

# Hospital Operations Toolkit for COVID-19

## Capacity:

### Supply Chain and Resource Management

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The COVID-19 pandemic stressed the healthcare supply chain in unprecedented ways. There has been high demand for personal protective equipment (PPE) and pharmacy, infection prevention, treatment, and diagnostic supplies and equipment ranging across diverse products from disinfectant wipes to Styrofoam trays to renal replacement supplies. While part of this demand is caused by perceived or actual need within the healthcare industry, demand has also been driven by non-healthcare purchasing to protect essential workers and the general public. Requirements of minimum days on hand supply of certain PPE and other products imposed by some states further add to demand.

In addition to the increased demand, the supply chain has been constrained by production challenges. Prior to the pandemic, hospitals and other purchasers relied on just-in-time delivery of products. Manufacturers needed time to scale up their production lines to meet a sudden surge in demand. Early patient surges in countries including China and Italy affected the production workforce. Global shipping networks continue to face challenges from overseas work stoppages due to virus outbreaks and congestion at U.S. ports creates backlogs in container ships waiting to unload imported cargo. Raw materials necessary for some products continue to be in short supply. Diagnostics needed to be created and potential treatments required review before production could expand.

Adding to the supply and demand challenges are alterations to usual supply chain operations. The U.S. federal government made large purchases of some supplies to allocate across the country to hospitals and jurisdictions based on need; some states have similarly made large purchases. These large-scale purchases added competition to the strained supply chain. The Defense Production Act was used to increase domestic capacity of certain products. The U.S. Food and Drug Administration (FDA) issued emergency use authorizations (EUAs) to enable the use of new products and existing products for new uses. Makers and non-traditional manufacturers are using 3D printing and other innovative methods to produce new products. Brokers and unknown suppliers have entered the healthcare market, driving up costs and leading to concerns about counterfeit, substandard, and fraudulent products. Hospital supply chain staff have expended significant time and effort vetting new products and suppliers.

While many issues have improved over time, these supply chain challenges require hospitals to be aware of current and anticipated shortages and thoughtful and innovative in their approaches to acquire and manage products.

## General Supply Chain Resources

- American Society of Health-System Pharmacists: [Current Drug Shortages](#)
- American Society of Nephrology: [COVID-19 Toolkit for Nephrology Clinicians: Preparing for a Surge](#)
- ASPR TRACIE:
  - [COVID-19 Supply Chain Resources](#)
  - [COVID-19: Healthcare System Operations Strategies and Experiences](#)
  - [Partnering with the Healthcare Supply Chain During Disasters](#)
- Food and Drug Administration: [Medical Device Shortages During the COVID-19 Public Health Emergency](#)
- Health Industry Distributors Association:
  - [Building a More Robust Supply Chain: A Public-Private Framework to Create a Pandemic Response Infrastructure](#)
  - [COVID-Driven Demand Created Supply Problems That Have Challenged the Supply Chain](#)
  - [Demand Planning Roadmap: Competencies and Characteristics for a Highly Resilient Supply Chain](#)
  - [Lessons Learned: A Path Forward for Pandemic Planning](#)
- Hick, J.: [Critical Care Planning – COVID-19 Quick Notes](#)
- Kaiser Permanente Northern California: [COVID-19 Hospital Surge Playbook](#)
- The National Academies of Sciences, Engineering, and Medicine: [How Can Hospitals Overcome Staffing and Supply Shortages Amid COVID-19 Surges?](#)

## Selection and Acquisition

Hospitals should start with their established and trusted supplier relationships when seeking to procure products during the COVID-19 pandemic. Hospitals can consider the following steps:

- Determine what supply chain resources may be available if the hospital is part of a larger health system that has greater purchasing power.
- Understand what procurement tools are available for the hospital to rapidly execute contracts or make large purchases.
- Establish a process to review, inspect, and test supplies to ensure they are effective and appropriate for their stated use. Inexperienced brokers and bad actors have introduced mislabeled, counterfeit, and substandard products into the market and misrepresented the intended use of other products.
- Connect with vendors and suppliers to discuss their projected ability to meet the hospital's supply needs.
- Follow-up with alternative sources identified by traditional supply chain partners if they are unable to meet needs.
- Borrow supplies such as gloves, masks, and disinfectant wipes from outpatient departments when their services are temporarily curtailed.

- Consider retail sources for supplies the hospital is not able to access through established healthcare distributors. Simple/procedure masks, gloves, barrier gowns, hygiene items, disinfectants, and cleaning products may be available.
- Work with the healthcare coalition (HCC) and other community response partners. There may be stockpiles available in the community, opportunities to share or exchange supplies based on needs, options for another entity to acquire items on the hospital's behalf, or the ability to enter into joint contracting or other purchasing partnerships that increase attractiveness as a buyer. This is particularly important for smaller hospitals, especially those in rural areas, that may not be able to compete with larger purchasers or have other resources readily available.
- Know what resources are available at the state and federal level and how the hospital may access them. Health departments, emergency management agencies, and other state government agencies may have stockpiles or initiated purchases during the pandemic. In addition to the Strategic National Stockpile, the U.S. government has made large purchases of items including ventilators, testing equipment and supplies, vaccines, and treatments such as monoclonal antibodies. Hospitals should understand what items may be allocated to them, what items may be requested, and the process for seeking access to these state and federally acquired resources.

Some items remain difficult to acquire regardless of sourcing efforts or willingness to pay. In some instances, hospitals substitute different items, but this requires an assessment of the trade-offs and potential risks of using an other-than-usual product.

The [Crisis Standards of Care](#) section has additional information on circumstances that may influence the use of some of these strategies.

- Re-useable (washable) gowns offer an advantage over disposable gowns in waste disposal and cost overall when the facility has the option. Fluid resistance may degrade with washing and should be re-assessed at regular intervals.
- Imported respirators used under an EUA may not pass fit-testing. Obtaining sample masks and fit-testing them is critical prior to purchasing large quantities of a new respirator.
- Many products are not approved for export from foreign countries if labeled for medical use. Therefore, many items such as gloves that have specifications appropriate for medical use (e.g., nitrile, 2-4mil thickness, beaded cuff) may not carry such labels but be adequate for medical applications.
- Some hospitals have successfully transitioned to using elastomeric half-mask and full facepiece air purifying respirators or powered air purifying respirators instead of N95 respirators, at least for some procedures. These alternative respirators may be easier to acquire, but hospitals should plan for required training on their proper use, purchase of replacement filter canisters and cartridges (which may have their own supply challenges), rapid fit testing, and acceptance by staff.
- If not available commercially, dialysate for continuous veno-venous hemodialysis can be produced on-site.

- To be successful, substituted products must be accepted by staff, which requires training staff on the proper use of the product, describing how it compares to the usually-used product, and explaining the factors that led to the substitution.

When hospitals are unable to acquire needed equipment, they may be able to repurpose other items they already have or can easily access. This is often a temporary solution until better options become available. For example, some anesthesia machines can function as ventilators and some BiPAP machines can be configured to provide pressure support ventilation.

- Work with respiratory therapists and vendors to determine potential uses and agree when each option would be invoked.
- Determine the specific adaptations required for each device and write “tip sheets” as needed including initial settings, troubleshooting, alarm actions, and caveats.
- Determine if any licensing or EUA issues exist governing the use of the device.
- Ensure staff are trained and understand how to use repurposed devices and equipment.

Those hospitals that worked with trusted supply chain partners to vet new suppliers were most successful in mitigating costs and securing quality products. Other strategies hospitals have used to reduce the associated risks during supply chain challenges include:

- The HCC or other community partners may be able to share advice on product selection or feedback on experiences with various vendors or products.
- Government agencies and other organizations maintain lists and other information on vetted suppliers and products that hospitals can refer to when researching options, though these are challenging to keep up-to-date and hospitals should not rely on their accuracy.
- If purchasing through a third party, verify lot numbers with the manufacturer whenever possible to rule out counterfeit products.
- Hospitals should be aware of warning signs identified by government agencies and know how to report fraudulent items to protect other purchasers.

### *Resources Related to Selection and Acquisition*

- American Society of Anesthesiologists and Anesthesia Patient Safety Foundation: [APSF/ASA Guidance on Repurposing Anesthesia Machines as ICU Ventilators](#)
- Association for Health Care Resource & Materials Management: [Vetted Non-Traditional Suppliers Offering PPE and Other Supplies and Services](#)
- ASPR TRACIE: [COVID-19 Regional Support Resources Topic Collection](#)
- Burgner, A., Ikizler, T., and Dwyer, J.: [COVID-19 and Inpatient Dialysis Unit: Managing Resources during Contingency Planning Pre-Crisis](#)
- Centers for Disease Control and Prevention:
  - [Optimizing Personal Protective Equipment \(PPE\) Supplies](#)
  - [Resource Guide on How to Respond to Problems with Purchasing Needles for Influenza and Other Routine Vaccinations](#)

- Columbia/New York-Presbyterian: [Dialysate for CVVHD](#)
- Federal Emergency Management Agency: [Respirators for Healthcare during COVID-19: Authorized Use & Avoiding Fraudulent Products](#)
- Food and Drug Administration:
  - [Considerations for Selecting Respirators for Your Health Care Facility](#)
  - [Emergency Use Authorization](#)
  - [FAQs on the EUAs for Non-NIOSH Approved Respirators During the COVID-19 Pandemic](#)
  - [Postmarketing Adverse Event Reporting for Medical Products and Dietary Supplements During a Pandemic](#)
  - [Testing Supply Substitution Strategies](#)
- National Institute for Occupational Safety and Health:
  - [Counterfeit Respirators/Misrepresentation of NIOSH-Approval](#)
  - [NPPTL Respirator Assessments to Support the COVID-19 Response](#)
  - [Understanding the Use of Imported Non-NIOSH-Approved Respirators](#)
- National Institutes of Health/National Institute of Allergy and Infectious Diseases, Food and Drug Administration, Veterans Healthcare Administration, and America Makes: [COVID 3D Trust: Trusted Repository for Users and Suppliers through Testing](#)
- U.S. Department of Justice, National Center for Disaster Fraud: [Disaster Complaint Form](#)
- University of Michigan Medicine: [Connectology for Emergent CRRT Dialysate Solution Preparation Using In-house Supplies](#)
- Yale New Haven Health: [Personal Protective Equipment \(PPE\)](#)

## Allocation and Inventory Management

Hospitals require situational awareness of their supply usage, inventory, and projected needs to inform purchasing decisions.

- Those hospitals that are part of a larger health system may be able to rely on enterprise logistics for central purchasing, allocation, and inventory management.
- Following the incident command structure can improve logistics and supply accountability.
- Hospitals should estimate days on hand supply of PPE, pharmaceuticals, mortuary, and other supplies and equipment that may be affected by shortages. Various tools are available to aid hospitals in determining their usage patterns, burn rates, and projected needs.
- Many hospitals developed “dashboards” to track the status of their critical supplies.
- Establishing triggers for the implementation and loosening of preservation strategies can help hospitals maintain predictable inventory levels.
- Issuing guidelines on utilization and management of various resources to inform staff, make allocation decisions, or suggest alternatives to traditional use can help facilities maintain inventory and awareness.
- Some supplies require additional security control measures to manage access to inventory. Hospitals should identify which resources need additional oversight and tracking.

Hospitals should identify supplies essential to their operations and consider whether some level of stockpiling may minimize disruptions to their supply chain.

- Stockpiles may enable ongoing access to some critical supplies.
- Due to continued demand during the pandemic, it may be impossible for hospitals to purchase many products in quantities sufficient for stockpiling.
- Stockpiling by large purchasers in anticipation of future needs may impede the ability of small hospitals and other healthcare facilities and providers to purchase products they need currently.
- Space is at a premium as hospitals continue to experience surges in patients. Hospitals need to consider storage options, including environmentally controlled areas for consumables, cold chain requirements for vaccines, and security requirements for monitoring.
- Expiration dates are another important factor for hospitals to consider, particularly when purchasing products that were not used at high volumes prior to the pandemic.

Other options include establishing backup vendor arrangements to normal suppliers and working with the HCC and other community partners on sharing arrangements. Certain equipment and supplies are not needed by all hospitals at all times. Identifying what may be available as part of a health system or as a regionally-held asset and the process for accessing it can reduce overall stress on the supply chain.

### *Resources Related to Allocation and Inventory Management*

- AABB: [Extending the Blood Supply - 10 Tips for Hospitals](#)
- American Hospital Association: [Dynamic Ventilator Reserve](#)
- American Society for Health Care Engineering: [Medical Air and Oxygen Capacity Assessment Tool](#)
- American Society of Health-System Pharmacists: [Patient Surge Management During a Pandemic: Toolkit for Hospital and Health System Pharmacy](#)
- ASPR:
  - [ASPR's Response to COVID-19](#)
  - [Strategic National Stockpile](#)
  - [Veklury \(remdesivir\)](#)
- ASPR TRACIE: [Hospital Personal Protective Equipment Planning Tool](#)
- Beth Israel Lahey Health: [CODE VENT Triage Plan to Manage Scarcity of Ventilators During a Public Health Emergency](#)
- Centers for Disease Control and Prevention:
  - [Personal Protective Equipment \(PPE\) Burn Rate Calculator](#)
  - [Strategies to Allocate Ventilators from Stockpiles to Facilities](#)
- COVID Staffing Project: [Daily PPE Calculator](#)
- Food and Drug Administration: [Information for Health Care Facilities and Providers on “In-Use Time”](#)
- Hackensack Meridian Health: [COVID-19 Medication Shortage Management Strategies](#)
- Health Industry Distributors Association:

- [90-Day PPE Stockpile Mandates Increase Shortages and Drive Up Costs](#)
- [What Does “Allocation” Mean in the Healthcare Supply Chain?](#)
- Kaiser Permanente: [Medical Air and Oxygen Capacity](#)
- Massachusetts General Hospital: [Procedure to Maximize the Effectiveness of Ventilator Distribution Across States](#)
- National Institute for Occupational Safety and Health: [PPE Tracker App](#)
- National Emerging Special Pathogens Training and Education Center:
  - [Supply Management and Inventory Control Webinar – Part 1](#)
  - [Supply Management and Inventory Control Webinar – Part 2](#)
- Stevens, J., Toma, K., Tanzi-Pfeifer, S., et al: [Dashboards to Facilitate Nephrology Disaster Planning in the COVID-19 Era](#)
- The University of Mississippi Medical Center:
  - [Blood Product Utilization Guidelines](#)
  - [Medication Conservation Guidelines](#)
- Yale New Haven Health: [Personal Protective Equipment \(PPE\)](#)

## Preservation

In addition to the substitution and repurposing considerations previously mentioned in the Selection and Acquisition section, the supply chain shortages resulting from the COVID-19 pandemic required large-scale implementation of preservation strategies – particularly for PPE – that most hospitals would not normally employ. Hospitals should be aware of guidance by the Centers for Disease Control and Prevention and other organizations on optimizing the use of respirators and facemasks, gowns, eye protection, and gloves and determine which approaches are feasible in their facilities. On April 9, 2021, the federal government determined that the respirator supply chain improved enough to recommend shifting back toward conventional use.

The [Engineering Controls](#) and [Administrative Controls](#) sections include information on ways that hospitals can reduce their reliance on PPE for infection control, thereby reducing overall PPE use.

Preservations strategies for PPE include:

- Using expired products, most often during training. N95 respirators have a manufacturer-designated shelf life while facemasks, gowns, eye protection, and gloves may or may not have labeled expiration dates.
- The extended use of N95 respirators, facemasks, gowns, eye protection, and gloves with multiple patients without removing the PPE item between encounters. Practicing hand hygiene between patients is essential with extended use of gloves.
- The reuse of N95 respirators and facemasks by wearing the same item for multiple patient encounters but removing and storing the item between patients. Reusable gowns may also be

Additional information on considerations to drive these preservation strategies is available in the [Crisis Standards of Care](#) section.

used when dedicated for use during multiple encounters with a single patient or when laundered between different patient encounters.

- Combining PPE items. Staff in many hospitals wear facemasks over their N95 respirators to keep the latter clean of droplets.

Hospitals implementing preservation strategies should establish accompanying policies identifying criteria (e.g., soilage, ill fit) that require immediate replacement of a PPE item as well as specifying the maximum length of time items should be worn under extended use and the maximum number of times items should be reused.

Some mask disinfection strategies (e.g., UV, hydrogen peroxide) have been used by various health systems to enable reuse of items. While these strategies have been successfully applied in some health systems and facilities, in many cases, the logistics of disinfection and return to the worker negated the benefits to the strategy. In particular, many staff lacked confidence that the disinfected items were their own and not previously used by others.

As supply improves, hospitals should move toward more liberal usage (e.g., reducing the degree to which N95 respirators must be conserved). This may involve specifying a maximum number of shifts or instances of use and adjusting these numbers as supply grows.

The [PPE](#) section has additional information on staff safety related to substitution, use of expired products, extended use, and reuse of items.

### *Resources Related to Preservation*

- ASPR TRACIE: [COVID-19: Optimizing Healthcare Personal Protective Equipment and Supplies](#)
- Association of State and Territorial Health Officials: [Optimizing PPE Supplies with Decontamination and Reuse](#)
- Beth Israel Lahey Health: [Personal Protective Equipment Guidance](#)
- Centers for Disease Control and Prevention: [Optimizing Personal Protective Equipment \(PPE\) Supplies](#)
- Cleveland Clinic: [PPE](#)
- Federal Emergency Management Agency: [Coronavirus \(COVID-19\) Pandemic: Personal Protective Equipment Preservation Best Practices](#)
- Healthcare Resilience Working Group: [PPE Preservation Planning Toolkit](#)
- National Emerging Special Pathogens Training and Education Center: [PPE \(COVID-19\) Use and Conservation](#)
- Nebraska Medicine: [Personal Protective Equipment \(PPE\)](#)
- Spectrum Health: [Personal Protective Equipment](#)
- University of California San Francisco: [Personal Protective Equipment \(PPE\)](#)
- University of Kentucky HealthCare:
  - [Guidance for the Reuse and Extended Use of Masks](#)
  - [Guidance for the Reuse and Shared Use of PAPR Hoods](#)



- U.S. Food and Drug Administration: [FDA Recommends Transition from Use of Decontaminated Disposable Respirators](#)
- Yale New Haven Health: [Personal Protective Equipment \(PPE\)](#)

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