An Evidence-Based Strategy to Scale Vaccination in Canada

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Abstract

Provincial health systems have been challenged by the surge in healthcare demands caused by the COVID-19 pandemic; the COVID-19 vaccine rollout across the country has further added to these challenges. A successful vaccination campaign is widely viewed as the only way to overcome the COVID-19 pandemic, placing greater urgency on the need for a rapid vaccination strategy. In this paper, we present emerging findings, from a national research study, that document the key challenges faced by current vaccine rollout strategies, which include procurement and leadership strategies, citizen engagement and limitations in supply chain capacity. These findings are used to inform a scalable vaccine strategy comprising collaborative leadership, mobilization of an integrated workforce and a digitally enabled supply chain strategy. The goal of vaccinating the entire Canadian population in the next few months can be achieved when supported by such a strategy.

Introduction

Global health systems are struggling to meet the demands of the second wave of the COVID-19 pandemic while attempting to implement a mass vaccination strategy rapidly enough to slow the spread of infection across populations. COVID-19 cases continue to surge well beyond the rates evident in the first wave of the pandemic. Given the lack of effective antiviral medications to treat COVID-19, vaccination is widely viewed as the most effective strategy to control the COVID-19 pandemic (ECDC 2020). However, despite the promise of these rapidly emerging vaccines, almost every country is facing challenges in mobilizing the capacity needed for rapid implementation of vaccination at the population level. Early efforts have focused on the procurement of vaccines in anticipation of vaccine approval by each country. However, the procurement of vaccines and the logistics of distribution during a pandemic are only the first steps in achieving a scalable vaccination strategy. The much more challenging phase is scaling vaccination capacity quickly enough to vaccinate an entire population. What is centrally important for all the countries is prioritizing vaccination scalability as a strategy to overcome the devastation of this pandemic – "vaccines do not save lives, vaccinations save lives" (Orenstein 2019).

The purpose of this paper is to report on the emerging findings of case study research on the impact of COVID-19 and the capacity of the health system to respond to this pandemic in the seven Canadian provinces. The emerging findings have identified the critical associations among leadership strategy, supply chain capacity and effective management of the COVID-19 pandemic. This research, supported by a

COVID-19 operating grant (Canadian Institutes of Health Research Reference Number VR5 172669), has uncovered evidence that may inform Canada's vaccination strategy to mobilize rapidly enough to protect the Canadian population. A mixed-methods case study approach was used to document the response of provincial health systems to the COVID-19 pandemic and the role of leadership and supply chain capacity in supporting pandemic management. Analyses include a qualitative analysis of over 140 interviews of key stakeholders across the seven provinces, a secondary analysis of public reports and quantitative analyses of publicly available data sets.

Vaccination Processes in Canada

In 2003, Canada implemented a national immunization strategy whereby bulk buying of vaccines is conducted through Public Services and Procurement Canada and the Vaccine Supply Working Group (Government of Canada 2017). Supported by the Public Health Agency of Canada, these groups manage vaccine contracts on behalf of all Canadian jurisdictions (Government of Canada 2017; GS1 Canada 2005). The provinces and territories pay for their portion of the vaccines from this program and are responsible for the distribution of vaccines to hospitals, regional health authorities, local public health clinics, doctors' offices and pharmacies (Government of Canada 2019; The Multi-Stakeholder Steering Committee on Drug Shortages in Canada 2013). The provinces and territories have the option to "opt out" of the bulk-buying program and, instead, create their own individual contracts with the manufacturers (Government of Canada 2017). To date, leaders in all provinces have reported reliance on federal procurement initiatives to access the needed COVID-19 vaccines once approved by Health Canada.

The Canadian government has focused its efforts on the procurement of vaccines to proactively secure a sufficient supply to vaccinate all Canadians in a timely manner. The management of contracts for vaccines at the federal level has been implemented with the successful procurement of 76 million vaccine doses even before these vaccines were approved by Health Canada (Government of Canada 2020a). By comparison, the European Union has been criticized for a lack of proactive initiatives to procure vaccines for its member states (Lynn 2021). Although Canada has been very proactive in negotiating contracts with vaccine manufacturers, provinces are now under intense scrutiny for what is viewed as a very slow implementation of vaccination programs (McGregor 2020). The following sections describe emerging evidence of provincial capacity to respond to the COVID-19 pandemic. Informed by these findings, the paper proposes a rapid vaccination strategy that is effective in protecting the health of all Canadians.

Lack of Pandemic Preparedness

It is well documented that events such as pandemics are managed well when planning has been well established and training and education (e.g., simulation events) support leader preparedness (Pearce 2019). A consistent finding across provincial case studies has been the lack of preparedness planning, despite experiences with similar events in recent years (e.g., SARS, H1N1 and Ebola), that would support teams in responding to the COVID-19 pandemic. When health system and government stakeholders were interviewed between March and November 2020, a recurring theme was that pandemic plans either did not exist or were perceived to be inadequate, resulting in leadership teams having to design and develop their own responses as the pandemic unfolded. Leaders consistently reported that pandemic planning had been in place following the SARS epidemic; however, the planning was not sustained, and few learnings from the SARS epidemic had been implemented, leaving provincial preparedness woefully inadequate. When leaders were asked about vaccination plans for their respective populations, every province stated that planning for vaccination "was not yet known" or was "in development." There was no evidence of preparedness plans to support mass vaccination – at either the federal or the provincial level. Every jurisdiction was eagerly awaiting vaccine approvals; the first vaccine was approved on December 9, 2020 (Government of Canada 2020b). Each province and territory began their vaccination planning just as vaccines were approved by Health Canada. Vaccination planning continues in many jurisdictions as public health teams continue to be challenged in managing the many demands of this pandemic, including testing, contact tracing and implementing public health directives to reduce the risk of transmission of the virus.

There was no evidence of preparedness plans to support mass vaccination – at either the federal or the provincial level.

Variation in Leadership Strategies across Provincial Jurisdictions

Provincial leadership strategies with regard to pandemic management have varied widely (Figure 1). Some provinces (British Columbia, Alberta, Manitoba, Nova Scotia and Newfoundland and Labrador) were found to have a highly centralized leadership strategy, characterized by the coordination between key stakeholders and health organizations across these provinces. Lead decision makers were by and large the chief medical officers of health, with political leaders engaged to varying degrees in each province. In these centralized leadership models, supply chain experts were engaged at provincial

decision-making tables to inform decisions regarding the feasibility of public health initiatives (e.g., wearing masks) based on availability of personal protective equipment (PPE). Centralized leadership strategies featured highly integrated leadership teams and decisions were led by public health and informed by robust collaboration with experts from long-term care, home care, acute care and community agencies, as well as government policy makers. Provinces where a centralized leadership strategy was evident have experienced lower rates of COVID-19 transmission and morbidity and mortality due to COVID-19 (Government of Canada 2021). Notably, both Nova Scotia and Newfoundland and Labrador were among the provinces that experienced the lowest rates of COVID-19 in the country.

FIGURE 1.
Features of centralized and decentralized leadership strategies

Features of a centralized leadership strategy	Features of a decentralized leadership strategy
Public health officer leads the pandemic strategy	Multiple leaders (political, public health, health system) guide the pandemic strategy
Coordination of supply chain strategy across the health system	Limited coordination of supply chain strategy across the health system
Supply chain experts engaged in provincial decision-making tables	Supply chain experts not engaged at provincial decision-making tables
Integrated management strategy with collaboration across long-term care, home care, acute care, community agencies and government leaders	Health organizations manage the pandemic somewhat independently and have limited collaboration

In contrast, Ontario and Quebec implemented a more "decentralized leadership strategy," in which the provincial government engaged many stakeholders across multiple ministries and pandemic-management decisions were led by a combination of public health officials, political leaders and leadership committees, thus varying widely. Supply chain leadership and expertise were largely absent from decentralized leadership approaches, and public health units and health organizations across these two provinces managed the demands of the pandemic somewhat independently, with little evidence of province-wide coordination or collaboration. In late November 2020, vaccination preparations began with the establishment of Ontario's vaccination task force, which is led by a retired general and comprises a number of stakeholders, including government leaders, industry leaders (e.g., automotive, technology), medical specialists (e.g., coroners and experts in infectious diseases and trauma surgery), First Nations leaders and bioethics experts. Consistent with a decentralized leadership approach to pandemic leadership, the Ontario task force does not include supply chain experts or public health, primary care or retail pharmacy experts, which collectively represent that segment of the health system that routinely manages and leads vaccination processes across the province. In provinces with decentralized leadership approaches, supply chain was the responsibility of each health organization, which resulted in limited ability to coordinate supply chain strategies across the province. Key findings also included perceptions of a "command and control" style of decision making that offered little opportunity for collaboration among key stakeholder groups and posed significant challenges for the health workforce, who experienced fear and uncertainty for their safety and high rates of COVID-19 transmission, particularly in long-term care settings.

Underdeveloped Health Supply Chain Infrastructure

A key outcome of the provincial case studies was that supply chain infrastructure, processes and expertise were found to be profoundly underdeveloped across most provincial health systems. The fragility of the health system supply chain in Canada has been previously reported (Snowdon et al. 2021). These features of supply chain fragility present unique challenges for vaccination planning, as described below:

- Decentralized leadership approaches offer little capacity to coordinate public health efforts across health organizations or coordinate the efforts of public health teams, which may result in multiple and varied vaccination plans across

these provinces. This lack of leadership coordination at the provincial level may also contribute to the challenges of scaling vaccination capacity and speed of implementation.

- The use of global standards (e.g., GS1) to identify which vaccines are administered to which citizens has not been adopted by the majority of provinces in Canada. Thus, data with regard to tracking the type of vaccine, with specific details such as the lot and batch number, given to each citizen will require a manual capture to ensure that both doses are completed within recommended time frames and to identify potential adverse outcomes.
- Only one province (Alberta) was found to have existing digital infrastructure, whereby citizens can access their health records and book online appointments for COVID-19 testing and for vaccinations. The lack of digital infrastructure in most other provinces will limit the ability to track the progress of vaccination strategies, prioritize populations at greatest risk, track vaccine inventory to minimize waste and support digital tracking of outcomes (i.e., adverse events) that may emerge following vaccination.
- A "reactive" approach to supply chain capacity was a common finding in many provinces, meaning that many provinces were found to "react and respond" to pandemic events as they unfolded rather than proactively anticipating risks (e.g., risk of supply shortages, impact on health workforce) and intervening to prevent these risks from becoming a reality. This "reactive" approach toward managing supply chain processes across provinces may contribute to delays in vaccination implementation.

Citizen Confusion and Erosion of Confidence

The significant number of deaths, extraordinary number of job losses and prolonged periods of social isolation have had a devastating impact on citizens, who face social, emotional, psychological and economic challenges resulting from the lengthy and stringent public health directives.

Evidence emerging from citizen advocacy groups in this study suggests significant challenges with the highly varied and constantly changing communication of public health directives. Citizen stakeholders have questioned directives that encourage social isolation from family members during holidays, yet community members are able to shop in big-box stores, where exposure to the virus is viewed as substantial (Charbonneau 2020). Moreover, citizens question why and how public health directives are so inconsistent and highly varied across regions within the same province (Casaletto 2020). This pandemic is unprecedented in scope and complexity, which likely contributes to changes in directives and pandemic strategies as evidence emerges. However, the frequent changes in public health strategies and the highly varied approaches across provinces are a growing challenge to citizens' confidence in pandemic management that has been further exacerbated by the recent vaccination efforts.

Citizens are expressing concerns and uncertainty in media publications regarding when and how they can expect to be vaccinated (Ivison 2021). There is little evidence of the use of communication campaigns that directly address the concerns of the general public, including, but not limited to, the timing of vaccine availability and details regarding how jurisdictions will contact citizens to notify them of their eligibility for vaccination. The growing concerns among citizens may be an indicator of the eroding public confidence in health systems, which has placed pressure on health system leaders to strengthen trust and confidence by engaging citizens directly to respond to their concerns.

These findings provide an important basis for planning effective and efficient vaccination strategies that are urgently needed to reduce the devastating impact of this pandemic. The following section proposes a strategy that builds on the emerging findings to inform vaccination planning that increases the likelihood of success in achieving the goal of having every Canadian citizen vaccinated by September 2021.

A Scalable Vaccination Strategy for Canadian Health Systems

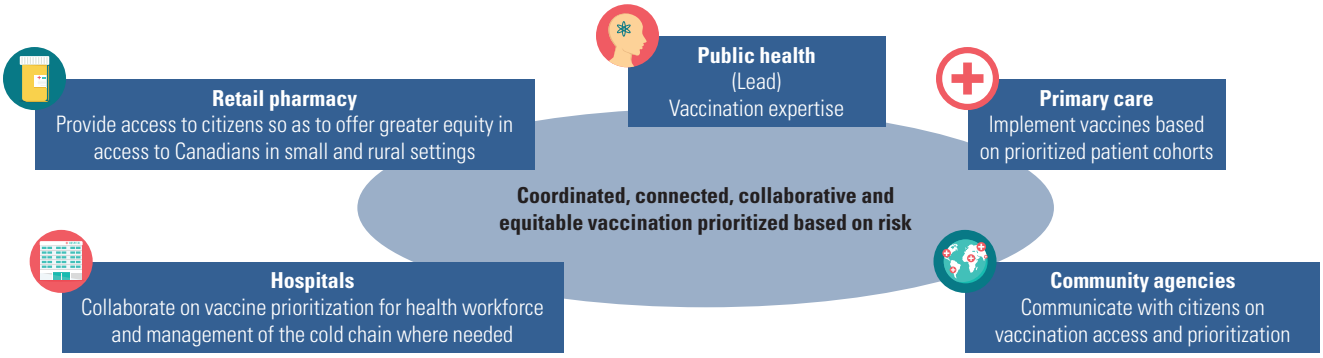
Vaccine production across the world is scaling rapidly to meet the global demand and urgency for vaccination so that COVID-19 can be overcome. Yet, the infrastructure and capacity needed to rapidly implement effective immunization at the population level are far beyond the scope and scale of the existing vaccination capacity of public health teams across Canada. We propose a strategy that would help rapidly scale vaccination capacity across Canada, including a highly collaborative model of leadership, mobilization of an integrated vaccination workforce and establishment of digital supply chain infrastructure that offers precision in vaccine distribution.

Collaborative model of leadership

Vaccination efforts are typically the responsibility of public health teams in Canada. However, the scale and scope of the capacity required for effective and timely COVID-19 vaccination command an unprecedented leadership approach that is collaborative and focuses on engaging key stakeholders across health systems in a highly coordinated effort. The urgency to vaccinate a minimum of 70% of the population to achieve herd immunity (Anderson et al. 2020; Randolph and Barreiro 2020) will require the collaboration and coordination of multiple teams and organizations across every Canadian health system. Leadership is a fundamental and critical dimension of a high-performing health system, whereby the many key stakeholders are supported and enabled to deliver high-quality,

safe care to patients (Baker et al. 2008). Figure 2 illustrates the key roles and features of a collaborative leadership strategy to mobilize the necessary resources needed for the COVID-19 vaccination strategy. In provinces with a centralized leadership strategy, there was exceptional coordination of effort to inform public health planning and decisions that resulted from meaningful engagement of key stakeholder expertise. This same leadership strategy can be applied to vaccination planning. This engagement of key stakeholders necessary for an effective and timely vaccination strategy must include experts from primary care, pharmacy, hospitals and the community.

FIGURE 2.
The leadership features of a centralized leadership strategy



The key features of collaborative leadership, evident in provinces with strong pandemic outcomes, are as follows:

- *Role clarity:* In provinces with centralized leadership approaches, there was a clear distinction of leadership roles – chief medical officers of health led decisions, and government and health system leaders clearly focused on supporting the implementation of public health decisions and directives. Clarity of roles and accountability will support vaccination efforts, whereby public health leaders define vaccination protocols and health system and government stakeholders focus on operationalizing vaccination plans, as vaccines become available.
- *Inclusion:* Collaborative leadership engages multiple key stakeholders to inform decisions and to ensure that diversity of knowledge and expertise is acknowledged and carefully considered in pandemic-management decisions. For example, in provinces that engaged experts in long-term care early in pandemic leadership decisions, the long-term care sector was prioritized for PPE distribution; these provinces had lower case numbers and lower mortality rates in long-term care settings (Hsu et al. 2020). In order to be successful in rapidly implementing vaccination programs across provinces, vaccination strategies must be inclusive and consider the unique perspectives of multiple health-system sectors (e.g., long-term care, home care, acute care, primary care, community groups).
- *Transparency:* Transparency was a key feature of collaborative leadership, whereby clear and consistent communication from public health leaders was associated with a high degree of confidence among all stakeholders, including citizens. In provinces demonstrating a high degree of transparency in their communications, chief medical officers of health were viewed as "heroes" by system stakeholders and citizens alike, who were highly supportive of directives and readily followed them in an effort to contain the spread of the virus. Communication in times of crisis plays a critical role in creating an open and transparent flow of information, which builds confidence across all stakeholder groups, particularly citizens. Transparency in communication regarding when, by whom and how vaccination can be accessed will be critical to the successful implementation of vaccination programs.

A collaborative leadership strategy with very clear expectations of roles and transparent communication will support a highly efficient and effective network of organizational leaders, who will be able to support the execution of an effective and timely vaccination strategy for all Canadians.

Mobilize a workforce capacity to achieve vaccination at scale

Achieving the required vaccination levels in the shortest time possible will be critical to overcoming the devastating impact of COVID-19 on the lives of all Canadians. Typically, Canada vaccinates 31–33% of the population, approximately 10 million people every year (Statista 2020). Vaccination efforts must now be scaled to achieve 63,402,920 vaccinations (i.e., two vaccines for each of the 31.7 million citizens over the age of 12 years), which is approximately six times the volume of annual vaccinations in Canada.

The Government of Canada has projected that 60 million doses of vaccine will be available to ensure that every Canadian can be vaccinated by September 2021 (Ballingall 2021). To meet this objective in just 273 days (January 1–September 30, 2021), public health teams must rapidly increase their capacity to deliver over 60 million vaccinations across Canada. Two important sectors of the health workforce with expertise and experience in vaccination are primary care and pharmacy teams. There are just over 43,000 primary care doctors across Canada who routinely offer vaccinations to their patients, including annual flu vaccines for seniors and routine vaccines for children and adults (CIHI 2020). In addition, there are currently 13,492 retail pharmacies across Canada that routinely offer flu vaccines in almost every rural and urban community (IBISWorld 2020). If vaccination programs mobilize primary care and pharmacy teams, the capacity of vaccination increases substantially, making it possible to reach the goal of vaccinating every Canadian by September 2021. Consider the following points:

- A total of 31,500,000 Canadians (over the age of 12 years) require 63,000,000 vaccinations in 273 days, which is *278,388 vaccinations per day* (assuming a seven-day/week vaccine strategy).

If all retail pharmacies and *half* of Canada's primary care physicians are mobilized,

- 22,000 primary care physicians + 13,492 pharmacies = 35,492 vaccination sites and
- *35,492 vaccine sites that offer eight vaccinations per day per site, which is over 77 million vaccinations in 273 days*.

If the goal to vaccinate all Canadians was accelerated to June 1, 2021 (105 days),

- 706,666 vaccinations per day would be required to reach that goal, and
- 35,492 sites delivering *20 vaccinations per day* over 105 days would achieve that goal.

Clearly, the rate-limiting step for vaccinating the Canadian population is vaccine availability. However, public health teams can be successful in scaling vaccination programs by engaging both primary care and pharmacy teams in an integrated team approach to achieve the workforce capacity needed for mass vaccination efforts. The higher our speed of vaccination, the fewer lives will be lost to COVID-19 and the more quickly recovery efforts can get under way.

Establish a digital supply chain strategy for precision in managing vaccination supply and outcomes

Healthcare supply chain teams source and distribute products to ensure timely access to the essential products and equipment needed to support the safe and effective delivery of patient care. Supply chain infrastructure in health systems includes the movement of products, the people involved and the processes, from the manufacturer to the point of care, ensuring that patients receive care when and where needed (Snowdon and Alessi 2018). Of the seven provinces participating in the current research, only one has the digital infrastructure necessary to automate the distribution and traceability of vaccines, supplies and vaccination processes so as to reduce the risk of vaccine waste and ensure that priority populations receive the vaccine as quickly as possible. Digitally enabled supply chain infrastructure enables an accurate and proactive distribution of the vaccine to where it is needed most by prioritizing the population segments at greatest risk, identifying citizens within each high-risk segment for vaccination and tracking vaccination outcomes with precision. Every Canadian carries a unique health card number, which creates the opportunity for the traceability of vaccination for every vaccine-eligible citizen and tracking the timing of the required two-dose administration, while also ensuring that supplies are available to vaccination teams. The key features of digitally enabled supply chain infrastructure are as follows:

- An online resource for citizens to access credible and clear information about vaccines supports health literacy and transparency of information, engaging citizens and building confidence in the vaccination process. Online tools engage citizens directly; offer transparency of information; and offer convenience, such as automated scheduling of appointments for vaccination and automated reminders of vaccination appointments, to support coordination of vaccination accessibility for all citizens.
- Barcode scanning at the point of care in pharmacies, primary care units, public health units and hospitals further automates the mobilization of data when vaccination is completed for each citizen, which is then linked to their health record. Currently, pharmacies and some primary care settings require patients to complete paper-based forms to collect patient data (e.g., allergy status, demographic data), which is then linked to the vaccine product information provided to the patient. Automating patient and vaccine captured data ensures accuracy, reduces workload for pharmacies and primary care teams and enables traceability of vaccine doses for every citizen linked to reported outcomes so as to ensure the safety and efficacy of each vaccine (Gorfinkel 2020).

- Interoperable flow of data linking vaccination product information to individual health records (e.g., stored electronic medical records), pharmacy databases and public health vaccine registries enables digital tracking of completed vaccinations and traceability of vaccine outcomes. Interoperability of vaccination data also enables analytic tools to track progress toward vaccination program goals and identify the populations at greatest risk so as to inform prioritization decisions.
- Algorithms can further automate the distribution of vaccines to each public health team, physician office or retail pharmacy to offer greater precision in the distribution of vaccines. This ensures that vaccinations can be completed efficiently, with minimal waste of vaccine doses, which can occur when vaccines are shipped but not used within the timelines essential for maintaining cold chain requirements. Automation and precision of vaccine distribution using predictive algorithms will ease the workload burden for the public health agencies overseeing vaccination programs, which are supported by highly coordinated supply chain teams across provincial health systems, to support rapid implementation of vaccination for all citizens.

Transparent, fair and equitable process for determining access to vaccinations

The rollout of vaccination programs across Canada must be clearly communicated to all citizens, and the decisions regarding which citizens should be prioritized for vaccination must be deeply embedded in established ethical frameworks. This will support the identification of those at greatest risk, ensure fairness and equity in access and build public trust. There is substantial evidence in provinces with centralized leadership approaches that communication of public health directives must be highly transparent, and communities must have the opportunity for input into decisions in an equitable and effective manner. Decisions on vaccination priorities determine which healthcare and community sector is eligible for the vaccine and the order in which each population group is prioritized to receive vaccination. Such decisions are challenging and must aspire to minimize the risks to every citizen and reduce the transmission of and deaths due to COVID-19 while also implementing vaccination as quickly as possible. For vaccination programs to be successful, public health teams must make decisions that are highly transparent and guided by established ethical frameworks. This will ensure that citizens feel confident that decisions are focused appropriately on minimizing harm to those at greatest risk, are equitable and fair, are based on best available evidence and support open participation wherever possible (Government of Ontario 2020). It is only when these principles guide and inform public health decisions on how vaccinations will be made available to citizens that public trust is supported and sustained. The confidence of Canadians in the integrity of decisions is a critical factor in the success of vaccination strategies in protecting and supporting the health and quality of life of every Canadian.

Summary

A rapid, precise and scalable vaccination strategy that protects Canadians from COVID-19 is achievable with a collaborative and inclusive leadership and integrated workforce strategy across Canadian jurisdictions. Emerging evidence from the current COVID-19 operating grant research has identified the critical importance of leadership and an integrated workforce approach to scale vaccination efforts in order to achieve the targeted vaccination of every Canadian by September 2021, or earlier if vaccine doses are available. The value of supply chain best practices offers the automation and precision of vaccine distribution and the accurate capture of data to enable the tracking and traceability of every vaccine dose, along with the lot and batch number, received by every Canadian citizen who chooses to be vaccinated. Canada does have the strategic assets to accomplish the vaccination of the Canadian population. The mobilization of these strategic assets (e.g., highly experienced health workforce, supply chain infrastructure), supported and enabled by collaborative leadership approaches and informed by ethical and transparent decisions, will enable Canada to realize its aspirations and goals to protect the health and wellness of every Canadian. HQ

References

Anderson, R.M., C. Vegvari, J. Truscott and B.S. Collyer. 2020. Challenges in Creating Herd Immunity to SARS-CoV-2 Infection by Mass Vaccination. *The Lancet* 396(10263): 1614–16. doi:10.1016/S0140-6736(20)32318-7.

Baker, G.R., A. MacIntosh-Murray, C. Porcellato, L. Dionne, K. Stelmacovich and K. Born. 2008. Learning from High-Performing Systems: Quality by Design. In *High Performing Healthcare Systems: Delivering Quality by Design* (pp. 11–26). Longwoods Publishing.

Ballingall, A. 2021, January 9. Trudeau's Goal to Have Vaccines for All Canadians by the End of September Assumes Health Canada Will Approve Them. *Toronto Star*. Retrieved February 9, 2021. <https://www.thestar.com/politics/federal/2021/01/08/trudeaus-goal-to-have-vaccines-for-all-canadians-by-the-end-of-september-assumes-health-canada-will-approve-them.html>.

Canadian Institute for Health Information (CIHI). 2020. *Physicians in Canada, 2019*. Retrieved January 14, 2021. <https://secure.cihi.ca/free_products/physicians-in-Canada-report-en.pdf>.

Casaletto, L. 2020, November 13. COVID-19 Confusion: Breaking Down Ontario's Colour-Coded Framework by Region. *CityNews*. Retrieved January 14, 2021. <http://www.toronto.citynews.ca/2020/11/13/covid-19-confusion-breaking-down-ontarios-colour-coded-framework-by-region/>.

Charbonneau, D. 2020, October 4. Rules Change "Every Day": Confusion over Ontario's Social Gathering Limits during COVID-19 Pandemic. *CTV News*. Retrieved January 14, 2021. <https://www.ottawa.ctvnews.ca/rules-change-every-day-confusion-over-ontario-s-social-gathering-limits-during-covid-19-pandemic-1.5132493>.

European Centre for Disease Prevention and Control (ECDC). 2020, December 22. COVID-19 Vaccination and Prioritisation Strategies in the EU/EEA. Retrieved January 14, 2021. <https://www.ecdc.europa.eu/en/publications-data/covid-19-vaccination-and-prioritisation-strategies-eueea>.

Gorfinkel, I. 2020, August 13. A National Vaccine Registry Blueprint. *Canadian Medical Association Journal*. Retrieved January 14, 2021. <https://www.cmaj.ca/content/national-vaccine-registry-blueprint>.

Government of Canada. 2017, April 11. Roles and Responsibilities to Address Drug Shortages. Retrieved January 14, 2021. <https://www.canada.ca/en/health-canada/services/drugs-health-products/drug-products/drug-shortages/roles-responsibilities-address-drug-shortages.html>.

Government of Canada. 2019, October 22. Vaccine Supply. Retrieved January 14, 2021 <https://www.canada.ca/en/public-health/services/vaccine-supply.html>.

Government of Canada. 2020a, December 7. Canada to Receive Early Delivery of Pfizer-BioNTech COVID-19 Vaccine. Retrieved January 14, 2021. <https://www.canada.ca/en/public-services-procurement/news/2020/12/canada-to-receive-early-delivery-of-pfizer-biontech-covid-19-vaccine.html>.

Government of Canada. 2020b, December 9. Health Canada Authorizes First COVID-19 Vaccine. Retrieved January 14, 2021. <https://www.canada.ca/en/health-canada/news/2020/12/health-canada-authorizes-first-covid-19-vaccine.html>.

Government of Canada. 2021, February 3. Coronavirus Disease 2019 (COVID-19): Epidemiology Update. Retrieved February 4, 2021. <https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html#a3>.

Government of Ontario. 2020, December 29. *Ethical Framework for COVID-19 Vaccine Distribution*. Retrieved January 18, 2021. <https://files.ontario.ca/moh-ethical-framework-for-covid-19-vaccine-distribution-en-2020-12-30.pdf>.

GS1 Canada. 2005. Canada Vaccine Project: Cost-Benefit Analysis and Conclusions on Barcode Requirements. Retrieved January 14, 2021. <https://www.gs1.org/docs/healthcare/events/160609/4_Van%20Exan_Canada%20Vaccine%20Project.pdf>.

Hsu, A.T., N. Lane, S.K. Sinha, J. Dunning, M. Dhuper, Z. Kahiel et al. 2020, June 4. Understanding the Impact of COVID-19 on Residents of Canada's Long-Term Care Homes – Ongoing Challenges and Policy Responses. Retrieved January 18, 2021. <https://ltccovid.org/wp-content/uploads/2020/06/LTCcovid-country-reports_Canada_June-4-2020.pdf>.

IBISWorld. 2020, June 30. Pharmacies & Drugstores in Canada – Market Research Report. Retrieved January 14, 2021. <https://www.ibisworld.com/canada/market-research-reports/pharmacies-drug-stores-industry/>.

Ivison, J. 2021, January 12. Confused about Canada's Vaccine Rollout? You Should Be. *National Post*. Retrieved January 14, 2021. <https://nationalpost.com/opinion/john-ivison-confused-about-canadas-vaccine-rollout-you-should-be>.

Lynn, M. 2021, January 9. The EU Has Botched Its Vaccination Programme. *The Spectator*. Retrieved January 14, 2021. <https://www.spectator.co.uk/article/the-eu-has-botched-its-vaccination-programme>.

McGregor, G. 2020, December 28. Slow Vaccine Rollout across Canada Draws Criticism, Anger. *CTV News*. Retrieved January 14, 2021. <https://www.ctvnews.ca/health/coronavirus/slow-vaccine-rollout-across-canada-draws-criticism-anger-1.5246911>.

Orenstein, W. 2019. Vaccines Don't Save Lives. Vaccinations Save Lives. *Human Vaccines & Immunotherapeutics* 15(12): 2786–89. doi:10.1080/21645515.2019.1682360.

Pearce, K. 2019, November 6. Pandemic Simulation Exercise Spotlights Massive Preparedness Gap. Johns Hopkins University. Retrieved January 14, 2021. <https://hub.jhu.edu/2019/11/06/event-201-health-security/>.

Randolph, H.E. and L.B. Barreiro. 2020. Herd Immunity: Understanding COVID-19. *Immunity* 52(5): 737–41. doi:10.1016/j.immuni.2020.04.012.

Snowdon, A. and C. Alessi. 2018, October 16. *Visibility: The New Value Proposition for Health Systems*. World Health Innovation Network. Retrieved October 6, 2020. <https://issuu.com/worldhealthinnovationnetwork/docs/full_paper_-_win_visibility_thought/1?e=25657717/39177387>.

Snowdon, A.W., M. Saunders and A. Wright. 2021. Key Characteristics of a Fragile Healthcare Supply Chain: Learning from a Pandemic. *Healthcare Quarterly* 24(1): 36–43. doi: 10.12927/hcq.2021.26467.

Statista. 2020, August. Percentage of Canadians Who Have Received the Influenza Immunization Less than One Year Ago from 2003 to 2019. Retrieved January 14, 2021. <https://www.statista.com/statistics/434275/share-of-canadians-with-influenza-immunization-in-last-year/>.

The Multi-Stakeholder Steering Committee on Drug Shortages in Canada. 2013. *Multi-Stakeholder Toolkit: A Toolkit for Improved Understanding and Transparency of Drug Shortage Response in Canada.* Retrieved January 14, 2021. <https://www.fdanews.com/ext/resources/files/archives/10113-01/09-16-13-Canada.pdf>.

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