Reimagining Personal Protective Equipment (PPE) Supply Chains

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HEALTHCARE ANCHOR NETWORK

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Tale of Contents

Introduction

The COVID-19 pandemic has revealed many vulnerabilities in our global supply chains which are making it difficult for countries around the world to access basic supplies—most critically, personal protective equipment (PPE). Recently, a report in the *Guardian*, based on interviews with US healthcare and industry experts, revealed that "logistical challenges continue seven months after the coronavirus reached the United States" and suggested that shortages are likely to continue through 2021 and potentially into 2022.[1] This includes PPE that is not available, not available in the quantities necessary for users (both in terms of insufficient quantities or minimum order requirements that are too high), and/or unaffordable. On this latter point, during the pandemic prices for some kinds of PPE have seen as much as 20-fold increases and many suppliers are now requiring significant advance payments, hampering the procurement efforts of less well-resourced buyers.[2]

These shortages and supply challenges are hindering our ability to effectively contain the spread of COVID-19 and are putting lives, and especially the lives of healthcare workers, in jeopardy. As WHO Director Dr. Tedros Adhanom Ghebreyesus put it in March 2020, "the chronic global shortage of personal protective equipment is now one of the most urgent threats to our collective ability to save lives."[3] Similarly, Carmela Coyle, CEO of the California Hospital Association, was quoted in the *Guardian* report as saying "any one piece [of PPE] that's in shortage or not available creates risk for patients and for healthcare workers."[4] Moreover, with the pandemic still largely out of control in many parts of the country, and the a risk of spikes in cases as schools re-open and people increasingly stay inside as the weather changes (combined with the onset of flu season), the implications of these supply chain challenges are likely to become ever more acute in the coming months.

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PPE is a general term for the clothing and equipment designed to protect people from injury or infectious disease. PPE can include a wide variety of items (including gloves, goggles, face shields, gowns, and masks). In recent years and decades, manufacturing of much of the global supply of PPE has been concentrated in Asia, with China becoming the principal producer of several items, including

masks. In fact, China is the largest producer of finished products and raw materials if you consider PPE as a whole.[5] When the COVID-19 pandemic hit, this global supply chain was interrupted on various levels. First and foremost, given the geographic concentration of PPE producers in Asia, the initial outbreak in that region disrupted production as businesses were closed and communities locked down. Second, as the pandemic spread around the world, demand increased and numerous countries instituted export bans to prevent the dissipation of their supplies. And third, due to pandemic related quarantine measures and public health concerns, transportation and shipping were constrained, and some domestic production facilities were temporarily shuttered.

This led to what has been described by some experts as a "wild west" PPE market as health systems, federal and state governments, and countries around the world competed with one and another to procure and transport critical products.[6] In some cases, health systems (13 percent according to one survey) have turned to directly manufacturing their own PPE to deal with supply issues—although the types of PPE (and quantity) that can be directly produced in this way is limited.[7] In another attempt to secure control over PPE supplies, 15 health systems banned together and purchased a minority stake in Prestige Ameritech, a domestic PPE company that produces N95 respirators (among other products).[8] Other creative approaches have included sourcing PPEs through new non-profit efforts like Masks for America, GetUsPPE, Project N95, and Gowns4Good (also see: manufacturingcoalition.com).

Though US based companies do manufacture a significant amount of PPE, traditionally the sector has been fairly concentrated with a small number of large, multinational corporations playing dominant roles. Moreover, while the companies may be based in the US, much of the productive capacity is located overseas (especially with regard to most of the raw materials, such as cotton fiber, polyester, and meltblown polypropylene). Additionally, much of what the US produces is often exported to other countries in North and South America (these exports continued in the early days of the pandemic, even as hospitals began to run out of supplies, until export restrictions were put in place in early April).[9]

The COVID-19 pandemic is likely to be a turning point with regards to how supply chains are organized in the future. In addition to demonstrating the inefficiencies and inadequacies of the current supply chain model, it has given us a glimpse into a future in which climate change (and its effects) increasingly disrupts international trade and global supply chains. While undoubtedly each future emergency (natural disasters and other public health emergencies) will be unique, and have variegated effects on PPEs, the potential frequency of future supply chain shocks and interruptions to global shipping operations should at a minimum bring the question of supply chain resiliency into renewed focus. Recently, the Economist Intelligence Unit (EIU) released a report in which it predicted that the COVID-19 pandemic, coupled with the ongoing threat of climate change and trade tensions between nation states (primarily the US and China), will not only halt the era of globalization, it will reverse it. "By building quasi-independent regional supply chains in the Americas and Europe, a global company will provide a hedge against future shocks to their network," the report concluded.

Already this is beginning with PPE. For instance, according to the *Guardian* report, domestic production of the material used in disposable masks is projected to increase from 850 tons in 2019 to 10,000 tons in 2021. "We have planted the seeds to render the United States self-sufficient," Dave Rousse, president of the Association of Nonwoven Fabrics Industry, is

quoted as saying. However, each PPE product is different and not all of them have been, or are projected to be, re-shored at the same rate (or at all). Between the highly regulated nature of the industry and high start-up costs related to the sophisticated machinery necessary to produce PPE, domestic producers may be wary of entering the market without the guarantee of long-term contracts. Moreover, simply re-shoring production while leaving it in the hands of a small oligopoly of large corporations is unlikely to increase resilience (which must be predicated on a broad base of suppliers), let alone address issues of inequitable distribution and access, ecological devastation, concentrated ownership, and community economic development and stability.

This working paper is divided into two sections. The first consists of background research that was completed in early September 2020. In the background sections we provide a basic macro level economic analysis of the US PPE industry and supply chains, with emphasis on the broad trends and the bigger picture. This includes: 1) a current overview and analysis of the PPE industry and supply chains; 2) an analysis of some of the market and supply chain shifts that have occurred since the start of the COVID-19 pandemic; and 3) history and economic trends that inform an understanding of the current PPE market.

This background research then provided the basis for 19 interviews conducted in late September and early October with 35 executives at healthcare systems that are part of the Healthcare Anchor Network (HAN).[10] The goal of these interviews was to surface common perspectives, important differences, and suggestions and recommendations with an eye on moving HAN towards alignment around certain goals and values as it relates to PPE at the Healthcare Anchor Network's *Anchoring Resilience: Aligning Supply Chains and Impact Purchasing for Community Health* summit on November 18, 2020, and thereafter. Some of the results of these interviews are summarized in Part II of this paper and are provided along with potential next steps, paths forward, and areas for further discussion and research.[11]

PPE Market

The global PPE market is worth roughly $60 billion and expected to grow significantly over the next several years.[12] However, this figure includes PPE of various types destined for numerous different economic sectors (including mining, construction, etc.). According to an April 2020 analysis by the Asian Development Bank, the healthcare sector PPE market alone was estimated at $2.5 billion in 2018.[13] This includes products such as masks and respirators, gloves, goggles/eyewear, suits/coveralls, and gowns. Much of the physical manufacturing or production of this type of PPE occurs in Asia generally, and China in particular. For instance, according to research by the Peterson Institute for International Economics, "before the pandemic, China already exported more respirators, surgical masks, medical goggles and protective garments than the rest of the world combined."[14] Similarly, before the pandemic, China was cited as "the only place capable of mass producing clinical gowns."[15] While China is a major player, other prominent countries in the medical PPE supply chain include Indonesia, Malaysia, and Thailand.

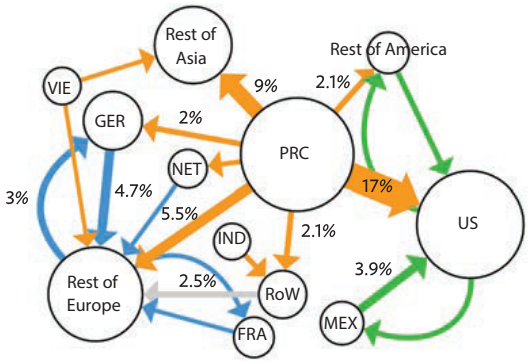
Unless otherwise specified, the three specific areas of PPE that we are focusing on in this paper are: 1) Surgical masks and respirators; 2) Medical gloves; and 3) Medical gowns. The reason we have chosen to focus on these three areas is because in the US these are the subset of PPE that are regulated by the FDA.[16] They are also among the most in demand products during the COVID-19 pandemic. For example, US hospitals and health systems usually buy around 22 million N95 respirators per year. However, according to data from Premier, Inc., "during the months of January and February, demand for N95s surged, up 400 percent and 585 percent, respectively."[17] Moreover, this was before the COVID-19 pandemic was fully recognized as having reached the US.

"Before the pandemic, China already exported more respirators, surgical masks, medical goggles and protective garments than the rest of the world combined."

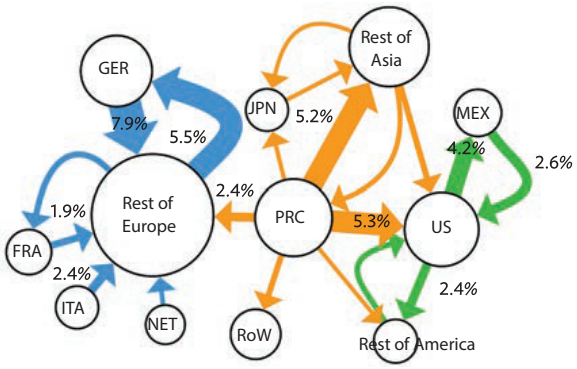
Similarly, even before COVID-19 really began to affect the demand for PPE in the US, a January 2020 recall of over 9 million surgical gowns by Cardinal Health (one of the major suppliers) created a shortage that was delaying surgeries across the country.[18] As the pandemic escalated, emphasis was first placed on ramping up production of masks

Figure 2. Global Trade Networks of Select PPE Products, 2018

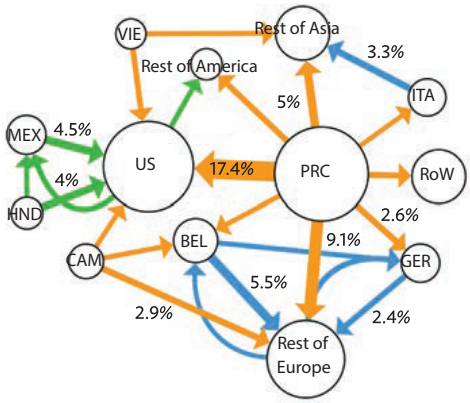
a. HS 630790 Including Surgical Masks:
Textiles; made up articles (including dress patterns), not elsewhere classified (n.e.c.)



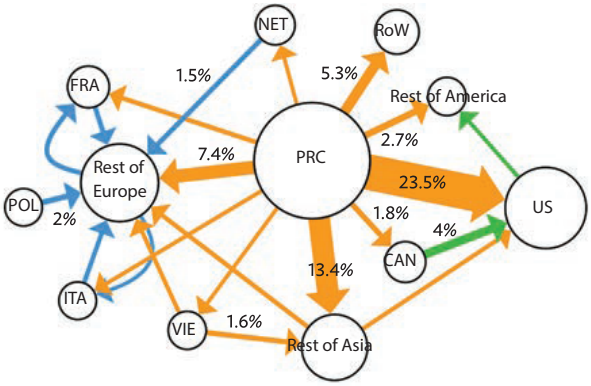
b. HS 392690 Including Respirators:
Plastics; other articles n.e.c.



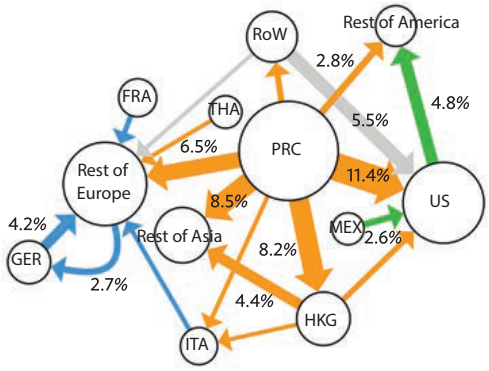
c. HS 621010 Including Surgical Gowns:
Garments; of felt or nonwoven (not knitted or crocheted)



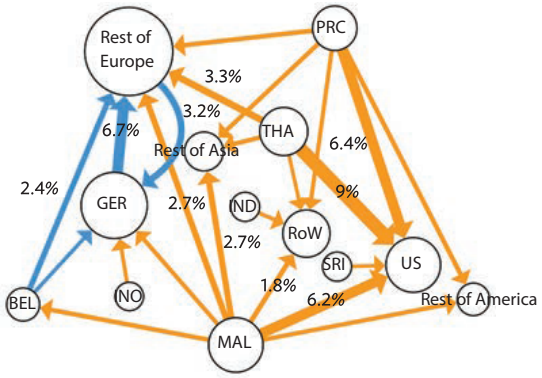
d. HS 392620 Including Protective Suits:
Plastics; articles of apparel and clothing accessories (including gloves, mittens, and mitts)



e. HS 900490 Including Protective Goggles:
Spectacles, goggles, and the like; (other than sunglasses) corrective, protective, or other



f. HS 401511 Including Surgical Gloves:
Rubber; vulcanized (other than hard rubber), surgical gloves



exports from Americas | exports from Asia | exports from Europe | exports from the rest of the world

Source: Cyn-Young Park, et. al. "Global Shortage of Personal Protective Equipment amid COVID-19: Supply Chains, Bottlenecks, and Policy Implications," *ADB Briefs*, April 2020, accessed 7/97/20, https://www.adb.org/sites/default/files/publication/579121/ppe-covid-19-supply-chains-bottlenecks-policy.pdf.

and respirators, leaving other PPE, such as gowns, in short supply.[19] Moreover, demand is skyrocketing with reports suggesting that requests to wholesale distributors for surgical isolation gowns have increased by 500% over historic levels during the pandemic.[20]

Many medical gowns are hand assembled as they have several parts and varying sizes.[21] This increases the complexity of manufacturing, and thus increases the costs. "The problem," Matthieu Menut, from Medline Industries, reports, "is that the focus on masks is so intense right now that there's not enough companies making gowns, which have a more complex design."[22] In July, 2020, the House Oversight Committee submitted a memo to the House Select Subcommittee on the Coronavirus about ongoing concerns in the PPE supply chain, which stated that raw material for surgical gowns is "unavailable at any price."[23] Moreover, six of the US's largest medical equipment distribution companies shared similar concerns with the Subcommittee.

Companies based in the United States have considerable market share in the PPE sector as a whole. The Asian Development Bank estimates that in 2018, North America accounted for 33% of PPE market share (based on revenue) and recent data puts the total revenue of the US PPE industry at $5.7 billion. While there are currently 228 US businesses (and 261 establishments) operating in the PPE manufacturing industry, according to Nick Masters from the market research firm IBISWorld, the industry is considered to be "highly concentrated" with three major corporations comprising more than 70% of the market (3M Company: 36.9%; Honeywell: 25.6%; MSA Safety: 8.7%). The remaining one third of industry revenue comes from smaller companies, including Bullard, Owens and Minor Inc., Moldex-Metric Inc., Prestige Ameritech, and Alpha Pro Tech Ltd.[24] While industry analysts expect that the number of US companies operating in the sector will slightly increase over the next 5 years, market concentration is also expected to increase. "Companies are actively acquiring smaller players and consolidating operations in light of growing import competition and a saturated market," Nick Masters writes.[25]

Respirators and surgical masks

While US manufacturers account for a significant proportion of domestic supply, and North America has the largest market share (by revenue) of any region in the world, this obscures the fact that much of the manufacturing of PPE actually occurs outside the US (and raw materials used to make PPE also largely comes from overseas).[26] For instance, as of March 2020, the US Department of Health and Human Services stated that 95 percent of surgical masks and 70 percent of respirators were made overseas. 3M is a good example of this. According to Masters, during the pandemic "the company has been domestically manufacturing an estimated 50 million masks per month. However, domestic production capacity is dwarfed by the company's capacity in the Asia Pacific region."[27] This became a significant problem when countries around the world began issuing export bans and restrictions on PPE once the COVID-19 pandemic began accelerating and domestic demand outpaced domestic production. For instance, with regards to N95 respirators, it was estimated in April 2020 that total domestic production was nearing 50 million per month, far short of the 300 million masks needed per month.[28]

N95 and similar respirators are generally made out of meltblown polypropylene as well as spun-bond polypropylene and a layer of cellulose or polyester. Bottlenecks and shortages in the meltblown supply chain have been a major issue since the start of the pandemic since meltblown is relatively difficult to make

and the machines that make it are complex and expensive.[29] Due to the pandemic, there is now a worldwide shortage of meltblown, and prices are skyrocketing. "Before the outbreak, the going price for one ton of meltblown fabric in China was under 6,000 dollars a ton. But now, it's about 60,000 dollars," a Chinese salesperson was quoted as saying in a March 2020 *NPR* report.[30] Similarly, there is a shortage of the machines needed to ramp up production of meltblown and other nonwoven fabrics needed to manufacture masks. In March 2020, Gus Nasrallah, President and CEO of Sharpertek (a manufacturing equipment company in Michigan), was quoted as saying that there was a six month backlog to deliver the $250,000-apiece machines that can make N95 respirators.[31] In terms of market share, although US-based Berry Global is the world's largest manufacturer of nonwovens (a category of fabric that includes meltblown), most of their manufacturing capacity is located abroad.[32]

Surgical apparel

With regard to surgical apparel, a subset of PPE that includes surgical gowns, drapes, shoe covers and face masks, Dimitry Diment writes that "despite rising demand conditions, low-cost imports have captured a growing share of the market and siphoned revenue from domestic manufacturers, with many global players opting to offshore US production. Imports are expected to grow from satisfying 35.2% of domestic demand in 2015 to 40.5% in 2020." Market concentration in this sub-sector is considered "medium" with two companies (Cardinal Health and Medline Industries) accounting for around 60 percent of domestic industry revenue. However, consolidation in the sector is expected to increase in response to structural changes in the hospital sector. "With hospital numbers declining," Diment writes, "medical supplies manufacturers and distributors will experience heightened competition for lucrative contracts. As a result, surgical apparel manufacturers are projected to maintain market share by acquiring smaller industry operators."[33]

Reusable PPE can also contribute to reducing energy consumption, greenhouse gas emissions, total water consumption, and solid waste generation.

Currently, disposable gowns, drapes and packs make up over 61 percent of the current market, whereas reusables account for only 15 percent. However, shifting from disposable to reusable cloth isolation gowns, that are sterilized and decontaminated, already forms part of the CDC recommendations to healthcare facilities for managing shortages and interruptions in the PPE supply chain.[34] Moreover, reusable PPE can also contribute to reducing energy consumption, greenhouse gas emissions, total water consumption, and solid waste generation.[35] According to "multiple science-based life cycle environmental studies, reusable surgical gowns and drapes demonstrate substantial sustainability benefits over the same disposable product in natural resource energy (200%–300%), water (250%–330%), carbon footprint (200%–300%), volatile organics, solid wastes (750%), and instrument recovery," Michael Overcash writes.[36]

While most of the raw materials for *disposable* PPE are sourced from Asia, the US has a robust textile industry and might be well-placed to ramp up production of *reusable* PPE. Quality reusable PPE products can be used 80-100 times, offsetting some of the costs of reusable over disposable PPE. For instance, a 2018 systematic review on studies comparing reusable vs disposable surgical gowns and drapes found that total costs are comparable.[37] Moreover, reusable PPE, such as gowns, can help shield against shocks to the fragile and highly

concentrated market that can result in massive price hikes and the extreme costs associated with PPE shortages during times of crisis.

However, the availability of sterilization and decontamination services may be its own pinch point for purchasers, at least in some markets. Furthermore, many of the current methods for decontamination of reusables may themselves produce damage to the environment (and thus our communities) through reliance on certain chemical agents. With disposable PPE also being highly dependent on petroleum-based materials, and supply chains for both these types of PPE strained, health systems may find that supporting local and regional businesses that can innovate the next generation of PPE could be part of building the resilient supply chains of the future.

Gloves

The market for medical gloves is also showing significant signs of strain. Producers of both raw materials and finished medical gloves are concentrated in Asia, with Malaysia alone contributing as much as three-fourths of the world's supply. When the country entered lockdown in early March 2020, factories had to seek special exemptions to resume operations and produce these essential products. Even then, factories were only allowed to operate at half capacity in order to reduce the risk to workers, putting significant strain on the global supply chain for medical gloves.[38]

Medical gloves are made from a variety of materials including latex, nitrile, vinyl, and neoprene. Gloves made from these different materials have different uses, with latex and nitrile offering the most protection to healthcare workers in high risk situations.[39] Thus, the fact that there is almost no domestic manufacturing capacity for nitrile gloves has caused particular concern during the pandemic (especially as a significant number of people have latex allergies which prevent them from using latex gloves).[40] There is, however, one small manufacturer of nitrile gloves in New Mexico, which opened only last year.[41] Though the manufacturer, Rhino Health LLC, has increased production since the pandemic began, their products account for only a small portion of the US market for nitrile gloves, and they remain dependent on raw materials shipped in from Asia. As of August 2020, latex, nitrile, vinyl, and polymer gloves all remained on the FDA's medical device shortage list.[42]

Market Shifts

In February 2020, the World Health Organization urged nations to ramp up PPE production by 40 percent to meet the imminent demand, and by April, the United States had joined many other countries in instituting export restrictions (through the Defense Production Act) on certain types of PPE.[43] The combination of increased demand and a drop in imports has led to an increase in domestic production in recent months. For instance, Berry Global "converted a pilot line in Waynesboro, Virginia, into a commercial operation making its proprietary Meltex meltblown material for both surgical masks and N95 and N99 respirators. This added capacity will allow the company to make materials for 200 million masks annually."[44] Similarly, Johns Manville (a Berkshire Hathaway company) announced in April that it was beginning to make nonwoven filtration material in its Richland, Mississippi factory.[45] And in Wisconsin, 5K Fibers shifted existing production lines to making masks and, as of May, was "weeks away from starting up new capacity, which is a mix of old and new technology, at a former Kimberly-Clark facility in Neenah, WI."[46]

With regards to gowns, Merrow, a Massachusetts-based maker of sewing machines and soft goods, started a new line of production aiming to produce 650,000 medical isolation gowns per week by July.[47] Similarly, Lawrence, Massachusetts-based sportswear manufacturer 99Degrees has altered production lines to make around 500,000 gowns per month.[48] And, Texas-based Dickies shifted its production to make 3.4 million reusable medical gowns as the demand for PPE grew.[49]

While smaller in scale, one interesting example of an anchor institution collaboration concerns a doctor at CommonSpirit Health who has designed a new surgical gown that is easier to mass produce. The doctor subsequently connected with a North Carolina-based manufacturer, Precision Fabrics Group, and a local non-profit staffed by fashion-designers that will sew the gowns around the clock.[50] Together, they aim to produce 30,000 gowns a week. Another example is the Nonwovens Institute (NWI) at North Carolina State University.[51] NWI is using its two research and training pilot production lines to produce both meltblown and a new nonwoven fabric (an alternative to meltblown) for US PPE manufacturers. North Carolina has the country's largest concentration of meltblown manufacturers, and the NWI is also reaching out to many of them for investments in the machinery needed to scale-up manufacturing capacity.[52]

The website *SupplyChainDive* is tracking US companies that have shifted supply chains or manufacturing processes in order

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to produce PPE since the pandemic started and, as of August 31, 2020, they listed 35 such companies.[53] These include most of the large manufacturers of PPE. For instance, in addition to 3M, Honeywell announced in April that they were increasing domestic production of N95 respirators to 10-20 million per month.[54] New domestic producers are also entering the market. For instance, durable clothing manufacturer Carhartt started producing surgical masks and surgical gowns. Using factories in the US and Mexico, the company aims to make 2.5 million masks per week.[55] Similarly, Nordstrom is working with Kaas Tailored and Providence St. Joseph Health to sew more than 100,000 masks made from surplus surgical wrap.[56] And even companies like Ford, GM, and Fiat have re-tooled some of their production lines to produce PPE.[57]

This increase in domestic production has been facilitated, to a degree, by government contracts and public investment. For instance, as of July 2020, the federal government had awarded contracts to 19 companies under the Defense Production Act.[58] State governments have also been active in incentivizing the increased production of PPE. One example concerns Strouse (an adhesives manufacturer), which received a grant from the state of Maryland to produce N95 respirators.[59] In total, as of May 2020, 20 Maryland companies had received state funds to produce PPE and other medical equipment such as ventilators (these were among more than 200 Maryland companies and organizations that have increased production of COVID-19 related supplies and or donated time, money, and supplies).[60]

Maryland is not the only state taking such proactive measures to stimulate and support PPE production. For instance, the CEO of Merrow, Charlie Merrow, said cooperation from the State of Massachusetts will help the company produce gowns and create a "durable, long-term supply chain" for PPE in the United States.[61] And similarly, 99Degrees' ability to shift production lines to gowns and rehire furloughed workers was enabled by a grant from the Massachusetts Manufacturing Emergency Response Team. In Ohio, Lt. Gov. Jon Husted announced in July 2020 that "a $20 million grant program from the state of Ohio will allow 68 manufacturers to buy equipment and expand existing facilities to produce personal protective equipment."[62] In Nevada, Senator Jacky Rosen announced in June that more than $300,000 from the federal CARES Act would be allocated to local SME manufacturers to produce PPE.[63] And in Michigan, three counties came together to develop a Personal Protective Equipment Resilience Grant Program to incentivize local businesses to modernize production capabilities to meet the needs of the PPE market.[64]

In most of these cases, the recipients of these state and local grants have been small and medium sized enterprises. This demonstrates: 1) that for smaller or newer producers, public or institutional support, and in particular large or long-term contracts, are critical to incentivizing and supporting producers so that they can invest in the expensive machinery and/or retooling that is necessary to produce PPE in higher quantities and enter into a market with relatively stringent regulations around quality; and 2) that small and medium sized enterprises can, and will, fill gaps in the PPE supply chain if economic conditions, supportive public policies, and institutional demand permit it. Moreover, the scale of these companies, and types of

production processes involved in producing PPE, appear conducive to worker cooperatives, Employee Stock Ownership Plan companies (ESOPs), non-profit social enterprises, and other alternative business forms that create additional wealth building and economic stability opportunities in local communities. Healthcare institutions can play a prominent role in creating the supportive conditions for the development of such locally controlled and democratically owned companies through direct purchasing, investments, technical assistance, and public policy advocacy.

While there has undoubtedly been a steady increase in domestic PPE production in recent months, this has been dwarfed by the growth in production capacity overseas, particularly in China. For instance, in the first 5 months of 2020, 70,802 new companies registered in China to make or trade face masks (a 1,256 percent increase compared to 2019) and 7,296 new companies registered to make or trade meltblown fabric.[65] Similarly, an April 2020 report in *Bloomberg* stated that "as of February, a registry of medical device companies maintained by the U.S. Food and Drug Administration listed only 40 or so respirator products. Since then the list has grown to more than 1,300 – with about 90 percent of the new products tied to suppliers with addresses in China."[66] And while before the pandemic, China made 20 million surgical masks per day, as of July 2020 production is up to 110 million per day.[67] While the rapid rise in PPE production in China is welcome news, it has led to concerns around quality. As of June 2020, US Customs and Border Protection revealed that up to that point it had seized 750,000 fake face masks among numerous other fraudulent, prohibited, or non-approved medical items (such as COVID-19 test kits and medications).[68]

Moreover, this increased overseas production does little to make supply chains more resilient if and when there is another crisis that restricts or halts international trade, and may even undermine resiliency by increasing lower cost imports in non-crisis times and reversing any gains that may have been made with regards to domestic production. In this context, some health systems have found that the lack of transparency among Group Purchasing Organizations (GPOs) regarding their PPE suppliers contributes to concerns about risk management. "We need to know, and they need to help us advocate to find out where the raw material comes from, where the actual manufacturing happens and what the distribution channel is of each of the suppliers we're considering making awards to," says Ed Hisscock, Senior Vice President of Supply Chain at Trinity Health.[69] "The pandemic revealed significant gaps in the global supply chain. Going forward, we will need to be more intentional as an industry. We have to comprehensively focus on: better visibility; flexibility; the end to end supply chain function; understanding quality metrics; and investing in talent," shared Mary Beth Lang, Chief Procurement Officer at Kaiser Permanente.[70] Without knowing whether the GPOs themselves have built redundancy in their supply chains, health systems often can't know what risks they are facing when confronted with unexpected and rapid surges in demand.

Another market shift (and area of innovation) since the beginning of the COVID-19 pandemic has been around decontamination and reusable PPE. As previously mentioned, reusing PPE is included in the CDC's recommendations on weathering supply shortages and many health systems and companies have been experimenting with methods of decontamination and reuse for traditionally non-reusable PPE items like respirators and surgical masks. For instance, in late March and early April 2020, an Ohio-based non-profit organization called Battelle received FDA authorization to begin deploying its modular Critical Care Decontamination System capable of

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decontaminating up to 80,000 pieces of PPE at a time.[71] This includes normally single use disposable N95 respirators that the company claims can be reused up to 20 times using its method and machinery.[72] More recently, it was announced that a partnership between University Hospitals and NASA had developed two new methods for decontaminating and reusing masks and respirators that now will go through further testing. In a statement, UH's chief clinical and scientific officer and president of UH Cleveland Medical Center Dr. Daniel Simon said that the institution needs "to proactively and prudently plan for potential future needs."[73]

Additionally, some health systems have shifted to newer respirator technologies designed to be reusable in the first place, like the CleanSpace Halo. One advantage of such technologies, particularly in an emergency scenario is that it only has to be fit-tested once per healthcare worker. "The problem with [the various] N95 masks... [is that] you have to fit-test each one of those for your clinicians--does it fit right? Do they know how to use it? Are they going to be safe using it? So here, if I have a reusable product [and] I don't have to do the fit-testing but once--that's making us very successful," says Patrick Vizzard, Vice President of Supply Chain Management and Strategic Sourcing at University of Maryland Medical System.[74]

Going beyond decontamination and reuse of usually disposable items, PPE that is designed and manufactured to be reusable can reduce reliance on vulnerable global supply chains and increase stockpile resiliency in the event of a crisis (like a pandemic). Moreover, as previously mentioned, it can, potentially, have a significant and positive environmental impact depending on what processes are used for decontamination and reuse. It can also have a positive local economic impact. In addition to creating jobs at domestic (and preferably local) suppliers that will design and produce reusable PPE, it can also create companies and jobs in the "reprocessing" industry.

Due to historical changes in the medical supply industry in recent decades, along with enabling public policy decisions (discussed further below), health systems have both greatly increased their reliance on disposable PPE (and other medical products, sometimes called "single use disposables" or "SUDs") and been reluctant (for liability reasons) to clean and or reprocess these items. As such, a third-party industry has developed that serves this function. "The reprocessing industry is tightly regulated by the FDA, and hospitals can now safely and routinely outsource the sterilization of many single-use disposable medical supplies," Dr. Jodi Sherman from Yale University explains. "Only a small fraction of medical devices are reprocessed by third-party vendors, however, approximately 2-3% overall, and so there is tremendous capacity to reduce supply chain vulnerability."[75] Additionally, cleaning and reprocessing PPE (and other medical supplies) is an activity that benefits from proximity to healthcare facilities (due to transportation and time considerations), making it a good opportunity to help create and support (with healthcare institution contracts) local and democratically owned companies, such as cooperatives and employee owned businesses.

Not all health systems are currently set up to properly sterilize, decontaminate, and reuse PPE supplies, and making the switch from disposable to reusable products may require entirely new supplier relationships, contracts, and ways of working. This could be mutually beneficial to healthcare systems and local suppliers in the long-term but may involve significant upfront costs associated with making the shift. Additionally, some health systems have concerns about the risks of cross contamination associated with reusable products. Despite these concerns, however, Steve Standley, former Chief Administrative Officer at University Hospitals, suggests that shifting to reusable PPE may help health systems respond to the initial problem of procuring a supply of PPE in times of emergency given the bottleneck in the market around raw materials for disposables and "this whole story about how many machines there even are" to produce the disposable varieties of PPE.[76]

Ultimately, there is not likely to be a one-size-fits-all solution. However, working with local and regional suppliers to assure availability of appropriate PPE products and services for local needs could be an important part of assuring future supply. Health systems might even support local suppliers and entrepreneurs in innovating products that better meet local needs. By providing a secure market for new products, communicating about needs, and knowing the legal and regulatory standards that govern the production of products in one's own region, health systems can move towards a future in which they can be more assured of the quality of locally-produced products while also influencing the supply to best meet demand.

Historical Context and Long-term Trends

The past 30-40 years have seen a steady process of de-industrialization in the United States combined with the increased globalization of supply chains. In February 2020, before the COVID-19 pandemic, around 12.8 million Americans were employed in manufacturing—down from nearly 20 million in 1979.[77] Moreover, manufacturing now accounts for just 8 percent of total employment, down from around 25.5 percent in 1970.

This has occurred due to numerous intersecting trends and factors, including the growth of container shipping, liberalization of trade norms, automation, the rapid economic development of export led economies like China, and the increasing specialization of producers and regionalization of the supply of raw materials. However, an additional major factor has been the decision by US companies to offshore and/or outsource production to countries with lower labor costs and less labor protections.[78] For instance, in just the ten-year period between 1999 and 2008, employment at overseas affiliates of US companies rose by 30 percent, while US employment of multinational corporations fell by 8 percent.[79]

The process of offshoring and outsourcing has had a major impact on domestic employment and community stability. Historically, manufacturing jobs tended to have good pay and benefits, as well as employment protections through union contracts.[80] Moreover, they were often the primary economic engine of a local community—especially in smaller towns and cities. As such, de-industrialization and outsourcing/offshoring has had a significant economic, social, and political impact in many US communities (such as rising inequality, population loss, and deteriorating health and wellbeing).

Similarly, these trends have also had a major impact on supply chains. Recently, the Institute for Innovation and Public Purpose reported that "as de-industrialisation and outsourcing of manufacturing to fast emerging countries becomes the norm, China has gone on to become the leading manufacturer of the world, accounting for nearly 30 percent of global manufacturing output in 2018. Coupled with the contraction elsewhere in the world, concentration of manufacturing capacity has substantially reduced the resilience of supply chains, which is particularly exposed during systemic shocks."[81] And, as previously mentioned, the Economist Intelligence Unit (EIU) has suggested that the COVID-19 pandemic and the threat of future crises will reverse the process of globalization and incentivize the re-localization and regionalization of supply chains.

The PPE industry followed these general trends around outsourcing and offshoring.[82] According to one estimate, Europe and North America's

PPE production has been "outsourced to Asian countries to the extent of between 60% and 70%."[83] Similarly, IBIS World's PPE market analysis affirms that US companies have been "offshoring production to low-wage countries, such as China."[84] In fact, 3M—the biggest US producer of PPE—was one of the first major US companies in any sector to establish operations in China, with its subsidiary there becoming the first wholly foreign owned enterprise established in Shanghai in 1984.[85]

In 2008, 12 years before the COVID-19 pandemic, *Infection Control Today* released an article warning of the risks of PPE outsourcing in the case of a global pandemic. "In the past decade," the article stated, "most U.S. face mask sellers have moved their manufacturing operations overseas. A handful of U.S.-based manufacturers remain, and they cannot produce enough masks to protect Americans during an impending pandemic."[86] The article went on to describe how, in 1997, Tecnol Medical Products—which controlled 87 percent of the US face mask market—was bought by Kimberly-Clark Health Care. Kimberly-Cark Health Care went on to outsource and offshore much of its mask production, to the extent that by 2013, when it was spun off as a separate company, "the business had more than 16,000 employees…with a large majority located in low-cost manufacturing operations in Latin America and Asia."[87] In total, it is estimated that around 90 percent of US mask production was offshored or outsourced in just a ten year span during this time period.[88] Similar trends can be seen with regards to other types of PPE. For instance, the *Infection Control Today* article states: "Taking part in the exodus overseas since the late 1990s were many of the largest glove manufacturers, including Kimberly-Clark Health Care, 3M, Medline, Precept, Cardinal Healthcare, and Molnycke, who manufacture mainly in Mexico, China, and Thailand."[89]

"In the past decade, most U.S. face mask sellers have moved their manufacturing operations overseas."

As part of this outsourcing and offshoring process, many US PPE manufacturing facilities were closed or mothballed. For instance, MSA stopped making N95 respirators at its Jacksonville, North Carolina plant around 2010 and were unable to reactivate production when the pandemic began because the necessary machinery had been removed. For its part, Prestige Ameritech (now minority owned by a consortium of healthcare institutions) bought one of the closed Kimberly-Clark/Tecnol mask production plants in the early 2000s "believing a market remained for a dedicated domestic manufacturer of protective gear."[90] However the plant's four "like new N95 manufacturing lines" remained dormant due to the large cost of reactivating them and the lack of demand for higher-priced, domestically manufactured PPE.

Prestige's CEO Michael Bowen was one of the few experts who foresaw what would happen to PPE supply chains in the event of a global pandemic. In the 2008 *Infection Control Today* article, he is quoted as saying "in the event of a pandemic, mask-producing countries will divert mask supplies to their own people, removing up to 90 percent of America's ongoing supply. Prestige Ameritech and the few remaining American mask producers could not make up the difference. Hospitals would be out of masks in days or weeks at the most. When the masks run out, there would be no protection for America's HCWs [healthcare workers]."[91]

For years, Bowen and others tried to get both the US government and healthcare institutions to focus on domestic PPE manufacturing. In

terms of the latter, in 2008 he stated that if "America's healthcare facilities began buying American masks, the mask makers would return to the U.S. and we would, soon, have the necessary infrastructure with which to build stockpiles to protect America during a pandemic."[92] However, these efforts largely failed as healthcare institutions continued to largely purchase lower cost PPE from overseas production facilities.

Part of the problem is that the healthcare sector, like many others, has increasingly embraced "just in time" procurement and an opposition to stockpiling. "The JIT philosophy calls for lean inventories and tight connections between companies and their suppliers," MIT's Yossi Sheffi recently explained. "The philosophy reduces manufacturing and supply chain costs. It also reduces response times along the supply chain, enabling manufacturers to respond faster to changes in the marketplace." However, JIT supply chains are extremely vulnerable to disruptions and spikes in demand, like those that have occurred during the COVID-19 pandemic. This was predicted, with critics of JIT suggesting as far back as 2008 that supply chains organized around this principle would collapse in the event of a pandemic. "JIT purchasing is at odds with the very idea of pandemic planning and stockpiling, which is a 'just-in-case' approach," the *Infection Control Today* article stated.

However, as some health systems know from experience, it is really "what is behind just-in-time inventory that is important," according to Ed Hisscock.[93] For health systems that handle much of their distribution in-house and have contingency plans in place for disruptions, there may be ample stock to rely on to fill just-in-time orders, even in times of increased demand. But for others, disruptions in global markets may contribute to the sort of "wild west" scramble to fill orders experienced early in the COVID-19 pandemic. In other words, JIT procurement may not necessarily be a problem if deployed in conjunction with (rather than in opposition to) the existence of robust private or public stockpiles and the cultivation of suppliers with enough built-in surge capacity to meet unexpected spikes in demand.

Another part of the problem has been the shift towards disposable medical supplies, including PPE. "In the 1980s," Dr. Sherman explains, "the medical device industry recognized the money-making potential of manufacturing obsolescence by creating a new label called 'single-use disposable', or 'SUD'. The more stuff you throw away, the more you have to buy, so it's an advantageous business model for things not to be durable."[94] This shift from reusable to disposable medical products has been enabled and incentivized by industry-supported legislation and lobbying efforts at both the federal and state level against reusing and reprocessing SUDs.[95]

Related to outsourcing/offshoring, JIT, and the rise of disposable products, another impediment to increasing domestic PPE production has been the role of Group Purchasing Organizations (GPOs). In 2008, Bowen stated that "selling individual products to individual hospitals became impossible over a decade ago. In order to gain price-sensitive GPO contracts, America's medical companies utilize cheap offshore labor. The GPO focus on price tends to turn products into commodities and give foreign suppliers the advantage."[96] More recently, the GPO model has been identified as a weak point with regards to the PPE supply chain during the COVID-19 pandemic. "GPO contracts feature characteristics that make them challenging partners for hospitals when there is a surge in demand or shortage in supply," Anand Devaiah, et. al. write in *Health Affairs*.[97] These include disparities among who gets access to scarce resources, a lack of price and quality guarantees, and little to no transparency.

With regards to government purchasing of PPE and emergency preparedness, in 1998 President Clinton created a National Pharmaceutical Stockpile program to be run by the Centers for Disease Control and Prevention (CDC). In 2003, this was renamed the Strategic National Stockpile (SNS) program and in 2006, various forms of PPE were added to the stockpile, including N95 respirators and surgical masks. However, the 2009 H1N1 flu pandemic triggered the largest deployment of resources from the SNS in its history—including 19.6 million pieces of PPE and 85.1 million N95 respirators—depleting around 75 percent of its inventory.[98] Despite warnings that the national stockpile would be insufficient in the case of a novel pandemic (or even a severe flu outbreak), much of the PPE was never restocked. Because of this, when the COVID-19 pandemic began to significantly impact the US in the Spring of 2020 there was not nearly enough PPE in the federal stockpile to meet the demand. However, even a fully maintained national stockpile would not have been enough. "The stockpile can only be a bridge, it can never be the total solution," Greg Burel, the former director of SNS, said in March 2020.[99] In the absence of a massively expanded national stockpile of PPE, and given the largely privatized nature of the US healthcare system, the private sector (specifically healthcare systems) is likely going to remain primarily responsible for ensuring adequate supplies of PPE for the remainder of the COVID-19 crisis and beyond.

"The stockpile can only be a bridge, it can never be the total solution."

Conclusion

Unsurprisingly, there is a great desire and hunger to return to a sense of normalcy in the United States and around the world after an extended period of social and economic turmoil due, in part, to the COVID-19 pandemic. However, on many issues we cannot and should not simply return to the old status quo once the pandemic has subsided. This includes how we organize and orient supply chains, especially for critical products such as PPE. In place of vulnerable supply chains defined by "Just in Time" procurement, offshoring/outsourcing, corporate concentration, and a heavy reliance on disposable products, we need to develop robust, diverse, and resilient supply chains that can ensure a steady flow of PPE in a future that is likely to see increased economic and ecological crises. Moreover, given the many intersecting social, economic, and ecological challenges we now face, we must think beyond supply chains towards building resilient local communities, and how the two can and do interact and complement each other.

While global supply chains are incredibly complex, with numerous intermediaries, market forces, and local, national, and geopolitical considerations all playing a role, they are not impossible to change. It is important to remember that the current, pre-pandemic structure of concentrated and globalized supply

We must think beyond supply chains towards building resilient local communities, and how the two can and do interact and complement each other.

chains is relatively novel—at most just 30 years old—and before that a different, more localized and diverse model predominated for decades. It is also important to note how quickly things can change if economic and public policy conditions are aligned. For instance, in just the past six months increased demand (and a willingness to pay higher prices) and supportive policies (such as export bans, the Defense Production Act, and various federal, state, and local grants, subsidies, and contracts) have led to a significant increase in domestic production of PPE, both by established large corporations and new small and medium sized companies.

As some of the primary consumers of PPE, and as institutions on the front line of this and future public health crises, health systems have a prominent role to play in this transition. Already, during this present crisis, we have seen great innovation and flexibility amongst healthcare institutions as they attempt to get

critical protective equipment to their employees and save lives. This includes directly making PPE, buying equity stakes in domestic manufacturers, sourcing directly from new suppliers, and developing new technologies and techniques to reuse equipment. However, there is considerably more that can, and must be done, both in the context of the current pandemic and beyond.

This includes consciously investigating various institutional levers—including procurement, investing, technical assistance, and policy advocacy—to design more resilient PPE supply chains that benefit and strengthen local economies and communities. It also will require further analysis of the precise structure of each healthcare institution's PPE supply chains, the capacity of specific local communities and economies to produce or re-process PPE, and what supportive public policies would look like at the local, state, and federal level. We hope that this paper both provides the background context and motivation for healthcare institutions to begin this process.

Part II

Opportunities for Sector Collaboration and Innovation from Interview Findings

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From September to mid-October 2020, researchers with the Healthcare Anchor Network (HAN) conducted 19 interviews with senior supply chain executives and other leaders from leading health systems in the United States related to issues concerning the Personal Protective Equipment (PPE) supply chain.[1] This summary section provides a high level overview of some of the key findings from these interviews.[2] Along with the research presented in Part I, it is designed to further inform the Healthcare Anchor Network's *Anchoring Resilience: Aligning Supply Chains and Impact Purchasing for Community Health* summit on November 18, 2020.[3]

The interviews clearly illuminated how the COVID-19 pandemic has exposed vulnerabilities throughout many areas of the supply chain with several areas standing out in particular:

Access to both finished PPE products and raw materials when demand initially surged during the first wave of the pandemic;

Concerns that some of those shortages persist and may continue into 2021 or even 2022;

Limited state, regional, and partner coordination and a general inability to secure finished products which left many health systems to fend for themselves and compete for scarce products;

Disruptions at various stages of the supply chain, and in particular the "last mile" (the final step in the distribution and transportation of a product to its final destination) distribution to individual health systems and their employees;

Failure of government officials to manage stockpile reserves and distribute them effectively; and

Concerns that the quality and safety of PPE products are not standardized, which makes it difficult for health systems to easily pivot and purchase from new suppliers during times of supply chain disruption.

We learned from these interviews about the diverse ways that individual health systems are experiencing the PPE challenge, and how they might respond more effectively in the future. To that end, the section below on *The Business Case for a New Model* summarizes how individual institutions might more effectively respond to future crises--both to pandemics specifically and to other future emergency

management situations more generally--that will likely threaten less resilient and poorly diversified supply chains.

A dominant theme from these interviews is the overwhelming agreement among supply chain leaders around the need for greater sector collaboration that would allow health system providers to come together to address the critical supply chain weaknesses that emerged as a result of the COVID-19 pandemic. This includes an interest in developing PPE supply solutions that go beyond the means of any single institution to localize manufacturing, redesign the reserves system, redesign PPE itself, advance better national PPE policy, and embed the values of the Healthcare Anchor Network around equity, sustainability, and community wealth building into PPE procurement. We explore these themes in the section on *Building a Resilient Supply Chain Together*.

The Business Case for a New Model

The supply chain weaknesses revealed during the pandemic will likely compel health systems to revisit current standards of operation. In short, interviewees largely agreed that the pendulum has swung too far toward concentration and outsourcing for many care providers. Among the most commonly suggested proposals on how to address this situation are that health systems should: 1) shift away from sole source contracts; 2) build additional internal supply chain team capacity; 3) reexamine how their last mile of supply chain is structured; and 4) demand greater levels of transparency from their supplier partners regarding their own supply chain access to raw materials and ability to provide finished products.

1) Shifting Away from Sole Source Contracts

Interviewees consistently noted the importance of moving away from a reliance on sole source contracts to mitigate different types of risk: geopolitical, natural disasters, biological, etc. Similarly, there was a general acknowledgement that returning PPE production (onshoring) to the United States would not fully eliminate that risk, but could be an important component of the overall strategy, while opening up the possibility for additional social impact. As Bruce Radcliff, System Vice President of Supply Chain at Advocate Aurora Health, noted: “Similar to an investment portfolio, we want to get to a blended average of expense. We’re going to have some low-cost providers...but we also are going to add in some high-cost providers [to diversify] the risk. So what we’re trying to get to is, what is our weighted average cost for those types of categories?”[4]

Another executive shared that they are partnering with a local university to identify a framework and/or formula for thinking about certain categories of spend and what percentage of business to give to any one supplier.[5] And a third suggested that this sort of diversification clearly makes sense for healthcare to consider given that diversifying vendors is common practice in other industries. For example, private label manufacturing exists in the soda industry so that companies can have their product bottled regionally under specific guidelines, and then distribution takes place locally and regionally.[6]

One prominent example of this type of shift taking place concerns the decision (in May 2020) by 15 health systems, including several HAN members, to commit to purchasing a portion of all surgical masks used annually from Prestige Ameritech, the largest domestic manufacturer of surgical masks and a certified Native American owned business, for up to six

years. Several HAN members, including Advent Health, Advocate Aurora Health, CommonSpirit Health, Henry Ford Health System, and University Hospitals, were among the 15 health systems that took a minority stake in the company as part of their strategy to create a more diverse, reliable supply chain.[7]

2) Strengthening Internal Supply Chain Teams

Interviewees generally shared the sentiment that the experience of securing sufficient PPE supplies for their organization during the COVID-19 pandemic felt like the 'Wild West' and that they had to rely on their internal teams to secure the necessary PPE for their staff rather than their traditional partners. Some suggested that the trend of health systems outsourcing most of their supply chain functions to Group Purchasing Organizations (GPOs) exacerbated this situation for either themselves or health systems they interacted with and that this over-reliance on GPOs was exposed as a liability during this crisis. Kurt Knoth, Senior Vice President, System Supply Chain & Security Services at Spectrum Health, noted that:

"Almost four years ago, we had a very small sourcing team. We did rely almost exclusively on our GPO... But then as we started to build our local team, we realized that...we always got better pricing...So we continued to build up that local sourcing group. We weren't anticipating... an international pandemic, but what that did do was give us the resiliency to get through this. The interesting thing was [for] systems that were bigger than us that had totally turned the keys over to a GPO, [we] were helping them buy certain types of PPE..."[8]

Another executive decided to build a more robust supply chain department when they joined their institution and found that this paid off during the pandemic as health system staff had to divert their focus to sourcing PPE and other necessary materials. They made the point:

"There were a lot of folks on these [GPO] calls that...didn't have supply chain teams... And I would hear folks [ask], when are we going to get some contracts for this and that, we can't find anything this or that…folks that thought in this pandemic that they could rely on the GPO to find them products when the deals were coming out every single day. There's just no way to take that on.... I think that a health system has to decide if they're going to invest in internal supply chains..."[9]

3) Securing The 'Last Mile'

Interviewees revealed a clear difference in experience between those systems that had more robust infrastructure to deal with stockpiling and distribution of reserves to their facilities and those that did not. Those that did experienced far fewer stresses on their system: they had greater reserves and a more rapid ability to coordinate and deploy supplies across their systems. One executive, for example, had last mile infrastructure in place before the pandemic began:

"last mile was actually never a concern for us. We had a regular cadence of [multiple] points a day communication with every single location and we had various temporary storage that we put up in strategic locations, in different markets in preparation for what was starting to ramp up very early on."[10]

However, Simrit Sandhu, Chief Supply Chain and Support Services Officer at Cleveland Clinic, called for a need to focus on the last mile, stating that

"the last mile supply chain is missing in this country...We need to reimagine and reinvent the last mile of supply chain because it will not matter if the product lives even nationally, in situations like this, if that last mile is not thought through. That's [where] anchors...can create some of those resiliency plans."[11]

4) Demanding Greater Levels of Transparency from Suppliers

A common theme among the interviews was their intention to demand greater transparency from their current partners in their supply chain moving forward. Lisa Scannell, Corporate Director of Supply Chain Management at Mass General Brigham put it simply,

"Transparency needs to improve... Understanding where our suppliers manufacture their goods, where they source their raw materials and how they're impacted by disruptions is needed to improve the resiliency of the healthcare supply chain."[12]

Similarly, another executive cited supply chain transparency as key to making more efficient procurement decisions and ensuring quality of products, highlighting the importance of transparency around "country of origin [and] the quality metrics that are available for the products, so that we have the right testing and certification [and have] some standard adoption of different levels of products for different use so that you can...bulk buy or buy into production based on standard criteria [for] the product that you want to use."[13]

Building a Resilient Supply Chain Together

Many of the vulnerabilities and approaches discussed above are ones that institutions will work to address and implement individually. However, a rich set of ideas and suggestions emerged from the interviews about how collaboration could greatly enhance the chances of success. This section provides a high level summary of some of the ideas that resonated most frequently as opportunities for sector collaboration. Generally, these fall into three categories: 1) coordinating strategic investment in vendors and regional infrastructure; 2) redesigning reusable products and/or processes and standardizing qualifications; and 3) aligning to advance public policy solutions.

1) Strategic Investment in Vendors & Regional Infrastructure to Create More Resilient and Equitable Local Economies

A coordinated strategy by healthcare providers could help stabilize and scale new vendor relationships, enhance economic benefit for the communities they serve, allow for supply chain diversification, and mitigate the individual risk to any participating health system. The top two ideas related to this focus are: 1) securing key PPE items, including possibly raw materials, in areas where the market is too concentrated; and 2) regional reserves and last mile storing and distribution of PPE.

As illustrated by the Prestige Ameritech example noted in Part I, the combination of long-term contracts and strategic investment by multiple health systems in domestic vendors could help health systems diversify their suppliers while also permitting a conversation around locating that investment in communities of need. While most new vendor relationships are unlikely to emerge at the scale of the Prestige Ameritech deal, they are still a viable option for health systems and consortiums of health systems. For instance, Ed Hisscock, Senior Vice President of Supply Chain at Trinity Health, described how a small company, Detroit Sewn, had manufactured masks for Trinity Health during the pandemic, providing much needed PPE and saving around 330 local jobs. "I think that therein lies an opportunity for us to continue developing that local supplier from the small business that they are today and see if we can't grow that business over time and make them a competitor for bigger shares of business over time," Hisscock stated.[14]

One example from outside of the PPE sector that was mentioned in the interviews was CivicaRX. The non-profit pharmaceutical company was formed in response to cyclical shortages of drugs due to price gouging. HAN members Catholic Health Initiatives (now CommonSpirit Health), Intermountain Healthcare, Providence St. Joseph Health, SSM Health, and Trinity Health were among the seven original founding members. In addition to the founding members, Kaiser Permanente is represented on their board and now all members receive pharmaceutical drugs through CivicaRX in a way that ensures surety of supply and price transparency. Although this collaboration was not designed specifically around the economic benefits it could yield for the broader community, it represents an example of the type of collaboration that exists based on aligned strategies (and even one that could be further leveraged in the future with the values of HAN as part of that conversation). A similar collaboration could exist focused on manufacturing PPE with the intentional mission alignment of investment in communities of need.

Additionally, and perhaps alternatively, we heard significant validation of the idea that 'reimagining the last mile of supply chain' was a critical need and one which might provide more ripe opportunities for diverse, employee-owned and other locally-owned businesses to support. At its most expansive imagining, this idea could translate into developing regional reserves that cut across health systems, help leverage economies of scale to support PPE access to smaller players across the continuum of scale (such as nursing homes), and involve coordination with state and local governments around storing, rotating, distributing, and replenishing products.

2) Redesigning Reusable Products and Standardizing Specifications

There is an opportunity for a more intentional conversation around the most effective product design for key PPE products, specifically for the healthcare sector. Standardizing product specifications, such as cost and customization for healthcare settings, might enable better diversification and thereby increase supply chain resilience.

Cleveland Clinic's Simrit Sandhu, suggested completely redesigning PPE products so that they can be assembled from materials sourced in, or closer to, the United States. This could remove potential international sourcing chokepoints and allow for competition with existing manufacturers. Sandhu explained that

"you can retool and reimagine the product differently...redesign it to be a very specific US product that is then exportable to the rest of the world, as well as our pandemic product. Something that is so nuanced and different, that we create global opportunity through it. [In short] we are creating reusable, reprocessing, responsible green product[s] that create jobs... that pay decent, great wages."[15]

While the interviews found a split between those health systems exploring the potential for reusable PPE and those remaining with disposables, one senior supply chain executive made the case strongly that the true opportunity for sustainable PPE is with regards to the stockpile and reserve.[16] Although measures to diversify suppliers, including on-shoring, would increase resiliency and mitigate a variety of risks, the demand surge at the peak of the pandemic was so extreme that it would have been difficult, if not impossible, for any entity to scale up production to meet the need given raw material and production capacity. It is also inefficient to have to store the amount of disposable products required to be even

adequately prepared. Instead, regardless of whether a health system decides to go with disposables or reusables for normal operations, reserves should bias toward reusables.

The interviews surfaced a need for sector collaboration to better design reusable PPE products, specifically for the healthcare sector, such that both clinicians and patients are comfortable with them. Jeremy Strong, Vice President of Supply Chain at Rush University Medical Center, is already looking into a healthcare-specific reusable mask option for stockpiling: "we are testing a reusable right now that's much smaller, [and looks] much more like a regular disposable [mask]...So we are looking for more healthcare-focused options."[17]

Advocate Aurora Health's Bruce Radcliff made the point that resilience and security will come with specification-based sourcing. Rather than products being defined by their manufacturer, specification-based sourcing would require manufacturers to create products according to specifications designed by the healthcare sector. He explains, "what we are trying to do is go to specification-based sourcing, which says, listen, if I want to create this Bic pen, as long as it is built to the specifications of a writing utensil that I want, it is an analogous product to Bic. And what I can do then is I can diversify my supply sources."[18] Doing this would reduce geopolitical, climate and biological risk.

3) Aligning to Advance Public Policy That Would Sustain Demand, Expand Transparency, Support Regional Public-Private Collaboration & Build Capacity for Existing Domestic Vendor Relationships

There are many areas where healthcare providers can advance meaningful sector collaboration. However, this set of interviews also revealed that there is a significant role for a broader public policy strategy to complement those efforts. One of the main points of agreement amongst interviewees as it relates to public policy was the need for better integration between the strategic stockpile and health systems. Nearly all interviewees said that during the peak of the COVID-19 pandemic, disbursements from the Strategic National Stockpile were essentially useless, both in terms of the amount of items provided and the quality since much of what was received was expired and not usable. The message here applies not only to strategic stockpiles but to any reserve strategy: it simply can't be a warehouse where goods are stored and not properly managed.

Connected to this, several interviewees expressed a desire to see better integration between states/localities and healthcare providers to ensure that the mistakes that occurred during the current pandemic are not repeated again. One executive proposed the idea proposed the idea of publicly-funded, annual strategic stockpile drills that would both increase preparedness and ensure that a portion of supplies would rotate and be replenished consistently.[19] As this idea shows, there is a role for state and local government to better facilitate the rotation of existing and future stockpile inventory.

Beyond public policy advocacy related to the national stockpile, several executives suggested advocating for the government to provide contracts or subsidies to local infrastructure and manufacturers in the PPE domain. One executive states, "one of the biggest things that a governing agency can do, that aligns with what we're talking about here, is [to provide] stimulus...to support a local industry to gravitate towards this space...If there's enough incentive there, it can offset what happens, to [the] end price."[20]

Another key role the public sector could play in building a more robust and reliable pandemic preparedness supply chain for PPE (and potentially other critical products) would be through public sector contract manufacturing facilities for products key to emergency response. In addition to resources like the national stockpile that sets aside a certain

amount of stock for future needs, a public contract manufacturing facility (publicly owned manufacturing facilities available for contracting from the private sector) could be put to work to produce new stock in times of need as a way to supplement the market in these goods. While it is difficult for commercial entities to build in the amount of slack that would allow for a massive uptick in manufacturing in times of need, the public sector can afford to invest in pandemic preparedness. This approach could help address the issue of long-term sustained needs in the PPE market being much lower volume than the needs during a pandemic. To avoid investing in a number of new or existing commercial businesses in order to accelerate current production to tens or hundreds of times the normal output—knowing that this demand will evaporate in a number of months—the public sector can provide surge capacity through contract manufacturing facilities.

Other executives interviewed suggested supporting public policies and regulations that would require a certain percentage of PPE be sourced locally to build resilience into the supply chain. John Wright, Vice President of Supply Chain & Support Services at Intermountain Health, noted: "I think the only way, in my opinion, this gets any type of legs is through regulation. And that could be through putting part of your CMS reimbursement at risk, based on the percentage of your products that you buy domestically, or something like that."[21]

Expanding transparency was another theme that surfaced during the interviews. Executives generally wanted more transparency coming from federal and state leaders during the COVID-19 pandemic, including information about how the distribution of stockpile supplies would occur in a fair and equitable manner. For instance, one stated that "we need to understand what the federal and the state response will be to a crisis, when they will engage, how they will respond to it so that we can plan our own response [and] know what's available to us and what won't be available to us, because we were on our own in this case."[22]

As noted above, there was an acknowledgement of a need for greater supply chain transparency from vendors and partners. Although no executive noted this as an area that the federal government could aid with, it does suggest a possible role for policymakers to require a greater level of transparency in order to reduce the burden on healthcare providers to receive this information voluntarily from their suppliers.

Finally, several executives noted a concern that the type of collaboration alluded to in this paper may be seen as collusion. This perception could discourage health systems from aligning to solve these challenges with the level of intention required so that future investment was both sustainable and benefited the communities they serve that have been most disinvested and impacted by the pandemic. Whether this concern is indeed valid, it is important to note that this concern could prove to be a potential barrier to encouraging collaboration, and that policymakers could address this concern and alleviate fear through their support and the provision of clarity as to the terms of what would constitute collusion.

Interviews with almost 20 accountable executives and supply chain executives at Healthcare Anchor Network member health systems illuminated the need for future collaboration in building a more resilient PPE supply chain. The current challenges that health systems face also present an opportunity to align these strategies with efforts to advance supply chain strategies that also advance equity, sustainability, and community wealth building in the communities they serve. Part II above outlines both the business case for building a new model for individual health systems as well as the opportunities for sector collaboration that were discussed during interviews. This conversation will continue on November 18, 2020 during the summit, as we look forward to the potential for a more resilient PPE supply chain in the future.

Appendix

Interview Subjects and Contributors

Advocate Aurora Health (Downers Grove, Illinois)

Bruce Radcliff, System Vice President of Supply Chain

Bon Secours Mercy Health System (Cincinnati, Ohio)

Noah Dunlap, Vice President of Strategic Sourcing

John Horne, Chief Strategic Sourcing Officer

Dan Hurry, Chief Supply Chain Officer

CHRISTUS Health (Irving, Texas)

Kim Lemmons, Vice President of Supply Chain Management

Cleveland Clinic (Cleveland, Ohio)

Simrit Sandhu, Chief Supply Chain and Support Services Officer

Henry Ford Health System (Detroit, Michigan)

James O'Connor, Vice President of Supply Chain Management

Intermountain Healthcare (Salt Lake City, Utah)

John Wright, Vice President of Supply Chain & Support Services

Kaiser Permanente (Oakland, California)

Mary Beth Lang, Chief Procurement Officer

Mass General Brigham (Boston, Massachusetts)

Ingrid Beckles, Manager of Supplier Diversity

Mark Faulkner, Senior Director of Strategic Supply Chain Management & Sourcing

Lisa Scannell, Corporate Director of Supply Chain Management

Todd Turner, Director of Supply Chain Contracting

Northwell Health (Great Neck, New York)

Phyllis McCready, Vice President & Chief Procurement Officer

Providence Saint Joseph Medical Center (Burbank, California)

David Carlson, Vice President of Strategic Sourcing

Jennie Ritchie, Director of Clinical Risk Management

Rush University System for Health (Chicago, Illinois)

Jeremy Strong, Vice President of Supply Chain

Seattle Children's (Seattle, Washington)

James LeRoy, Director of Strategic Sourcing & Value Analysis

Spectrum Health (Grand Rapids, Michigan)

Sarah Chartier, Senior Sustainability Project Manager

Kurt Knoth, Senior Vice President of System Supply Chain & Security Services

Trinity Health (Livonia, Michigan)

Ed Hisscock, Senior Vice President of Supply Chain Management

UMass Memorial Health Care (Clinton, Massachusetts)

Ed Bonetti, Vice President of Supply Chain

Douglas Brown, President of UMM Community Hospitals and Chief Administrative Officer of UMass Memorial Health Care

Therese Day, Chief Financial Officer

Henry Lopez, Director of Supply Chain Logistics

University of Maryland Medical System (Baltimore, Maryland)

Jon Burns, Senior Vice President and System Chief Administrative Officer

Kristin Jones Bryce, Chief External Affairs Officer

Gary Tuggle, Director of Enterprise Diversity and Inclusion, Supply Chain

Patrick Vizzard, Vice President of Supply Chain Management and Strategic Sourcing

University of Utah Health (Salt Lake City, Utah)

Kenneth Carlisle, Director of Purchasing and Contracting

Other Interviews

Anna Fox, Chief Operating Officer, Greenhealth Exchange

Janet Howard, Member Engagement Manager, Health Care Without Harm

Thresa Pattee, Director of Sustainability, Greenhealth Exchange

Steven Standley, Former Chief Administrative Officer, University Hospitals

John Ullman, Director of Safer Chemicals and Procurement, Health Care Without Harm

Susan Wilburn, Director of International Sustainability, Health Care Without Harm

Part I Endnotes

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Part II Endnotes

1 The full list of health systems interviewed is available in Appendix.

2 Some of the quotes in this section have been lightly edited for clarity.

3 To be held in partnership with Health Care Without Harm and Practice GreenHealth with support from Kaiser Permanente.

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11 Simrit Sandhu, interview by David Zuckerman, September 10, 2020.

12 Lisa Scannell, interview by David Zuckerman, October 15, 2020.

13 Interview by David Zuckerman and Thomas Hanna, September 3, 2020.

14 Ed Hisscock, interview by David Zuckerman, October 8, 2020.

15 Simrit Sandhu, interview by David Zuckerman, September 10, 2020.

16 Interview by David Zuckerman, October 15, 2020.

17 Jeremy Strong, interview by David Zuckerman, October 15, 2020.

18 Bruce Radcliff, interview by David Zuckerman, September 30, 2020.

19 Interview by David Zuckerman, October 8, 2020.

20 Interview by David Zuckerman, October 15, 2020.

21 John Wright, interview by David Zuckerman, September 21, 2020.

22 Interview by David Zuckerman, October 1, 2020.

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