

EDITORIAL

Supply chain failures amid Covid-19 signal a new pillar for global health preparedness

The COVID-19 pandemic has challenged health systems around the globe and exposed a myriad of fault lines, demonstrating how critically important the healthcare supply chain is to health systems and as a consequence, to the well-being of individuals, families, and communities. Supply chain inefficiency and its brittleness in times of crises have been a well-noted barrier in low- and middle-income countries, but the graphic descriptions of preventable death through absence of effective personal protective equipment (PPE) in developed economies is both chastening and confronting. In countries known for material prosperity and scientific advances, the scarcity of masks and gloves is unfathomable to many, which makes the number of attributable deaths unforgivable (Davidson, Padula, Daly, & Jackson, 2020). Furthermore, the availability of testing improves over time, but the limiting factor can often be a swab or viral media to obtain specimens, leaving health systems with few alternatives but to manufacture their own. Nurses have been at the frontlines of the failures of supply chain without essential tools to protect themselves and the patients they care for.

The pandemic has exposed the otherwise uninitiated to the global healthcare supply chain that is vulnerable to geopolitical instability (Artenstein, 2020). A supply chain is a network—consisting of raw material suppliers, manufacturers, distributors and retailers, among others—that designs, manufactures and distributes a specific product to its end users. In the case of the healthcare supply chain, such a complex network involves diverse entities in multiple countries, regulatory processes of various strengths, resources, and most importantly, divergent incentives. The importance of supply chain management is obvious and indeed front and centre in the case of a pandemic. The failures that we are facing underline the need to increase the focus on supply chain issues.

1 | WHAT WENT WRONG WITH THE GLOBAL HEALTHCARE SUPPLY CHAIN?

Well before the World Health Organization (WHO) declared the COVID-19 pandemic, it became abundantly clear that PPE was in dire shortage across the globe. For example, the US Department of Health and Human Services (HHS) disclosed in February 2020 that the country had a stockpile of only 12 million N95 masks, far fewer than what it estimated to be adequate (Tett, 2020). Yet, the US Federal government proceeded with inaction in ramping up its domestic capacity of N95 masks and turned down at

least one domestic manufacturer's offer to help achieve just that (Davis, 2020). The failure of the United States is in strong contrast to the successes of Taiwan and South Korea, which, in a matter of weeks, mobilized their domestic manufacturers to form consortia that proved capable of supplying adequate PPE to healthcare workers (Kim 2020).

The fiasco of the US supply chain, among other industrialized countries, has had a fateful precedent. During the 2009 swine flu pandemic, US-based PPE manufacturers responded to the briefly surging demand by increasing their production capacity, only to be left with mounting inventory and little interest from hospitals when the pandemic receded, reflecting strategy that is of a short-term nature (Berzon, Evans, Armour, & Hufford, 2020).

The COVID-19 pandemic has revealed the crudeness of the hyper-globalized healthcare supply chain. On the one hand, despite the intertwined, interdependent nature of different entities of the supply chain, they are nevertheless subject to geopolitical upheavals and often vulnerable to national and local politics (Dai & Tayur, 2019). The healthcare supply chain does little to account for such glaring ramifications and appears to operate under “the best is yet to come” assumption. On the other hand, for a supply chain to function resiliently and smoothly, a mechanism needs to be in place to engineer a sophisticated web of incentives that aligns otherwise divergent interests, shares risks and rewards, and promotes data transparency. Yet the healthcare supply chain is woefully lacking in system-level design and excessive in individual-level optimization.

2 | FIXING THE GLOBAL HEALTHCARE SUPPLY CHAIN

The healthcare supply chain supplies a strategic product category essential to public health and should be managed accordingly. From the health economic perspective, as the Gary Becker, a Nobel Laureate in Economics, estimated more than a decade ago (Becker, 2020, p. 55),

The expected worldwide cost in terms of willingness to pay to avoid the risk of another great pandemic that had a one in hundred probability of occurring during the next twenty years would be approximately 1/100 * \$20 trillion, or about \$200 billion. This cost would justify sizable increases in [public health investments].

First and foremost, a “vision test” of the healthcare supply chain is needed and data transparency must be improved. The current healthcare supply chain is opaque and fragmented. In the case of the PPE supply chain in the United States, for example, other than the location of each manufacturing facility, government and healthcare providers alike have no basic supply chain information (Dai, Bai, & Anderson 2020). Questions such as where PPE is being made, how much each facility is capable of producing, and whether a product is subject to risk of shortage, late delivery or quality issues upon delivery arise. All such essential information has been kept as trade secrets (Evans & Hinshaw, 2020). The COVID-19 debacle shows without data transparency and intentional collaboration, the healthcare supply chain is at risk of continued failures in future pandemics.

Second, public-private partnerships are needed to ensure agility in responding to future demand and supply shocks. In this COVID-19 pandemic, countries successful at ramping up their domestic supply chain in a timely manner are those with full-scale industrial commons consisting of manufacturing and infrastructure, human resources, and research and development capabilities that span across the entire healthcare PPE supply chain (Dai, Bai, & Anderson 2020). Industrial commons for healthcare supplies are costly to build and maintain in normal times, so the private sector has little incentive to participate. Forming public-private partnerships through which governments help guarantee a level of service and pay if it falls short are critical for preparedness and global security.

Third, new tools rooted in artificial intelligence (AI) and digital transformation have proven valuable in maintaining the continuity of manufacturing and supply networks (Wuest, Kusiak, Dai, & Tayur, 2020). For example, wearable technologies can help maintain physical distancing and detect sick workforce; 3D printing can help expand the local capacity of PPE supply; digital twins allow remote design and supervision in factories that would otherwise require physical human presence. In response to the COVID-19 pandemic, government agencies and businesses should bolster, not slash, their spending on AI and digital transformation.


Fourth, global governance, or lack thereof, has become a determinant of success or failure of global battles against pandemics (Gostin, 2015). In the United States, the inexplicable competition between federal and state governments for the same pool of PPE and testing kits has given rise to skyrocketing prices and the proliferation of irregular contracting practices. Across the globe, the United States, United Kingdom and France, among other wealthy countries, have been bidding against some of the least developed countries in Africa and Latin America. A global governance infrastructure, rooted in shared ethical values, is in order not only for crisis response, but also for increasing the resilience of the healthcare supply chain.


3 | THE IMPORTANCE OF GETTING THIS RIGHT

Experts around the globe broadly concur that the world has no real chance of recovery without an effective vaccine. Treatment and

vaccine development are the first critical step. Ensuring distribution is dependent on effective supply chain management. Although many of our health systems discuss preparedness, in reality, many are mute on supply chain issues and many nurses are not engaged. Many of us particularly in high-income countries have been jolted by the fact that basic issues such as access to masks cannot be assumed. We have come to realize we have to give the healthcare supply chain our full and immediate attention. Failing to focus on these issues is at our peril.

Tinglong Dai PhD, Associate Professor^{1,4} 

Muhammad H. Zaman PhD, HHMI Professor of Biomedical Engineering² 

William V. Padula PhD, Assistant Professor³ 

Patricia M. Davidson PhD, MEd, RN, Dean, Professor⁴ 

¹Carey Business School, Johns Hopkins University, Baltimore, MD, USA

²College of Engineering, Boston University, Boston, MA, USA

³Department of Pharmaceutical & Health Economics, School of Pharmacy, Leonard D. Schaeffer Center for Health Policy & Economics, University of Southern California, Los Angeles, CA, USA

⁴School of Nursing, Johns Hopkins University, Baltimore, MD, USA

Correspondence

Tinglong Dai and Patricia M. Davidson, Johns Hopkins University, Baltimore.

Emails: dai@jhu.edu; pdavidson@jhu.edu

ORCID

Tinglong Dai  <https://orcid.org/0000-0001-9248-5153>

Muhammad H. Zaman  <https://orcid.org/0000-0002-3723-5431>

William V. Padula  <https://orcid.org/0000-0003-1161-6954>

Patricia M. Davidson  <https://orcid.org/0000-0003-2050-1534>

REFERENCES

- Artenstein A. W. (2020). In Pursuit of PPE. *New England Journal of Medicine*, 382, (18), e46. <http://dx.doi.org/10.1056/nejmc2010025>
- Becker, G. S. (2020). Some economics of flu pandemics. *Chicago Booth Review, Summer*, 54–55. Retrieved from https://review.chicagobooth.edu/sites/default/files/272309_Chicago_Booth_lowRes.pdf
- Berzon, A., Evans, M., Armour, S., & Hufford, A. (2020, April 29). Miscalculation at every level left U.S. unequipped to fight coronavirus. *Wall Street Journal*. Retrieved from <https://www.wsj.com/articles/miscalculation-at-every-level-left-u-s-unequipped-to-fight-coronavirus-11588170921>
- Dai, T., Bai, G., Anderson, G. F. (2020). PPE Supply Chain Needs Data Transparency and Stress Testing. *Journal of General Internal Medicine*, <http://dx.doi.org/10.1007/s11606-020-05987-9>
- Dai, T., Tayur, S. (2019). Healthcare Operations Management: A Snapshot of Emerging Research. *Manufacturing & Service Operations Management*, <http://dx.doi.org/10.1287/msom.2019.0778>
- Davidson, P. M., Padula, W. V., Daly, J., Jackson, D. (2020). Moral outrage in COVID19—Understandable but not a strategy. *Journal of Clinical Nursing*, <http://dx.doi.org/10.1111/jocn.15318>

- Davis, A. C. (2020, May 9). In the early days of the pandemic, the U.S. government turned down an offer to manufacture millions of N95 masks in America. *Washington Post*, Retrieved from https://www.washingtonpost.com/investigations/in-the-early-days-of-the-pandemic-the-us-government-turned-down-an-offer-to-manufacture-millions-of-n95-masks-in-america/2020/05/09/f76a821e-908a-11ea-a9c0-73b93422d691_story.html
- Evans, M., & Hinshaw, D. (2020, February 27). Masks run short as coronavirus spreads. *Wall Street Journal*. Retrieved from <https://www.wsj.com/articles/masks-run-short-as-coronavirus-spreads-11582829321>
- Gostin, L. O. (2015). The politics of global health security. *The Lancet*, 386, (10009), 2134–2135. [http://dx.doi.org/10.1016/S0140-6736\(15\)01059-4](http://dx.doi.org/10.1016/S0140-6736(15)01059-4)
- Kim, E. T. (2020). How South Korea Solved Its Face Mask Shortage. *New York Times*, <https://www.nytimes.com/2020/04/01/opinion/covid-face-mask-shortage.html>
- Tett, G. (2020, May 6). My pity package of Chinese face masks sends a bigger message. *Financial Times*. Retrieved from <https://www.ft.com/content/556a4bea-8e76-11ea-a8ec-961a33ba80aa>
- Wuest, T., Kusiak, A., Dai, T., Tayur, S. R. Impact of COVID-19 on Manufacturing and Supply Networks – The Case for AI-Inspired Digital Transformation. *SSRN Electronic Journal*, <http://dx.doi.org/10.2139/ssrn.3593540>