

Facing disruption: Learning from the healthcare supply chain responses in British Columbia during the COVID-19 pandemic

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Abstract

The healthcare supply chain crisis surrounding Personal Protective Equipment (PPE) during the onset of the COVID-19 pandemic presented unique and complex challenges in achieving the primary aim of supply chain management, that is, delivering the right amount of the right supplies to the right people at the right time. This article describes the key findings from a case study on PPE supply chain responses to the COVID-19 pandemic in British Columbia (BC). It highlights a set of constructive response mechanisms to potential crises along healthcare supply chain. Effective and trusted leadership, a unity of purpose, integrated and robust digital infrastructure and capabilities, consistent learning, resilience building, and environmental sensing for reliable intelligence were found to be essential for preparing, for containing, and mitigating the crisis as it evolved across various phases of crisis management.

Introduction

The British Columbia (BC) healthcare system has five regional health authorities, one provincial service health authority as well as a First Nations Health Authority, all of which report to the Ministry of Health. On March 17, 2020, BC declared the COVID-19 public health emergency and a provincial state of emergency.^{1,2} These declarations acknowledged the disruption and challenges faced by the province and enabled the use of emergency powers and access to resource assets by the Public Health Officer (PHO), as set out in the Emergency Program Act and Public Health Act. A number of PHO orders came into effect immediately, including the suspension of in-class learning, social distancing requirements for restaurants and cafes, travel restrictions and isolation requirements, as well as measures related to hospital operations, Long Term Care (LTC) facilities, casinos, and mass gatherings.³ The priority was to flatten the curve of infections as quickly as possible to protect the population, vulnerable citizens, health workers, and healthcare capacity.

Against this backdrop, a personal protective equipment supply chain crisis loomed large.⁴ Buying only .2% PPEs from Canadian sources in March 2020,⁵ Canada relied heavily on other jurisdictions, which resulted in significant challenges in supply chain operations when PPE exports were banned. Personal protective equipment shortage consumed the attention of healthcare leaders and the public.⁶ A smoothly operating healthcare supply chain is one that goes unnoticed and simply provides people with what they need when they need it. However, behind the scenes, the process is complex and requires proper forecasting, sourcing, testing, storage, distribution, tracking and returns to work in unison. In healthcare, supply chain management has the primary responsibility of linking major functions and processes within the healthcare system and across organizations (eg, suppliers,

intermediaries, third party service providers, and frontline workers) into a cohesive and efficient network to deliver necessary products and services reliably. It includes the planning and management of all activities involved in sourcing, procurement, logistics, and information technology.

In BC, the Provincial Health Services Authority (PHSA) employs approximately 1,000 people across the province to work in supply chain shared services. The PHSA partner network consists of suppliers, warehouse operators, third party logistic providers, supply chain staff working in individual regional health authorities, and clinical safety teams across various healthcare units. All partners coordinate with the PHSA supply chain to ensure smooth operations.

This paper analyzes the response from BC's healthcare supply chain and leadership during the initial phases of the COVID-19 crisis. Examples from the BC pandemic PPE supply chain are used to illustrate what is at stake and what more can be done to prevent or mitigate negative impacts in the future.

Case study approach

From July to October 2020, the research team conducted 16 semi-structured interviews with 12 leaders from the Ministry of Health, Regional Health Authorities and Public Health Services Authority as well as two physician leaders and two key leaders from tier 1 suppliers (ie, vendors and distributors that work directly with PHSA). These informants were intimately involved in the public health and supply chain responses

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during the pandemic. Although the system was under duress with the pandemic, our informants were very willing to participate in the interviews to support future supply chain success for healthcare. The objective was to gain a BC-specific yet comprehensive perspective of the healthcare supply chain policies, processes, and infrastructure and to understand how they contributed to the health system capacity and the care outcomes for the British Columbians during the early stages of the COVID-19 pandemic, up to November 2020. The interviews were audio-recorded, transcribed, and reviewed by the researchers to identify key patterns and themes from the case data.⁷ We also consulted over 1,000 pages of secondary data, including BC government websites and publications, pandemic-related guidelines, allocation policies and white papers. In addition, a digital maturity survey at the provincial level using the Healthcare Information and Management Systems Society (HIMSS) Clinically Integrated Supply Outcomes Model (CISOM) was completed to inform our study.

Given the broad impact of the pandemic and the fact that multiple entities were involved with leading the efforts in effecting the pandemic responses, our approach focused on the following key areas: the health system and organizational design, supply chain function and processes, digital infrastructure tracking and health system capacity to deliver care and outcomes. We also used the crisis management phased framework⁸ depicted in Figure 1 to help track the ever-evolving responses of the healthcare supply chain to the pandemic. Although presented sequentially, these phases often follow a non-linear iterative pattern. For example, a second wave of community infection could disrupt the recovery phase after the first wave appears to be contained and normality starts to return, therefore delaying efforts in prevention and preparedness. This phased analytical framework is useful for characterizing different responses and providing a temporal reference for understanding the complex interactions among the healthcare supply chain actors, thus helping identify the primary focus through which leaders can influence the outcome across phases.⁹

This BC-specific case study approach allowed us to uncover not only weaknesses in the responses but also factors that contributed to the effective crisis response management in BC,

such as PHSA's role in enabling centralized PPE inventory management and data-driven decision-making. Applying the crisis response management framework to understanding the strengths and weaknesses in the BC context yielded concrete examples to health leaders regarding how these factors may be integrated to better prepare for and manage future crisis.

Although this case study approach met our research objectives by providing a holistic, rich, and nuanced account of the BC healthcare supply chain responses regarding PPE shortage and contributing to knowledge on crisis management, there are several limitations. These limitations include, (1) challenges with generalizing results to geographic areas beyond BC, (2) subjectivity inherent in qualitative interviewing, (3) absence of hypothesis formation at the outset of the project, and (4) difficulty in replication due to access to informants, time, and cost.

Analysis of the responses of the BC healthcare supply chain

The pandemic caused unprecedented challenges across the world that threatened the ability of healthcare systems to function properly. Healthcare systems and leaders worldwide were forced to prioritize care or pause non-emergency services in anticipation of surges, and the reliance of healthcare systems on global supply chains was pushed to the forefront.

In BC, the Ministry of Health and the Provincial Health Office led the COVID-19 response efforts in this complex and uncertain environment. Early health outcome reports were favourable to BC with outcomes during the first wave at a cumulated rate of 17.5 hospitalizations/100,000 people and 5 deaths/100,000 people as of October 17, 2020.¹⁰ As of November 2, 2020, BC had experienced 515 infections and 151 deaths among long-term care and assisted living residents.¹¹ The following themes emerged from the interviews regarding BC's healthcare supply chain responses:

1. **Governance structure:** Existing governance structures with prior experience in emergency management, such as emergency operational centres or committees (EOCs) at the provincial and health authority levels, contributed to the quick mobilization of leadership and governance structures throughout the system.

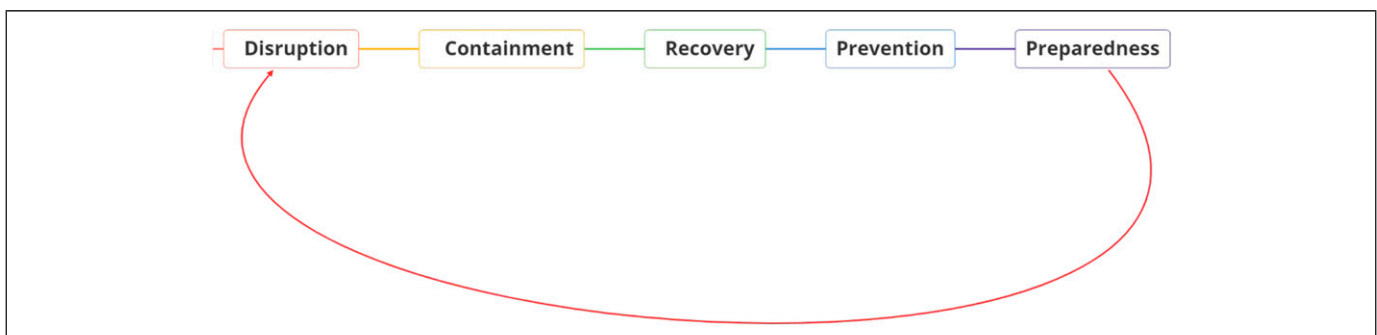


Figure 1. Supply chain crisis management phases (illustration developed by the authors based on Holla et al.⁸).

2. **Decision-making:** Early and decisive actions, such as centralized pandemic inventory management mandated by the PHSA, collaboration between PPE suppliers, pre-emptive hospital capacity planning, and long-term care staffing guidelines, supported the response to the first wave of the pandemic in BC.
3. **Digitalization:** Digital dashboards consolidated, integrated, and disseminated up-to-date and accurate inventory information to internal decision makers at ministries, regional health authorities, and healthcare departments and provided information on the distribution of PPE inventory as the situation evolved.
4. **Leadership stability:** The stability of the leadership and relatively consistent public health policies in BC supported broad-based and timely decision-making that is essential during times of crisis.

Table 1 presents a thematic analysis summary of the healthcare supply chain responses by the BC healthcare system from the pandemic onset up to November 2020. The next section highlights the insights from **Table 1** by describing the BC healthcare supply chain crisis response organized into four key areas: (i) leadership, governance, and decision-making; (ii) supply chain response; (iii) sourcing

Table 1. Summary of BC healthcare supply chain response to the COVID-19 pandemic.

Response of British Columbia healthcare supply chain to COVID-19 Pandemic			
Leadership, governance and decision-making	Supply chain response	Sourcing and procurement strategies	Data and digital infrastructure
The introduction of the EOC structure infused the system with much needed role clarity and accountability	The initial decentralization of procurement and inventory management policies caused different levels of inefficiency, ineffectiveness, and potential for PPE shortages	Sourcing was fragmented with minimal central coordination. PHSA had several established contracts with domestic suppliers, and health authorities managed their separate contracts	Data timeliness and data transparency across regions was an initial issue
The system was reliant on individual relationships, rather than purposeful structures for trust and communication networks	Scenario-based decision-making was necessary to prepare for evolving novel crisis	Existing procurement policies and practice created barriers for suppliers integration into healthcare system supply chains	Centralization through the preliminary development of a provincial data dashboard, displaying inventory, and other key data, did evolve overtime, but transparency continued to be a problem
Right data and right timing informed the right decisions to support effective care	For historical reasons, BC did not develop integrated and comprehensive healthcare supply chain disruption scenarios	An all-out strategy characterized this phase as federal, provincial, and local health authorities competed nationally and internationally to secure critical supplies of PPE and other essential material	Interoperability across all systems involved in supply chain and connectedness of underlying supply chain IT infrastructure needed to be increased
Healthcare supply chains lacked agility to support all parties involved to be creative and innovative in addressing ever changing circumstances	An early warning system would have been useful to detect or predict future disruptions and support collective responses	Early issues with decentralization for inventory management created inefficiency and ineffectiveness related to PPE. This was exacerbated by historic procurement policies and procedures that created barriers to solution building with supply chain partners	Need for increased data analytics and accurate forecasting to support decision-making
An expanded definition of collaboration emerged to include more broad-based external and internal actors to contain the crisis, solve unforeseen problems, and maintain business continuity	Lack of protocols and standards to support crisis-action decision-making process Crisis raised the bar for stability in structure, policy, and leadership roles required for healthcare delivery Several stakeholders lacked a shared awareness about the healthcare supply chain as a critical determinant of the provision of care	Awareness of supply chains and their importance was limited in the healthcare system. This was evident by the lack of stockpiles and scenario planning and early warning systems to detect or predict supply chain sensitivity	Data standardization, data quality, and data integrity were ongoing issues The centralization and aggregation of fragmented aggregation of fragmented supply chain data evolved over time

and procurement strategies; and (iv) data and digital supply chain infrastructure.

Leadership, governance, and decision-making

A salient theme emerged from the qualitative data involved the well-functioning structure through the EOCs and clear communication and escalation instigated by the leadership team. The BC Health System has longstanding senior leadership at the Ministry of Health and across the Regional Health Authorities, including Dr. Stephen Brown, the Deputy Minister of Health, and Dr. Bonnie Henry, the well-known BC PHO who has been recognized provincially, nationally and globally for her leadership and decision-making. These senior leaders had extensive experience with crisis leadership and the competencies required to lead during a healthcare crisis.^{12,13} This included Dr. Henry's experience during the 2003 SARS outbreak. Although the system leadership structures supported system-level decision-making, an absence of timely and accurate data created early challenges in effective decision-making at a clinical and operational level. BC had similar experiences to other provinces with the need to manage misinformation in order to protect PPE supplies, as well as to manage clinician concerns about the supply chain. Contributing to the confusion in the disruption phase, the system relied more on individual relationships rather than purposeful structures. As a solution, BC introduced an Emergency Operations Committee (EOC) at the beginning of the pandemic, based on their extensive experience in using EOCs during the annual provincial wildfires. The EOC infused the healthcare system with much needed role clarity, accountability, and integration to crisis containment. Overall, an expanded understanding of collaboration emerged to include more broad-based external and internal actors to contain the crisis, solve unforeseen problems, and maintain business continuity.

Supply chain response

The COVID-19 pandemic highlighted the critical role of the healthcare supply chain in determining the provision of care. Our informants shared that essential healthcare supply chain policies and processes such as inventory management were primarily implemented at the regional health authority level prior to the disruption. For example, 50% of our informants explained how the pandemic stockpile including PPEs should have been developed and maintained by individual regional health authorities after the SARS pandemic in 2003, yet only one out of the five regional health authorities had a pandemic stockpile at the start of the COVID-19 pandemic. This regional approach to supply chain management also contributed to the lack of supply chain visibility at the provincial level, which necessitated an all-out effort in announcing new mandate, protocols, and standards in the early days of the disruption phase to support decision-making across all levels of the healthcare system. These efforts were necessary to address the anticipated PPE shortages based on scenario analysis of surges in other parts of the world including Italy and Wuhan. The

effectiveness of these efforts could largely be attributed to the EOC leadership structure and prior experience in managing crises during a state of emergency. At the same time, several of our informants acknowledged the confusion and anxiety experienced by the frontline as the PPE guidelines continuously updated. This confirmed that leaders must engage in constant updating and lead with empathy in a fast-moving crisis fraught with uncertainty.¹³ Later, the containment of the initial disruption allowed the stakeholders of the BC healthcare supply chain to reflect on the responses and recognize the vital importance of having an integrated healthcare supply chain. It has become apparent that ongoing efforts are needed to develop tighter supplier integration, deeper collaboration between supply chain and healthcare providers, and the need for an early warning system to defend against future disruptions.

Sourcing and procurement strategies

A frantic and fragmented approach to sourcing and procurement at the beginning of the pandemic was quickly replaced with a coordinated approach in BC. Early issues with decentralization for inventory management created problems with the efficiency and effectiveness of PPE management. This was exacerbated by historic procurement policies and procedures that created barriers to integrating and coordinating solutions with supply chain partners. The awareness of supply chains and their importance was limited in the healthcare system, which was evident by the lack of stockpiles, scenario planning, and early warning systems to detect or predict supply chain sensitivity. Realizing the issues, BC healthcare leaders, EOCs, and PHSA started coordinating their response and actions. Measures were taken to ration available supplies, create centralized inventory holding spaces to control the consumption rates of the critical supplies, and to coordinate supplies and extended supply chain services to all healthcare sites, including most LTC facilities in the province that had not been traditionally part of the Regional Health Authorities. Trust in the ability of PHSA to fulfil orders grew. Several key suppliers helped by prioritizing public health and proactively providing PHSA and other healthcare organizations with updates on supply availability and upstream supply chain disruptions. In response to the pandemic, non-traditional health manufacturers switched to PPE production and increased local supply of PPEs.

During the containment phase, decision-making evolved from being a traditional function of the buying and the sourcing teams to a function of the supply chain team that involved PHSA and the regional health authorities to varying degrees, depending on their internal capacity. The BC experience suggested that, in addition to an early warning system and commitment to preparedness, the healthcare supply chain could have been enhanced by deliberative and crisis-action decision-making processes supported by protocols and standards. Our informants noted competition for PPE supplies during the early days of the pandemic, which

suggested opportunities for inter-provincial and national collaboration in sourcing and procurement.

Data and digital supply chain infrastructure

Having an effective digital infrastructure for supply chain management was identified early in the pandemic as being critical for developing an effective response to COVID-19. As can be seen in Table 1, issues related to the timeliness and transparency of supply chain data across regions were initially encountered. In response, the digital infrastructure for tracking and traceability to support supply chain management evolved considerably from the initial preparedness phase through to the disruption and containment phases. This evolution was characterized by a progression from information silos and isolated information resources to greater centralization through the development of a provincial data dashboard designed to display inventory and other key data from across regions. The dashboard was designed to be used by decision makers at all levels and was seen by stakeholders as being an important advance. However, other issues remained and required continued attention, including the need for greater interoperability across the many systems in the province, and for increased connectedness of the underlying supply chain IT infrastructure. In addition, stakeholders identified increased data analytic capabilities needed to enable decision makers to forecast PPE requirements more accurately. Additionally, greater standardization of supply chain data, and improved integrity and quality of data were also identified as ongoing needs.

Healthcare supply chain crisis management framework

The BC case study demonstrates that healthcare supply chains are complex, especially when essential supplies must be distributed rapidly and equitably. Complexity is increased by:

1. The composition, characteristics, and behavioural norms of response teams. The more complex the organizational relationships, the more complex the response.
2. The number of levels in an organization as branching increases and as an organization develops multiple chains of reporting.

3. Changes in organizational structure. Response procedures often require diverse groups of people to make decisions, and different parties will rotate roles and responsibilities as the response to an event evolves.
4. Organizational procedures becoming more complicated. Passing information up and down a hierarchy, and waiting for an informed response, can increase complexity, especially when this takes place within complex organizational structures.
5. The number of communication channels. During a fast-evolving and highly uncertain crisis, channels of communication must increase significantly to accommodate constant demand for new information and frequent updates following decision-making.

Increases in complexity create difficulties in healthcare supply chain management and therefore have a negative impact on healthcare organizations, suppliers, frontline workers, patients, communities, and other national and international stakeholders (eg, the federal government). The difficulties caused by complexity can be addressed by leveraging enablers, implementing mechanisms, and by anticipating and adapting to the trajectory of a crisis. Collaboration outside of the province also becomes essential and there was no evidence that active coordination occurred either inter-provincially or federally.

Based on the BC experience, we build on the crisis management phased approach to develop a general framework for healthcare supply chain leaders to prepare for and manage crises. This framework proposes mechanisms or enablers for health system leaders and supply chain stakeholders to quickly stabilize the healthcare supply chain and improve its resilience by proactively managing the phases of the crisis management process (preparedness, disruption, containment, recovery, and prevention). As shown in Figure 2, a successful response to a crisis requires five mechanisms: (1) effective and trusted leadership, (2) a unity of purpose, (3) integrated and robust digital infrastructure and capabilities, (4) consistent learning, and (5) resilience building and environmental sensing for reliable intelligence—working in concert at all stages of the crisis. To cut through the complexity

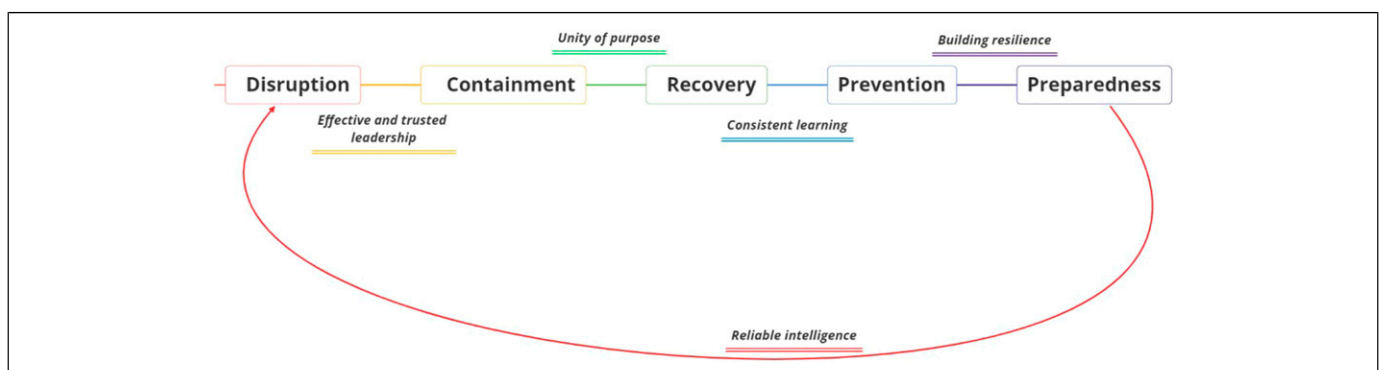


Figure 2. Proactively manage supply chain crisis by shifting the primary focus of responses across the phases.

of a fast-moving and highly uncertain crisis, leaders could lean on a key response at an individual stage. That is, focussing on effective and trusted leadership to contain disruption; unity of purpose to initiate recovery; consistent and continual learning to prevent the crisis from reoccurring; resilience to get better prepared for unforeseen crises; and reliable intelligence supported by up-to-date and reliable data and infrastructure to inform leadership and decision-making.

Conclusion

It is evident from the work described in this article that BC's public health depends on global supply networks, and that public health and the provision of care depends on the healthcare supply chain. As we emerge from this pandemic, BC must recognize that supply chains are an integral component of socio-economic resilience and therefore are also a potential vulnerability.

Healthcare supply chains are increasingly complex. The heightened uncertainty and complexity during the COVID-19 pandemic, coupled with the need to distribute supplies rapidly and equitably on a massive scale, has presented a rare opportunity to observe how leadership, supply chain structures, and digital capabilities operate during crises. With potential crises ahead, enhancing healthcare supply chain crisis management is essential, and BC health leaders must plan now. While formulations of effective crisis management can undoubtedly vary, insights from the BC case study suggest that preparedness and resilience arise from collaborations across organizational, professional, and geographical boundaries led by anticipatory and adaptive decision makers at many levels of the BC healthcare system.

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