Project description

From June 2020 - June 2021, members of Massachusetts General Hospital Center for Disaster Medicine and the MIT Humanitarian Supply Chain Lab conducted a year-long research project to support public health planners in creating a state-level emergency stockpile of personal protective equipment (PPE) for healthcare workers. The research revealed opportunities for policy makers and emergency management professionals to improve PPE preparedness for the next pandemic. These opportunities are outlined below.

Recommended preparedness steps

The steps below should not be seen as one-time items on a checklist, but rather as recurring processes that are revisited and adjusted over time. Each piece of this list builds on each other, and all components are required to form a cohesive approach. Each step relates to key findings in our research described in page 2-3 of this report.

Create emergency preparedness plans that allow you to quickly pull policy levers to adjust PPE demand (key lesson 1)

- Evaluate current guidance for cohorting patients in healthcare facilities
- Evaluate current emergency PPE reuse guidance
- Encourage facilities to create alternate care pathways to decrease in-person patient visits where appropriate
- Look for opportunities to decrease diagnostic testing turn-around times in emergencies, including a plan to support the demand surge for ancillary testing supplies

Invest in facilitating and understanding facility supply plans (key lesson 2)

- Create avenues for facilities to share information on PPE supply chains with each other and with government planners
- Encourage or mandate minimum facility PPE stockpiles
- Facilitate the creation of contingency supplier contracts for facilities with low non-pandemic demand or limited resources

Invest in a dynamic emergency stockpile (key lesson 3)

- Invest in human capital to monitor the emergency stockpile, place orders with suppliers, and reassess stockpile levels
- Create contingency agreements with suppliers

Maintain and improve situational awareness for preparedness planning

- Simulate demand for different pandemic scenarios and incorporate the results into the PPE preparedness planning process
- Plan for regular readiness reviews that revisit and update old assumptions
- Coordinate with other agencies to prevent redundancies in PPE preparedness

Research process

Our research followed the three steps shown in Figure 1 and covered acute care hospitals, long term care facilities, emergency medical services (EMS), inpatient behavioral health, and dental facilities. Our key findings are below.

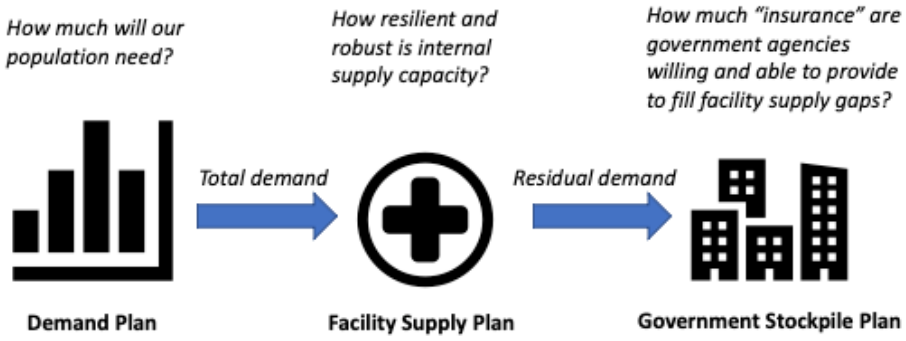

Figure 1: Research process

Key lesson 1: Facilities can decrease PPE demand by implementing conservation policies

Many policy interventions below were implemented during COVID-19, but were not adopted uniformly across facility type. Deliberate use of these policy interventions can decrease PPE demand during shortages.

- **Cohort COVID-19 patients so they can be treated by a small group of designated healthcare staff:** Cohorting patients decreases demand for N95s and eye protection because it minimizes the number of unique staff members who are required to wear PPE. Perfect cohorting can decrease N95 use by 47% in acute care hospitals, 92% in assisted living facilities, and 95% in skilled nursing facilities.
- **Increase length of PPE reuse policies for N95s and eye protection:** Increasing reuse policies has a linear effect on N95 and eye protection demand. For example, increasing N95 reuse from one use to five uses can decrease N95 demand by up to 80% depending on policy adoption and behavioral factors.
- **Decrease daily staff to patient contact rate:** Decreasing the number of times staff interact with a patient each day limits the number of gown and glove changes required by staff members and has a linear effect on gown and glove use. Decreasing staff to patient contact rate by 50% results in a 50% decrease in gown and glove use across all facility types.
- **Decrease turnaround time for diagnostic testing:** Decreasing turn-around times means fewer patients classified as Persons Under Investigation (PUI) and treated with full PPE. For example, decreasing COVID-19 test turnaround time from 2 days to 1 day decreases N95 use by 22% in skilled nursing facilities.

Key lesson 2: Robust healthcare facility supply plans can greatly decrease the preparedness investment for government agencies

Government stockpiles should be prepared to cover the PPE demand that facilities are unable to cover themselves, also known as residual demand. Empowering facilities to be prepared

using the approaches below will allow facilities to better absorb their own demand surges without stocking out and decrease the residual demand seen by government agencies.

- **Ensure robust facility stockpiles:** All facilities we interviewed had implemented a PPE stockpile by April 2021, but the plans varied widely among facilities. Many facilities expressed plans to decrease stockpile size in the near future due to cost concerns. Ensuring that facilities' internal stockpiles remain robust would decrease total requests for external assistance and delay requests to later in the pandemic, providing planners with valuable time. With COVID-19 facility stockpiles preserved, for a similar pandemic the residual demand seen by government agencies would begin 40-70 days later and result in half of the cumulative residual demand over 6 months.
- **Improve facility supplier relationships:** During shortages, suppliers limit the amount of product they send to each of their customers. Securing higher supplier allocations allows facilities to replenish their own supplies in an emergency, decreasing the need for external assistance. This may be especially difficult for facilities with low PPE demand during normal operations, such as long-term care, and may need to be facilitated by the government. Ensuring supplier allocations for all facility types are able to cover PPE demand on the average PPE use day during COVID-19 can completely eliminate residual demand seen by government agencies.

Key lesson 3: Government agencies reduce stockpile investment with active stockpile planning and management

Dedicating time and human capital to maintain a dynamic stockpile results in lower levels of PPE investment. Ongoing effort to maintain readiness through the following activities are recommended. Annex A of this report contains an expanded framework on how to choose an initial stockpile level that can be used to supplement the key lessons below.

- **Create a reorder plan:** Designating personnel to monitor and reorder product can decrease required stockpile level by 36-72% depending on PPE type.
- **Decrease product lead times:** Setting up agreements with suppliers to decrease lead times decreases required stockpile levels. Decreasing lead times from 8 to 6 weeks can decrease required stockpile level by 15-25%.
- **Reassess stockpile levels:** Preparing for a pandemic similar to COVID-19 but being met with a pandemic 5X worse than COVID would result in 59-111 stock out days depending on PPE type. Preparing for a pandemic that is 5X worse than COVID but being met with a pandemic similar to COVID-19 would result in over 225 million excess PPE items. Planners must rapidly adjust stockpile levels as the situation progresses to prevent stockouts or excess items.
- **Anticipate residual demand:** Instead of waiting for formal requests for assistance, anticipate demand and place replenishment orders in advance. Anticipating demand two weeks prior to the first request for assistance can decrease required stockpile level by 15-25%.

If you have any questions or comments about this document, please contact Jarrod Goentzel goentzel@mit.edu.

Annex A: Creating a framework for pandemic stockpile decisions

Policy makers must make difficult risk calculations when determining how to allocate limited resources towards emergency preparedness. The current focus on pandemic preparedness has spurred significant investment in state and local level emergency PPE stockpiles. When determining how to allocate these funds, decision makers should systematically review their assumptions and risk tolerance for each PPE item so they can both make informed stockpile decisions and communicate those decisions to the population they will support. We propose viewing a stockpile quantity decision as similar to purchasing an "insurance policy" that is meant to provide you coverage for different pandemic scenarios. Pandemic scenarios should include the following inputs:

- **Amplification of demand:** The severity of COVID-19-type pandemic that is being covered.
- **Healthcare facility stockpile size:** The anticipated state of healthcare facility internal stockpiles at the onset of the next pandemic.
- **Supplier allocations to facilities:** The percent of average daily COVID-19 demand that facilities can procure from the market. This is a crude assessment of the general ability for the market to meet COVID-19 level demand.
- **Government inventory policy:** The inventory management practice the government will follow for their stockpile.
- **Coefficient of variation:** The standard deviation of demand over the mean demand.
- **Ratio of cost of stocking out to the cost of overstocking**
- **Number of stockout days in a six-month period**
- **Lead time:** Weeks from the placement of a stockpile resupply order to the resupply arrival.

Table 1 outlines an example framework with these inputs, but many possible "insurance policy" configurations could be created from the inputs above.

Table 1: Example stockpile options

	Budget policy	Standard policy	Higher protection policy
Amplification of demand	1X COVID-19	1X COVID-19	1X COVID-19
Healthcare facility stockpile size	Post-COVID-19	Post-COVID-19	Pre-COVID-19
Supplier allocations to facilities	50-75%	20%	0%
Government inventory policy	Base stock, deterministic	Base stock, deterministic	Single period, stochastic
Coefficient of variation	N/A	N/A	0.2
Ratio of cost of stocking out to cost of overstocking	N/A	N/A	5:1
Number of stockout days in 6 month period	1	1	N/A
Lead time	8 weeks	8 weeks	N/A

Note: the shading indicates differences from the Standard policy.