelt et al., 2020). The death of healthcare professionals also creates knowledge gaps that take years to rebuild. Unlike other professions, the training required to replace a seasoned ICU nurse or infectious disease specialist is not quickly achievable.

As healthcare systems collapse, secondary mortality would rise sharply. Patients suffering from treatable conditions—heart attacks, infections, childbirth complications—would die for lack of care. This phenomenon was observed during the Ebola outbreak in West Africa, where deaths from untreated malaria, pneumonia, and childbirth complications outnumbered deaths from Ebola itself (Parpia et al., 2016). A 10% lethal virus would amplify this secondary mortality on a global scale.

Energy Grid Collapse: Lights Out

Energy infrastructure is the backbone of modern civilization. It powers hospitals, runs water treatment plants, enables transportation, and keeps homes warm in winter. Yet, this critical system is highly vulnerable to labor shortages and disruptions. The complex supply chain is illustrated with this figure.

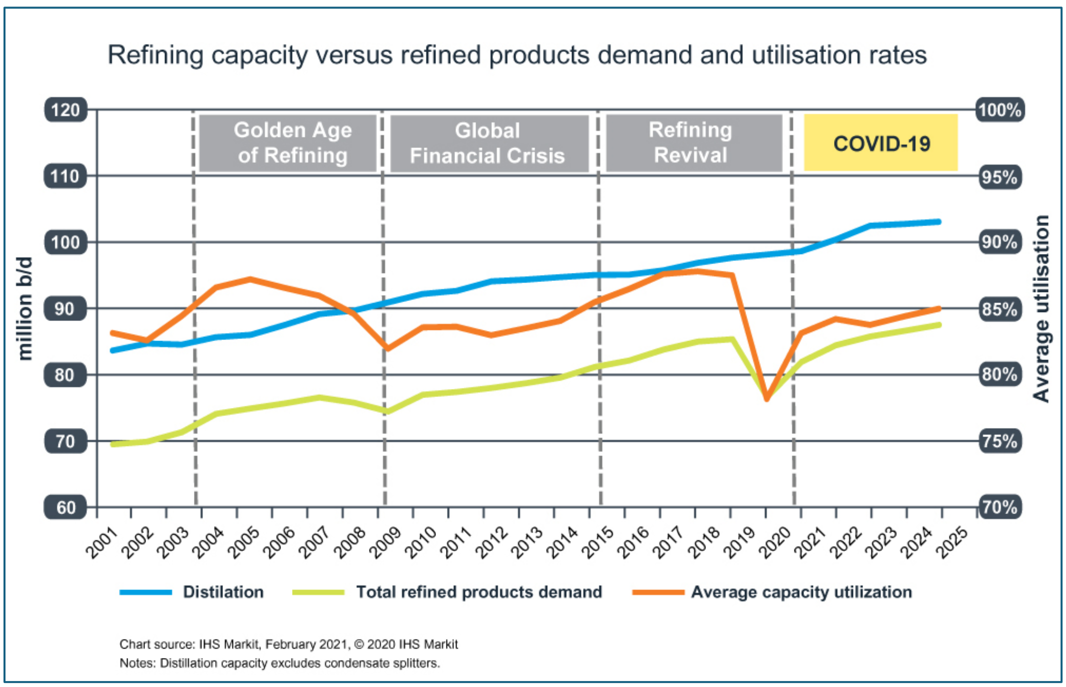


A 10% mortality rate among energy workers would trigger cascading failures across the grid.

Energy production and distribution require skilled labor at every level. Power plants, refineries, and pipelines demand constant maintenance and oversight, often by workers with years of specialized training. A 10% loss in this workforce would not only reduce operational capacity but also increase the likelihood of accidents, outages, and prolonged downtime (Amin & Wollenberg, 2005).

Historical examples illustrate how fragile energy systems can be. During Hurricane Katrina, disruptions to Gulf Coast refineries caused fuel shortages across the United States. Prices spiked, and transportation networks were crippled (Flynn, 2006). Unlike natural disasters, which are geographically contained, a pandemic-induced labor shortage would affect all regions simultaneously. There would be no unaffected areas to provide relief, exacerbating the crisis.

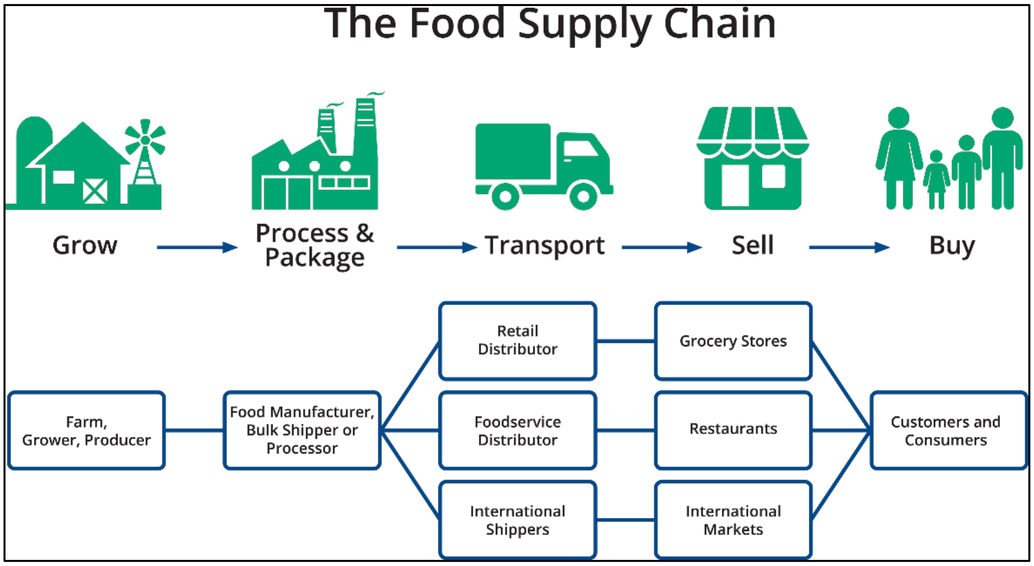
During the recent COVID pandemic there was a 9% reduction in refinery capacity, caused by a 1% lethal virus, as shown in this text figure. Here the capacity utilization fell more than the demand for product.



The ripple effects of energy shortages would extend far beyond power outages. Hospitals would lose the electricity needed to run ventilators and sterilization equipment. Refrigeration for food and medicines would fail, leading to spoilage. Communication networks, reliant on uninterrupted power, would falter, hindering emergency response coordination. These cascading failures would amplify the crisis, pushing societies toward collapse.

Food System Breakdown: Starvation and Chaos

The modern food supply chain is a marvel of efficiency, yet it is also one of the most fragile systems in existence. Agriculture, processing, transportation, and retail operate on razor-thin margins, with little room for disruption. This figure shows a simplified outline of the process.



A 10% workforce loss across these sectors would disrupt food production and distribution, triggering widespread hunger and societal unrest. This is supported by a comprehensive review of food supply chain research published in July 2024 (Juan, 2024).

Farmers depend heavily on seasonal laborers for planting, harvesting, and livestock care. Even a small labor shortage can reduce yields and delay harvests, increasing spoilage. During the COVID-19 pandemic, outbreaks among agricultural workers in the United States and Europe disrupted planting and harvesting cycles, leading to significant losses in crop yields (Luckstead et al., 2020). Meatpacking plants, which already operate with thin labor margins, became hotspots for infection, causing temporary shutdowns and supply chain bottlenecks. A synthetic virus with higher lethality would make these disruptions permanent.

Urban areas are particularly vulnerable to food shortages. Cities rely entirely on imported food, and supermarkets typically maintain only a few days' worth of inventory. Just-in-time logistics ensure shelves are replenished regularly, but any disruption to transportation networks or warehouse operations would leave them empty within weeks. Panic buying, hoarding, and price gouging would exacerbate shortages, leading to widespread unrest (Barrett, 2010).

Governance and Public Order: A Collapse of Authority

Governments play a central role in managing crises, but even they are not immune to the effects of a pandemic. A 10% mortality rate among government and military personnel would cripple their ability to respond effectively. Essential functions like emergency management, law enforcement, and public communication would falter, leaving populations without guidance or support (Comfort et al., 2010).

A natural experiment was conducted when Newark, New Jersey police force laid off 13% of the force in 2010 while Jersey City did not. The conclusion was a significant increase of overall crime, violent crime, and property crime in Newark as compared to Jersey City in the post-layoff period (Piza, 2020).

As public trust erodes, civil unrest would become widespread. Food shortages, energy outages, and healthcare collapse would spark riots, looting, and violence. Governments, unable to maintain order, would lose legitimacy, leading to localized governance by militias, criminal organizations, or community leaders. This fragmentation of authority would further destabilize society (Tainter, 1988).

Could the national petroleum reserves be activated in time to overcome the private sector energy supply chain disruption? The supply chain from the national petroleum reserves to the gas pump involves multiple steps, which include extraction, storage, transportation, refining, distribution, and retail. Here's a detailed breakdown of the steps involved:

1. Extraction and National Reserves

- **Strategic Petroleum Reserve (SPR)**: The U.S. SPR, for example, is a stockpile of crude oil stored in underground salt caverns, intended as an emergency supply. Oil is extracted from these reserves when authorized, such as during supply disruptions.
- **Commercial Reserves**: Companies also maintain private reserves to balance supply and demand.

2. Transportation from Reserves

- **Pipeline Systems**: Oil from reserves is transported via pipelines to refineries or distribution hubs. Pipelines are the primary method due to their efficiency.
- **Tankers and Rail**: In some cases, rail cars or ships transport oil, especially if pipelines are unavailable.

3. Refining

- **Crude Oil Refinement**: Crude oil is refined into usable products like gasoline, diesel, jet fuel, and heating oil. Refineries are equipped to process specific grades of crude, and refining involves distillation, cracking, and blending processes.
- **Byproducts**: Other byproducts include asphalt, lubricants, and petrochemicals for manufacturing plastics and chemicals.

4. Distribution

- **Bulk Storage Facilities**: Refined fuels are stored in bulk storage terminals near distribution points.
- **Secondary Transportation**: Trucks, railcars, or ships transport the refined product to regional distribution centers or directly to retail outlets.

5. Retail Delivery

- **Local Fuel Terminals**: From distribution centers, tanker trucks deliver fuel to gas stations and other retail outlets.
- **Retail Gas Pumps**: At the gas station, fuel is dispensed into vehicles. Stations may blend additives at this stage to meet local fuel standards or seasonal requirements (e.g., summer vs. winter blends).

6. Regulation and Pricing

- **Quality Control**: The fuel is regulated for quality and environmental standards at every stage.
- **Market Dynamics**: Final pricing at the pump reflects crude oil costs, refining and transportation expenses, local taxes, and retail margins.

The time required to release crude oil from the **Strategic Petroleum Reserve (SPR)** and transform it into usable fuel varies depending on logistical and operational factors. Here's an estimated timeline for each step:

1. Authorization and Release (1-2 Days)

- The process begins when the U.S. Department of Energy (DOE) authorizes the release.
- Contracts are awarded, and crude oil is drawn from the reserve’s underground caverns.

2. Transportation to Refineries (1-5 Days)

- **Pipeline Transport**: Oil is pumped into pipeline systems, which can take **1-3 days**, depending on the distance to refineries.
- **Ship or Rail**: Transport by tanker or rail can take **3-5 days** if pipelines are not an option.

3. Refining Crude Oil into Fuel (1-3 Days)

- Once the crude oil reaches a refinery, it typically takes **1-3 days** to process it into gasoline, diesel, or other products, depending on the complexity of the refinery and the products being produced.
- Modern refineries operate continuously, so production timelines are efficient.

4. Distribution to Retail (2-7 Days)

- **Bulk Storage to Gas Stations**: Refined fuel is transported to storage terminals or directly to gas stations via tanker trucks. This takes **2-7 days**, depending on the distance and logistical factors.

Total Timeframe

- From SPR release to the fuel pump, the entire process typically takes **4-12 days**, depending on transportation modes and refinery schedules.

Factors Affecting Timeframes

- **Location of Refineries**: Refineries closer to SPR sites (e.g., along the Gulf Coast) shorten transportation time.
- **Refinery Throughput**: If refineries are operating near capacity, processing may take longer.
- **Demand and Distribution Logistics**: High demand or supply chain bottlenecks can delay distribution.

Chronology of Collapse

In this section I examine the timeline of societal collapse due to a 10% lethal virus.

Phase 1: Immediate Outbreak (0–1 Month)

1. **Healthcare System Overwhelmed:**
    - Within weeks, hospitals exceed ICU and ventilator capacity. Mortality rates surge for non-virus-related conditions (e.g., heart attacks, trauma).
    - Frontline medical staff, exposed to the virus, begin to die, leading to cascading losses in expertise and resources.
    - **Historical Precedent:** Lombardy, Italy, collapsed within weeks during COVID-19 with only a 2% mortality rate.
2. **Public Panic:**
    - Supply chains for PPE, medications, and emergency supplies break down.
    - Governments enforce lockdowns, fueling fear and hoarding behavior.

Phase 2: Systemic Strain (1–3 Months)

1. **Energy Shortages Begin:**
    - 10% loss of skilled workers in refineries and power plants leads to rolling blackouts.
    - Maintenance schedules falter, causing grid failures in critical areas.
    - **Historical Precedent:** Hurricane Katrina's energy disruptions triggered price spikes and transport bottlenecks.

2. **Food Scarcity:**
    - Labor shortages in farming, meatpacking, and distribution lead to rapid declines in food availability.
    - Urban areas experience acute shortages, leading to riots and looting.
    - **Historical Precedent:** During COVID-19, outbreaks in agricultural facilities caused severe supply chain bottlenecks.

Phase 3: Institutional Collapse (3–6 Months)

1. **Governance Breakdowns:**
    - Absenteeism and fatalities among law enforcement and emergency management personnel increase crime and unrest.
    - Governments fail to maintain order; local militia or criminal groups gain influence.
    - **Historical Precedent:** Police layoffs in Newark, NJ, caused spikes in violent crime.
2. **Healthcare Decline Amplifies Mortality:**
    - With no functional healthcare, secondary deaths from untreated illnesses outnumber deaths from the virus itself.

Phase 4: Societal Collapse (6–12 Months)

1. **Economic Implosion:**
    - Energy shortages halt industrial production; financial systems collapse due to unpaid debts and failed institutions.
    - Employment plummets; currency values erode as essential goods become the only viable trade commodities.
2. **Widespread Starvation and Migration:**
    - Millions flee urban areas in search of food and stability, overwhelming rural communities.
    - Starvation, exposure, and violence claim lives at unprecedented rates.

Recovery Scenarios and Timelines

Option 1: Partial Recovery Through Centralized Intervention (5–10 Years)

- **Requirements:**
    - Rapid international aid and resource sharing.
    - Deployment of military forces to stabilize critical infrastructure.
    - Accelerated training programs to replace lost skilled workers.
- **Challenges:**
    - Rebuilding trust in government and institutions.
    - Mitigating climate and environmental damage caused by the collapse.

- **Outcome:**
  - Partial recovery of healthcare, energy, and food systems, but with long-term economic scars and inequality.

Option 2: Prolonged Decentralized Recovery (10–50 Years)

- **Requirements:**
  - Fragmented local governance takes over; small-scale economies emerge.
  - Communities rely on local agriculture, barter systems, and renewable energy.
- **Challenges:**
  - Loss of global trade and technological expertise.
  - Vulnerability to secondary disasters due to weakened infrastructure.
- **Outcome:**
  - Societies resemble pre-industrial economies, with uneven recovery depending on geographic and resource factors.

Option 3: Tipping Point to Irreversible Collapse (Centuries)

- **Scenario:**
  - Cascading failures across interconnected systems prevent recovery.
  - Knowledge loss from the death of key professionals and lack of educational infrastructure.
- **Outcome:**
  - Permanent regression to pre-industrial conditions; reliance on subsistence living.

Critical Factors Influencing Recovery

1. **Resilience of Key Systems:**
   - Decentralized grids, local food production, and autonomous governance structures can buffer collapse.
2. **Global Cooperation:**
   - Effective international aid and treaties could mitigate long-term impacts.
3. **Preparedness:**
   - Investment in robust healthcare, renewable energy, and food storage infrastructure is essential to prevent or mitigate collapse.

By understanding these dynamics, policymakers and society can better prepare for and possibly avoid such catastrophic scenarios. If you'd like, I can add visual representations or specific quantitative models for further clarity.

Conclusion: A Warning for the Future

A 10% lethal synthetic virus represents not just a public health crisis but an existential threat to modern civilization. Its cascading impacts on healthcare, energy, food, and governance would unravel interconnected systems, pushing humanity into a pre-industrial state. Unlike historical pandemics, which occurred in less interconnected eras, the global nature of modern society amplifies the potential for collapse.

Yet, this bleak scenario is not inevitable. Investments in resilience—expanding healthcare capacity, decentralizing energy grids, diversifying food supply chains, and regulating synthetic biology—can mitigate these risks. International cooperation is crucial to ensure that the tools of synthetic biology are used for progress, not destruction. The stakes could not be higher. The choice is ours: act now to build resilience or face the unimaginable consequences of inaction.

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