COVID-19: Supply Chain Challenges and Research Opportunities

Benjamin Melamed
Bill McLaury
Fred Roberts

Command, Control, and Interoperability Center for Advanced Data Analysis (CCICADA)
Rutgers University

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Medical Supplies, Testing Materials, Vaccines: Issues and Solutions

- **Issue:** Medically-related supplies sourced from foreign suppliers *(e.g., China)* are vulnerable to disruption, especially in pandemics
  - *Pharmaceutical products*, mainly active pharmaceutical ingredients (API)
  - *Medical supplies*, such as vaccines, PPEs, disinfectants, syringes, etc.
  - *Medical equipment and devices*, such as ventilators, X-Ray machines, etc.
- **Broad solution:** Declare selected medically-related supplies as strategic
  - Mandate that a set percentage be manufactured in the USA
  - US manufacturing to have rapid ramping-up production capabilities
  - Diversify the supplier base of each strategic product
  - Stockpile federal and state strategic reserves of each strategic product
  - Sign option contracts to supply each strategic product in case of emergencies
  - Develop contingency distribution plans for emergencies

Medical Supplies, Testing Materials, Vaccines: Research Topics

Problems: Need solutions for the following

- Develop product acquisition plan *(inventories sizing, shelf life control, stockpile geolocations, supply option instruments)*
- Develop distribution algorithms to allocate product *(private/public logistics, prioritization of shipments)*
- Compile logistics costs *(acquisition/restocking, storage, inspection, transportation, etc.)*

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Contingency Plan Coordination

- **Issue:** Coordination of contingency plans
  - Companies have private contingency plans largely unknown to government
- **Broad solution:** Setting up of a *Public-Private Contingency Planning and Coordination Council*
  - Government to mandate sharing of the contingency plans with the Council and a schedule for periodic revalidation and update of the contingency plans
  - Council to coordinate with CDC, FDA, FEMA, DoD
    - other agencies ?

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Vaccines

Vaccines have additional issues requiring special considerations

- Multiple vaccines have different efficacies
- Some have different requirements *(e.g., refrigeration)*
- Adaptive distribution strategy needed to respond to development and production of new vaccines
- Uncertainties in pathogen mutations and outbreaks call for specialized distribution algorithms *(who gets what and in what order)*

Pharmaceutical Supplies

Pharmaceuticals have additional issues

- API have longer shelf life than the drugs they constitute
- Once a drug is dosed, the expiration clock starts ticking toward the expiration date
- How much to store as API and how much as finished products?
  - Replenishment lead-time will be a factor
  - Stockpiling of API provides added risk pooling flexibility as API can be converted into different dosage forms *(e.g., tablets, capsules, injecibles, etc.)* and different strengths
- Where to preposition?
- Need to model costs of storage, inspection of supplies, restocking, etc.
- Need models to specify the terms of supply options

Role of IT/AI

- Technology is a cross-functional driver that can increase **efficiency** and **responsiveness** simultaneously, thereby reframing tradeoffs as win-win propositions
- AI/Machine learning allows more accurate prediction of demand
  - Enables lower inventories (efficiency) and just-in-time deliveries (responsiveness)
    - But lean inventories are vulnerable to black swan events
  - Need models to articulate the tradeoff between efficiency and resilience and identify win-win technology-driven solutions
  - Can tools such as blockchain help with supply chain visibility and early warnings of impending shortages?
- IT/AI for lowering Lead times
  - Since shorter lead times *(faster replenishment)* reduce the dependency on accurate forecasting, develop concepts/tools/models for lowering lead times
  - How to fund expedited *(and costlier)* deliveries in case of emergencies?

Role of IT/AI (Continued)

- Logistical resources
  - To optimize logistic operations, we need to understand them and their requisite resources *(manpower, machinery, IT support, etc.)*
  - Are machinery and workers interchangeable for different tasks?
  - Can automation/robots replace people?
    - More so in chemical manufacturing, but less so in pharmaceuticals

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Proposed Research Initiatives

- Development of **rigorous models** that can help **reposition supply chains of pandemic-related pharmaceuticals and medical equipment** as strategic national assets constituting a balanced portfolio of public and private assets and capabilities
- Formation of an information-sharing and collaborative platform that facilitates **coordinated contingency planning** of supply chains for strategic national assets
- Establishment of a public, open source **knowledge repository** that provides models, best practices, data, and white papers that focus on providing scientific and sustainable solutions for pharmaceutical and medical equipment supply chains
- Creation of **intelligent technological/analytics solutions** that uncover win-win supply chain strategies, where efficiency and resilience / responsiveness can be improved simultaneously

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Questions?

- Further information contacts
  - Ben Melamed: melamed@business.rutgers.edu
  - Bill McLaury: wmclaury@business.rutgers.edu
  - Fred Roberts: froberts@dimacs.rutgers.edu

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