



**Advancing Resilience
in the U.S. Health
Care Supply Chain
After the COVID-19
Pandemic:
Four Areas of
Opportunity**



NATIONAL ASSOCIATION OF
Manufacturers

Advancing Resilience in the U.S. Health Care Supply Chain After the COVID-19 Pandemic: Four Areas of Opportunity

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Acknowledgements: Scott Wasserman provided excellent research assistance. The time and insight provided by manufacturing executives and industry experts for background for this report is gratefully acknowledged. This report attempts to capture high-level lessons from the COVID-19 pandemic and opportunities to strengthen resilience in health care manufacturing moving forward. It is important to note that the pandemic environment changed rapidly, as did the experience of manufacturers, and the analysis is based on the time and reporting of events that occurred. In some cases, the same manufacturer experienced very different impacts of the policy environment at different times. In other cases, initial difficulties during the immediate emergency response were later smoothed out. The organizations, programs and initiatives described in this report are provided to be illustrative of the range of constraints and policy responses and are not evaluations or recommendations to continue or strengthen a specific program.¹

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› Executive Summary

Background

The COVID-19 pandemic spotlighted the crucial role of the U.S. health care supply chain—and its vulnerabilities. The pandemic demonstrated the importance of health care supply chain resilience in preparedness, mitigation, response and recovery from the pandemic.

U.S. health care supply chain resilience refers to the ability of the supply chain network to prepare and adapt to a disruption. Manufacturers across the United States produced critical health care supplies in an unpredictable market and policy environment. It is important for manufacturers and policymakers to ensure that resilience is maintained in the sector moving forward, with an eye on being prepared adequately for future events that might shock the system.

This report identifies key themes that came out of the pandemic about health care supply chain resilience, as well as four areas of opportunity to build resilience in the future.

Lessons Learned

Seven key lessons from the pandemic can be examined for future efforts to build resilience.

1. **Speed matters:** Manufacturers need to be able to serve demand quickly.
2. **Information matters:** Manufacturers need timely access to accurate information.
3. **Costs matter:** Firms face the costs of taking action within the supply chain, as well as the costs of managing market unpredictability and policy environment uncertainty.
4. **Networks matter:** Partnerships can support information sharing and networks to help manufacturers navigate the disruption.
5. **Size matters:** Small and medium-sized manufacturers and new firms can be differently—and uniquely—challenged compared with established larger manufacturers.
6. **Technology matters:** Technology can enable manufacturers to enhance production, innovate or improve efficiency, as well as support broader efforts to build partnerships.
7. **Flexibility matters:** Responses can come from unexpected sources and need a flexible policy environment.

Efforts to bolster the resiliency of the health care supply chain include actions that result in its ability to adapt quickly, effectively and appropriately to demand. A more resilient health care supply chain will allow manufacturers to better respond to and overcome disruption and will enhance long-term manufacturing competitiveness.

Next Steps

These seven lessons point to the opportunity to advance resilience with a focus on four key areas.

1. **Fostering a conducive regulatory environment.**
2. **Supporting partnerships for stronger information sharing and networks.**

3. Ensuring a healthier “baseline” industry.

4. Prioritizing changing workforce needs.

Building resilience in the U.S. health care supply chain is not a short-term effort: it requires a rethink of how the health care manufacturing ecosystem is evolving beyond the COVID-19 pandemic.

➤ Why Health Care Supply Chain Resilience Matters in the United States

Manufacturers experienced major change during the COVID-19 pandemic, including in product design, sourcing and supplier relationships, production, workforce management, technology use, logistics, transportation and distribution.

The pandemic demonstrated the vulnerability of U.S. health care supply chains, the success and failures of policy measures aimed at stability and meeting demand, and the need for an explicit future focus on resilience. Another pandemic is not the only possible major disruption that manufacturers will face in the future, given the potential for crises related to national security, technology-induced change, and political and environmental instability.

➤ Box 1. What Is Resilience in the U.S. Health Care Supply Chain?

U.S. health care supply chain resilience refers to the ability of the supply chain network to prepare and adapt to sudden (pandemic) disruption. This includes the extent—and the speed—of adjustments to the changes² that affected supply chain performance, the ability to maintain robustness³ with continued functioning at an acceptable level and the ability to recover quickly to pre-disruption conditions or more desirable conditions.⁴

Supply chain resilience is concerned with the overall health of the health care supply chain network. A highly resilient supply chain network will not only be able to withstand and minimize the difficulties caused by a disruption, but it will also be able to meet the new nature of demand quickly by mobilizing resources and exploiting potential opportunities created by the disruption.⁵

At the business level, business resilience refers to the ability of the firm to adapt, withstand and respond to disruption and to perform at a state of acceptable operation.⁶ A resilience goal can differ from a goal more squarely focused on expanding production, lean production, cost efficiency and savings. Resilience can also look beyond business continuity or recovery, which tend to focus on continuing operations during disruptions.⁷ There can be overlap across these goals—they are not necessarily mutually exclusive.

This report lays out some of the shifts that occurred for manufacturers in the health care supply chain during the COVID-19 pandemic and four domains of opportunity to improve resilience in the future. The analysis is based on a review of more than 115 reports, analyses and recommendations from multiple private and public sources, including government, research and academic publications, industry associations, nonprofits, manufacturers and media, as well as background interviews with senior executives at manufacturing firms.

➤ What Did the COVID-19 Pandemic Reveal About Health Care Supply Chain Resilience?

■ **Rethinking inventory management:** Resilience sometimes required slack in inventory so that manufacturers could respond more rapidly to changes in demand. However, the industry moved toward lean manufacturing and just-in-time practices in the decades before the pandemic.⁸ During the pandemic, manufacturers weighed the benefits of a just-in-case approach or just-in-time approach, weighing priorities of cost savings and responsiveness.⁹ Although the pandemic created unpredictable demand patterns, which called for more flexibility and responsiveness, manufacturers had concerns about long-term viability post-pandemic.

■ **The role of sourcing:** Reliance on global sourcing and production in health care received attention during the pandemic. Before the pandemic in 2019, the U.S. imported more than \$125 billion in pharmaceutical goods (medicines as well as non-medicine supplies, such as bandages, testing kits and dental products).¹¹

To improve the reliability of supply of critical products to customers, a Michigan-based medical and surgical equipment supplier announced several changes to production and sourcing, by bringing production in house, close to home, and developing alternative sources of supply.¹⁰

Some manufacturers moved to domestic and, in some cases, in-house production. Some looked for ways to secure sourcing through new suppliers and by establishing multiple sources of supply. Dual sourcing helped manufacturers manage the need to back up supplies. In some cases, large firms cultivated existing smaller suppliers and worked with them to improve their ability to provide reliability and dependency.

While manufacturers considered or made these shifts to gain greater control over production, even domestic production can still rely on inputs and materials from abroad.

■ **Old and new manufacturers in the health care supply chain:** While the health care supply chain is considered typically to include the network of manufacturers and firms directly participating in the making and distribution of health care products, the pandemic demonstrated the limits of this kind of strict definition. At least three types of manufacturers were involved in the health care supply chain during the pandemic: established health care manufacturers, preexisting manufacturers in other sectors that had not produced health care supplies previously and new firms joining the health care supply chain. These three types of manufacturers engaged in the supply chain with different resources and knowledge and required different engagement with and from public programs and policy interventions.

■ **Different experiences of “stepping up” and “stepping in” for firms new to the health care supply chain:** Some manufacturers that did not produce health care supplies typically were able to “step in” and shift their existing activities to produce personal protective equipment and other health care products, while other manufacturers already producing supplies in the health care context “stepped up” their production to more or a wider range of goods. Notably, the production of masks, face shields, medical gowns, gloves and related PPE equipment was undertaken by manufacturers that had not been in the health care supply chain previously. For some SMMs, pivoting presented an opportunity to keep business going.

Companies that stepped up and pivoted during the pandemic often made products that already had similar processes or purposes to medical supplies. This included companies in textiles and clothing, fashion and accessories, athletic goods and equipment, packaging and paper products, chemical products and fabrication.¹²

Some produced goods that could be applied readily in health care contexts with some changes and with the right approvals.

A challenge for manufacturers making new health care products for the first time (whether they were already in the health care supply chain or new pivots) was the difficulty identifying priority products and thus, prioritizing resource allocation and making production decisions. Timely and relatively easy access to information was important in helping manufacturers identify and respond quickly to changing needs, such as for PPE in a region. For smaller and regional manufacturers, the time and difficulty associated with obtaining information in the rapidly changing pandemic environment was important for their ability to respond to changes.

There was a great deal of optimism about pivoting to health care supplies by manufacturers in other sectors, particularly in the first phase of the pandemic, but it is still unclear if and how successful these pivots were for many firms during the pandemic and in the long term.¹³ The experience seems to have been mixed, with some manufacturers making pivots and continuing production or expansion since that time, but with others making pivots that ended quickly or did not sustain market connections. A California-based equipment and apparel manufacturer pivoted to produce disposable hospital gowns and secured federal contracts to supply the national stockpile in early 2020 but faced difficulty with uncertainty of the timing of orders later.¹⁴ A North Carolina-based athletics fabric supplier collaborated with others in the textile supply chain on materials, testing requirements, regulatory guidelines on labeling and product claims and production capabilities.¹⁵

Some pivots led to significant expansions in new products that firms were able to sustain or grow further. For example, a Massachusetts-based technical apparel and soft goods firm pivoted to health care supplies during the pandemic, worked with an emergency response partnership (see Box 2) and eventually established a medical division to continue to serve the health care market.¹⁶

■ **Potential opportunities—and barriers—for SMMs and new manufacturers to collaborate across the supply chain:** SMMs, as well as new entrants, faced unique and often disproportionate challenges during the crisis, despite making up the majority of U.S. manufacturers and exporters before the pandemic.¹⁷ The participation and persistence of SMMs in the health care supply chain varied, due at least in part to underlying existing challenges. These include access to capital, the cost of inputs including technology, access to information and networks and barriers to scaling.

Some large health care manufacturers redirected resources because they had multiple facilities or could move workers from one product line to another. Others financed new investments in technology, such as those enabling more effective sanitation and worker safety measures, production, tracking and distribution. In some cases, internalizing logistics and transportation needs allowed manufacturers to reduce their dependence on unreliable systems—but also required that they have the financial ability to do so. Manufacturers that had placed an emphasis on business continuity planning already also had the advantage of having a plan and insight into potential effects and company response during a disruption.¹⁸

SMMs often lacked the resources to be able to undertake many of these measures. SMMs and new entrants in particular did not have the same level of knowledge about the health care supply chain that established manufacturers did.

At the same time, the search for local suppliers and interest in diversifying sourcing presented unique opportunity to deepen collaborations for SMMs and new firms.²⁰ Some large manufacturers

Interest in collaboration across the supply chain was growing before the pandemic among manufacturers more broadly. One analysis reported that more than half (51%) of firms in a JDA 2018 Intelligent Manufacturing Survey cited “enabling collaboration across the supply chain” in preparing the supply chain for rapid change.¹⁹

worked closely with existing and new smaller companies to improve the stability of their sources of supply, helping them embed into the supply chain.²¹

■ **The importance of a conducive regulatory environment:** The regulatory environment during the pandemic created different conditions for manufacturers in the short and long term. Product regulations and emergency approvals were relevant immediately, but manufacturers also faced other regulatory hurdles during and after the pandemic (including those related to products, environmental guidance, worker safety and labor).

Some types of guidance on key operational considerations for manufacturers could vary from one state to another or with respect to federal guidance. For example, definitions of essential businesses and essential workers were not necessarily consistent across states and could change.²³ This was particularly relevant for manufacturers with a presence in several states.

A New York-based manufacturer shared frustration about the lack of clarity on worker safety, noting the difficulty obtaining clarity between state-level rules and federal-level guidance about how to keep workers safe.²²

“Every device used in health care must comply with Food and Drug (FDA) Administration regulations and other specifications associated with its product code and classification that are designed to ensure safety and efficacy. These guidelines have rapidly evolved; the FDA has released multiple guidance documents and emergency-use authorizations in recent weeks to help manufacturers respond quickly to Covid-19...” (Zeidel et al. in May 2020)

In addition to pandemic-specific regulatory changes and other forms of guidance, manufacturers introducing new products to the market or pivoting to new health care products for the first time navigated compliance processes specific to the products. This made the reliability and accessibility of information about these requirements important for manufacturers.

■ **Partnerships to improve information sharing and networks:** Lack of coordination or even conflicting approaches among agencies at the federal or state levels created difficulty for manufacturers of all sizes to operate in. Manufacturers needed to track and understand the changing policy landscape, but a lack of policy clarity made it difficult for them to assess the risk of potential decisions. This lack of clarity was felt acutely by SMMs with resource constraints.

Partnerships and network efforts between manufacturers, public agencies and many crucial private, industry and nonprofit organizations were often aimed at bringing together knowledge, networks and resources. Existing and new efforts came from groups that played an important role in the health care industry, in health care manufacturing specifically and in the manufacturing industry more broadly. Examples include the Americas Apparel Producers Network, American Hospital Association, Medical Device Manufacturers Association, the National Association of Manufacturers and the Society for Healthcare Organization Procurement Professionals. Some efforts expanded on existing resources and programs and others were shorter-term pandemic-specific responses. Regional and community partnerships developed all around the U.S. in response to the pandemic, such as Project Protect in Utah and the COVID-19 Regional Response Team in the Greater St. Louis region.

Partnerships also provided a “place” for manufacturers to go, rather than tracking several individual pieces of information (regulatory compliance from one source, safety protocols from another source, product design and standards from a third source). Effective partnerships that came together quickly enabled the consolidation and tracking of information and a source for manufacturers to obtain the information. For example, rapid compliance with regulatory requirements in the production of PPE was an important—and sometimes complicated—need for

manufacturers pivoting their products. There was a role for existing partnerships in the manufacturing industry and newly formed partnerships in response to the pandemic.

► Box 2. An Example of a Regional Partnership for Information Sharing and Networks

The Massachusetts Manufacturing Emergency Response Team was set up in March 2020 to assist manufacturers with pivoting operations to produce priority supplies during the pandemic.²⁴ It was a collaborative effort organized by MassTech, a public agency that supports the technology and innovation economy in the state. MERT included academic organizations, R&D centers and public and private partners in the state, such as the Massachusetts Manufacturing Extension Partnership, Associated Industries of Massachusetts, Advanced Functional Fabrics of America, Massachusetts Institute of Technology and Worcester Polytechnic Institute.

Manufacturers interested in pivoting production could consult with MERT on identifying items that needed to be produced; templates to assess products for the market; regulatory support, including reviews of guidance on use, labeling and packaging for products prior to submission; coordination with supply chain needs; and information about testing resources for products requiring compliance. MERT had product managers, a manufacturing subgroup and a regulations and testing subgroup and used a triage approach to work with interested manufacturers. The regulations and testing subgroup provided support with FDA approvals and regulatory performance requirements; physical specs and product requirements; rapid design testing and vetting; and product testing.

MassTech Executive Director Carolyn Kirk cited speed as critical to the initiative:

- MERT was convened within 10 days of the state of emergency.
- A PPE portal for pivoting manufacturers was available in 19 days.
- A first test of PPE testing by MIT was done within 22 days.
- Two companies that pivoted received orders within 30 days.
- A grant program was started within 34 days.
- PPE testing equipment was up and running at testing centers (43 days at MIT Lincoln Labs and 60 days at University of Massachusetts Lowell).

By December 2020, Kirk reported that 50 firms made it through the MERT “gauntlet” and produced 12 million PPE items. MERT also received a Future of Manufacturing grant from the National Science Foundation to support rapid execution for scaling production of needed designs.

In a little more than one year (between March 2020 and April 2021), MERT gave out more than \$16.1 million in state grants toward production and PPE testing capabilities, with the majority going toward the development of protective masks (45%), testing (20%) and gowns (20%). The grants also went toward ventilators, support for supply chain and materials, testing of PPE and hand sanitizer. MERT reported that more than 15 million items were produced by manufacturers that pivoted with its assistance, including more than 9 million isolation gowns and 3 million N95 respirators/masks, 5 million face shields and 10,000 ventilators.

■ **Persistence of existing labor market challenges—and the emergence of new ones:** Labor market challenges existed before the pandemic—and were exacerbated by the pandemic. Manufacturers prioritized bringing in workers and keeping them safe.

Even for essential businesses in the health care supply chain, required measures (and in many cases, meeting their own internal standards) for worker safety often meant investing in operational changes. Evolving federal or state requirements for worker safety and sanitation measures and a lack of clarity about these requirements made it harder for manufacturers to assess how costs would change as conditions changed during the pandemic.

Manufacturers made changes to the way work was being done. Although many other industries moved easily into partially or fully remote work, the nature of some parts of the production and distribution of health care supplies made this impossible and required onsite work.²⁷ Where it was possible, some manufacturers transitioned workers to remote work, which opened up opportunities to people who might not have been able or willing to work in the facility, such as people on the cusp of retirement or who did not live in the region.²⁸

Manufacturers used traditional and new approaches to address labor challenges.²⁵ A Massachusetts-based pharmaceutical company found that enabling workers not involved in manufacturing to work remotely helped with recruiting and retention.²⁶ The firm also enhanced policies for benefits, time off, and promotion, including more inclusive benefits for surrogate parents and same-sex partners. A California-based pharmaceutical company expanded its recruitment approach by tapping into its employees, offering \$3,500 for successful referrals. To manage retention, it focused on employee engagement and workplace culture, wellness programs, rewards programs and promotions. It also considered employee voice and needs in its approach to managing labor challenges: after an employee survey showed that 57% of employees faced child care issues, the firm introduced flexible schedules.

Manufacturers continued to face challenges of being able to find enough workers—and to retain them. While this was not unique to the health care supply chain, unpredictability of demand and the often urgent need for supplies made this particularly problematic.

Firms focused on recruiting and retaining workers, including by broadening talent acquisition strategies, providing expanded benefits and finding ways to reduce barriers to work.

■ **New technology use:** The pandemic imposed unique conditions on the production and distribution of health care supplies. The introduction of new technologies by manufacturers in the health care supply chain originated from necessity (more automation to support worker productivity and address worker shortages) or opportunity (ability to enhance production or increase efficiency) or some combination.

Some manufacturers were investing in new technologies already before the pandemic, such as 3D printers that allow for more rapid, and lower cost, innovation and experimentation with products.

An Indiana-based manufacturer, which principally produced automotive parts but had been interested in expanding its relatively small presence in health care, acquired a 3D printer before the pandemic. The capability for rapid prototyping enabled the firm to respond quickly to opportunities to produce face shields.²⁹

In addition to the role of technology in products, new technologies were used across a wide range of manufacturer needs and functions. Some firms used deep learning in drug development and predictive technologies to anticipate market shifts and introduced new technologies to manage information,

track products, support worker training and support compliance. Technologies related to 5G can enable easier tracking and tracing of steps in production and along the supply chain, as well as help manufacturers with inventory management, product use and early identification of potential disruptions, machine failures and safety concerns.³⁰

Another example of expanding technology use is virtual reality, which can be used to expand opportunities that might otherwise be limited to a particular facility or hands-on environment. For example, a pharmaceutical manufacturer's investment in a sterile injectables plant could also allow for future training through the use of VR wearables, making it possible to access training from other locations.³¹ The potential for VR to be used in medical research, for training to interact with machines, in managing compliance and safety and to learn various parts of the manufacturing process is the subject of growing research and industry efforts.³²

However, the introduction of new technology also points to new concerns for the industry. More reliance on technology in work processes also means a shift in risks related to security, data management and privacy for some firms. For example, the increased use of digital technologies in operations, before or as a push during the pandemic, highlights the nature of cybersecurity considerations for manufacturers.

► **Box 3. Unique Cybersecurity Needs for Manufacturers**

MForesight lays out several unique cybersecurity challenges in the manufacturing industry, including the sequential nature of manufacturing operations (where a previous operation with a minor flaw can jeopardize in the next operation); the nature of interoperations with other key industries with their own vulnerabilities (water resources, transportation systems); constant operations that make maintenance, installation and testing of systems difficult (e.g., without scheduled down time); interconnectedness of multiple sources, vendors and equipment in facilities that can make coordination for security operations difficult; and the nature of security beyond protecting operations (intellectual property in product design, processes and parameters and specifications also need to be protected).³³ Another challenge with the introduction of new technologies is that some manufacturers had not planned to do so (yet) and were not ready for needs associated with the technologies. The learning curve for these firms can be high. The need for a skilled labor force to utilize the new technologies—already a concern with questions about Industry 4.0 before the pandemic—remains a key post-pandemic challenge for manufacturers.

In addition, larger established firms, SMMs and new firms had differing abilities to access and deploy capital required to acquire, implement and manage new technologies, including training or competing for workers that use the new technologies.

► **Key Takeaways: Policy Opportunities to Support Health Care Supply Chain Resilience**

Manufacturers already in the health care supply chain may need to reallocate, repurpose, shift and acquire resources to adapt. Manufacturers in other sectors that could pivot face a new policy and regulatory environment when they transition to making health care supplies. New manufacturers also enter the health care supply chain as disruptions create new opportunities.

Whether they are incumbents, pivots or new firms, manufacturers need to be able to identify opportunities in the health care supply chain, to effectively assess risk during a disruption, determine how to make necessary investments, set up production and manage worker safety and make distribution decisions.

“Retooling, ordering new materials and establishing markets for new products is risky and expensive, so companies needed guidance to address uncertainties regarding the level of demand to expect for products and the corresponding amount of capital investment required for new equipment and their workforce.” (Zeidel et al. in May 2020³⁴)

Several important cross-cutting themes are useful for future efforts to build greater resilience into the U.S. health care supply chain.

- 1. Speed matters:** Manufacturers need to be able to serve changes in the market quickly. Their ability to do so is crucial to disruption mitigation, response and recovery—and requires clear and reliable information and communication channels in a conducive regulatory and policy environment.
- 2. Information matters:** Manufacturers need timely access to accurate information during times of disruption as well as during regular operations to navigate market shifts. Partnerships are one way information can be shared; they can play an important role in opening and sustaining channels of communication for the industry during and outside times of disruption. Effective partnerships can enable engagement between manufacturers, policymakers and a wide range of groups that play an important role in the ecosystem.
- 3. Costs matter:** Firms face the costs of “stepping in” or “stepping up” to take action during a disruption, as well as the costs of managing market unpredictability and policy environment uncertainty. These are complex business decisions; manufacturers weigh short- and long-term costs including the changing use of technology and changing associated labor force needs.
- 4. Networks matter:** Partnerships can support information sharing and networks to help manufacturers navigate the disruption. They can help with the flow of information between manufacturers and policymakers and with key needs within the industry, such as learning about market opportunities and demand, regulatory requirements, product requirements and production and distribution setup.
- 5. Size matters:** SMMs and new firms can be differently—and uniquely—challenged compared with established larger manufacturers. These challenges can include labor, technology, information, financing and other constraints, which also affect the health of the industry.
- 6. Technology matters:** Technology can enable manufacturers to enhance production, innovate or improve efficiency, as well as support efforts to build partnerships. Greater uptake or application of new technologies is not necessarily a silver bullet, as new technologies require commitment to invest, develop and maintain, integrate and build staffing and resources around.
- 7. Flexibility matters:** Responses to disruption—and support for manufacturers in the health care supply chain—can come from unexpected sources and need a flexible policy environment. Important benefits can come from innovative approaches to making products, unexpected solutions to shortages and new ways of building relationships, sharing information and collaborating.

Below are opportunities to address gaps in four specific domains to strengthen resilience.

- 1. Fostering a conducive regulatory environment.**
- 2. Supporting partnerships for stronger information sharing and networks.**
- 3. Ensuring a healthier “baseline” industry.**
- 4. Prioritizing changing workforce needs.**

➤ Fostering a Conducive Regulatory Environment

Manufacturers and their partners and supporters need clarity about regulations to reduce risk. One opportunity to improve regulatory clarity is to assess if and how existing programs and policies could potentially be applied to emergency situations to cut response time in the future.

Sharing guidelines across states could help to streamline requirements where possible and to make it easier for manufacturers to operate in/supply to multiple states, as well as make it easier to comply with multiple levels of potentially differing state and federal guidance.

Future resilience in health care manufacturing can benefit from reviewing regulatory actions undertaken during the height of the COVID-19 pandemic. Identifying which policies worked well will improve efficiency in advance of a future disruption.

The development of flexible regulatory frameworks in advance of a future disruption can enable manufacturers to incorporate them into business continuity planning. This would also allow manufacturers and broader partnerships to plan for processes in advance that will enable or expand distribution and production and could save time and resources in case of a disruption.

Early in the pandemic, the interpretation and implementation of federal and state critical infrastructure designations was confusing for some manufacturers in relevant industries.³⁵ The Department of Homeland Security identified 16 critical infrastructure sectors in manufacturing and other industries and provided a list of critical infrastructure occupations and guidance through the Cybersecurity and Infrastructure Security Agency. Where state orders differed, companies would have needed to obtain exemptions.

Regional and national industry organizations and partnerships could consider creating and maintaining (updating) lists of critical supplies that can reduce uncertainty for manufacturers when a disruption hits. Coordination and collaboration across regional and national industry organizations and partnerships could help manufacturers respond to need if future disruptions have uneven impacts across the country.

Additionally, action plans that clarify and disseminate guidance on standards and processes can facilitate greater industry access to information, lowering the time and cost burden of seeking information for SMMs and new manufacturers. This can be done by strengthening partnerships and networks of relevant organizations to share institutional knowledge and information about regulatory processes and requirements.

➤ Supporting Partnerships for Stronger Information Sharing and Networks

Developing sustained information channels for policymakers to inform manufacturers appropriately can support more effective communication about policy and policy changes. These channels can improve access to information for both manufacturers and policymakers as it will enable them to be better informed.

Channels for manufacturers to provide real-time and ongoing feedback to policymakers would amplify the voice of industry and help policymakers make necessary adjustments and anticipate implementation barriers to existing policies.

Industry groups and partnerships can open the door to unexpected resources and innovation and therefore should be strengthened to facilitate information sharing. Such partnerships can decrease time and cost barriers and enable existing manufacturers to pivot operations to the health care supply chain, as well as allow new firms to enter the market.

Strategies that help sustain partnerships and collaborations to reduce risk, such as through long-term commitments, can help increase transparency and certainty for manufacturers and their partners to be able to meet the needs of a future disaster.

› **Box 4. Ideas and Partnerships Can Emerge in Unexpected Ways**

A Missouri-based manufacturer described to Zenefits how the company pivoted from manufacturing window shades to face shields.³⁶ Given that the company had a facility, a talented workforce and equipment that cuts, they asked what they could make to help fight COVID-19 and become essential workers. When a worker shared a picture of a face shield, the manufacturer said it could be done.

A blind spot for policymakers is that potential solutions to a disruption are not always obvious—and new ideas can come from anywhere and from other sectors. During the pandemic, manufacturers of other, non-health care products, were able to pivot to produce PPE to help with critical local gaps. When successful, this not only helped with health care supplies but also kept manufacturers afloat and workers engaged.

However, pivoting is not necessarily an easy or efficient endeavor. Each manufacturer that wants to individually find potential need, make possible design changes, learn about standards and manage communication—while at the same time actually make the new products—is often replicating what other firms are doing to achieve similar outcomes. For these efforts to be effective at scale, some efforts emerged to provide connective tissue to organize information, connect interested manufacturers with the gaps in demand, lower the learning curve for firms that had not produced health care supplies previously and facilitate relationship-building. These efforts came both from established health care manufacturer organizations and partnerships as well as from sometimes unexpected, unpredictable and grassroots initiatives.³⁷

› **Ensuring a Healthier “Baseline” Industry**

Barriers to entrepreneurship and innovation in the industry constrain the contribution of SMMs and new manufacturers during a disruption. More robust entrepreneurship and scaling of new manufacturers contributes to a more competitive industry.

In particular, addressing capital challenges for small and potential new health care suppliers after the pandemic can contribute to more innovation and entrepreneurship, better positioning the supply chain for the future. Expanding access to the health care supply chain for SMMs and other small companies could support diversified sourcing opportunities in a future disruption. Reducing barriers and promoting entrepreneurship and innovation also cut across many needs relevant to the health care supply chain. Assessing if existing policies and initiatives aimed at the entrepreneurship and innovation ecosystem can be leveraged in the health care context is worthwhile.

Technology uptake can shift rapidly in a crisis. SMMs and new manufacturers face unique challenges, which should be considered when “futureproofing.”³⁸ Reducing barriers to technology investments among SMMs can also improve their ability to keep up with change and industry innovation. Such efforts can enable greater preparedness among manufacturers in and adjacent to the health care supply chain and can better position them to navigate disruption in a more resilient supply chain.³⁹

➤ **Prioritizing Changing Workforce Needs**

Prioritizing the workforce-technology nexus will be important to fill the labor needs of manufacturers that made new investments in technology during the pandemic. This is particularly important for manufacturers that invested because the pandemic required it, but before they planned to do so.

Programs for workforce development and economic development⁴⁰ can potentially provide layered benefits for manufacturers in the health care supply chain. Workforce development programs can support the growth of an adaptable workforce that can pivot across product lines and sectors. Economic development programs can play a role in alleviating barriers to work in manufacturing more broadly. These can help to reduce the burden of repeated and often replicative efforts by individual manufacturers to reduce labor market challenges. Additionally, research to understand how fiscal and other tools used in workforce and economic development programs (like tax credits or matching grants) affect long-term resilience in the health care supply chain can identify if there may be potential shared gains.

Policymakers can consider how workforce needs play a role in shaping the environment for manufacturers (including SMMs and competitiveness) and the extent to which these challenges are felt, shared and addressed by manufacturers, companies in other industries and the broader regional and economic environment. This can help identify opportunities for collaboration and avoid duplicative activities.

➤ A More Resilient Future: Final Thoughts

The COVID-19 pandemic illustrated how quickly disruptions can affect every level of industry and the need for the supply chain to respond quickly and effectively. It also demonstrated the commitment and efforts of manufacturers in the U.S. to step up—and that they can't do it alone.

Fostering a resilient health care supply chain is vital to preparing for and responding to a future disruption effectively and to supporting long-term industry competitiveness. A comprehensive and sustained, multistakeholder effort is needed to address health care supply chain resilience.

Drawing on lessons learned during the COVID-19 pandemic, this study identifies four domains to improve resilience in the health care supply chain. Fostering a conducive regulatory environment can support manufacturers, their collaborators and partners and policymakers in advance of the next disruption: clarity, predictability and coordination can reduce risk. Supporting partnerships for stronger information sharing and networks can improve communication and transparency during a disruption. Partnerships that enable feedback loops between manufacturers and policymakers, as well as broader communication and network expansion (such as through regional initiatives, trade associations, member organizations or community initiatives) can lead to better information and ultimately more resilience. Ensuring a healthier “baseline” industry, including by reducing capital and technology barriers for SMMs and new manufacturers, can improve industry competitiveness. Prioritizing changing workforce needs is crucial to improving resilience in the health care supply chain. Pre-pandemic workforce needs, as well as evolving needs at the workforce-technology nexus, require sustained efforts at all inflection points in the health care supply chain.

➤ Research Methodology

This analysis used an extensive review and analysis of more than 115 policy recommendations from private and public sources, including research and policy assessments, testimony, case studies, scholarly analyses, media coverage, program documents and industry reports. Sources include academic articles, working papers and communications, media reports and industry commentaries, congressional testimony, data and evaluation releases from public agencies and materials from entities, including the Access to Medicine Foundation, Alliance for American Manufacturing, American Hospital Association, Association for the Advancement of Medical Instrumentation, Association for Professionals in Infection Control and Epidemiology, Center for Strategic and International Studies, Ernst & Young, Deloitte, Food and Drug Administration, McKinsey, National Academies of Sciences, Engineering and Medicine, National Association of Manufacturers, Small Business Administration, Society for Healthcare Organization Procurement Professionals, Department of Treasury and the White House (two administrations). The research team also conducted background interviews with senior executives in manufacturing firms. All cited work and quotes/attributions come from publicly available material, such as program documents and evaluations, presentations, websites and media reports.

Notes and References

¹ Where available, data or evaluations are also reported, but this report does not interpret whether these are positive or negative reflections of program effectiveness and impact.

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