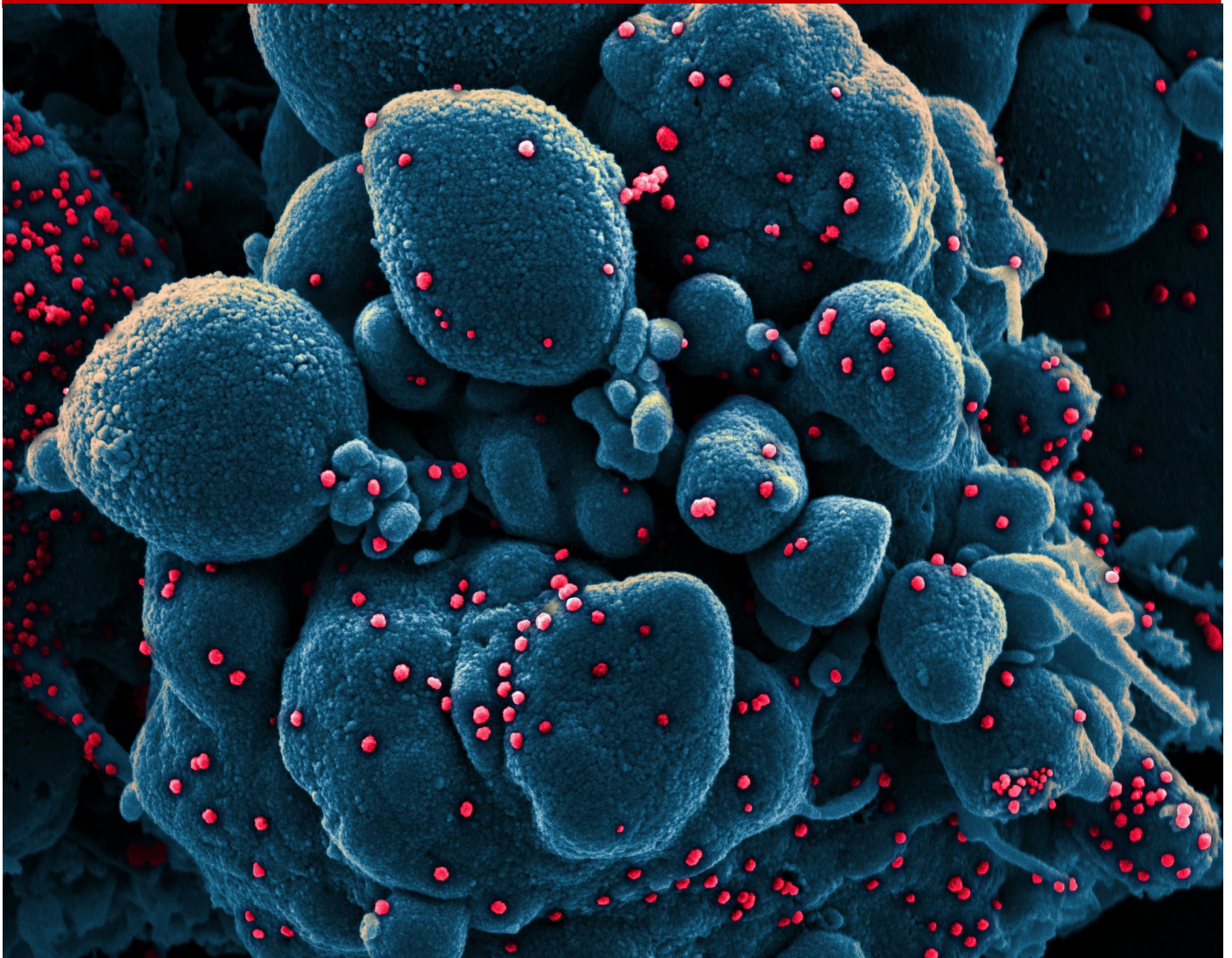


Response to COVID-19 Pandemic and its Impacts



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Scientific & Economic Impacts



Food, History and COVID

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After healthcare, our food system may be the sector of the economy most impacted by the pandemic. Worries about food security, and food supply chains, started early in the pandemic, when millions of Canadians simultaneously stocked up on food essentials. The spike in demand depleted inventories and the sight of empty grocery store shelves caught many Canadians off guard. Luckily, we have an extremely adaptable industry that rose to the challenge and within two weeks store inventories had largely returned to normal. Nevertheless, significant challenges for the food sector still exist.

Another huge challenge is how to deal with the shuttering of our restaurants and cafeterias. In addition to lost jobs and devastated businesses, the shut-down has caused a massive supply chain problem. Prior to the pandemic, most of us spent significant amounts of money purchasing food that was prepared outside of the home. This is no longer the case. And this means that farmers and food processors are having to quickly reorganize away from supplying venues that are now dark.

The pandemic is also revealing other hitherto unexamined bottlenecks in our food system. The way in which our farms depend on temporary foreign workers has been highlighted as a major challenge. Similarly, keeping our food processing sector operating as staff test positive for the virus is proving difficult.

There is also a massive food security crisis looming amongst low income Canadians, many of whom have lost their jobs and seen wages plummet.

To address these extraordinary challenges, government, philanthropy, academia, industry, and civil society have risen up in an extraordinary display of solidarity and flexibility. Canadians should be proud and thankful of the exceptional work that has gone into managing this crisis.

One of the lessons that we need to learn, however, is that we could have been better prepared. Unlike other countries, including the United States, Canada did not go into this crisis with a food security plan in place. Other countries had already put ideas on paper to guide how to keep food systems running in the event of a series of worst-case scenarios. If we had conducted such an exercise, then we would have been better prepared for the challenges we currently are facing.

After all, it's not like we should have been caught unaware. Experts have been warning for years that we are vulnerable to pandemics and we have history to guide us as well. For instance, maintaining food systems was a major preoccupation for governments and experts 100 years ago, during World War I. Then, the president of the Ontario Agricultural College, George Creelman, became a formal advisor to the

government whose job was to ameliorate the effects of food shortages. This role took him to France and England, where he explored how Canada could help with serious food security issues that loomed large at that time. Creelman's work highlights the importance that was placed on having strong food security plans during a crisis.

We should all take note that although food security planning during a pandemic may be new to this generation, it has incredibly strong antecedents in the wartime planning of generations past. To paraphrase a wartime politician, Winston Churchill once said that one should never waste a crisis. In keeping with Churchill's remarks, like the wartime planners that came before us, we believe that developing a plan to maintain food security and food system integrity during our current crisis is imperative. In fact, it could be one of the positive legacies that comes out of this pandemic.

Stakeholders in the food sector, along with government, should commit now to working together in the weeks and months to come and develop such a plan. The process to develop this plan would need the active participation of all relevant players, from farmer groups through to poverty activists. It would require the establishment of high-level principles and involve a contingency planning exercise based on potential

"worst-case" scenarios.

Doing this now is especially important as the threat of major disruptions to the world's food system will not simply go away once we recover from COVID-19. Consider the nightmarish prospect of an avian influenza epidemic that might have a 20% mortality rate and mostly affect younger people? Or the potential disruptions that could be caused by massive climate change events such as droughts and wildfires in key food producing regions around the globe? We need to plan today, to avert these crises tomorrow.

As we look to the future, most experts predict that the pace of disruption will increase. Preparedness planning is one of the best tools we have to proactively ensure that aspects of our society, especially fundamental aspects like our food system, function even under extreme scenarios. We all recognise the importance of insurance for our homes and our health care. We should take the same perspective with the systems that nourish us.

We will overcome COVID-19. The real question is will we learn important lessons for our food system about resilience and preparedness that help us all navigate the next major disruption?



Better Data, More Lives Saved

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On March 11, 2020, the World Health Organization declared the COVID-19 outbreak a pandemic¹. Governments around the world have been working to develop measures to prevent its spread and to identify and care for those infected. In Canada we have seen a concerted effort from all levels of government to work together to ensure the health and safety of Canadians.

In times of crisis, the quality and timeliness of the data used to inform decisions can mean the difference between life and death, yet the availability and accessibility of data are often limited. The COVID-19 pandemic has highlighted the need to improve Canada's data collection, management, and sharing protocols.

In particular, the pandemic has identified significant issues that limit our ability to respond appropriately and to keep the general public informed. These issues include data that are incomplete, inaccessible, or inconsistent. Several of these issues have been exacerbated by backlogs and changes to how testing was being performed and evaluated across Canada, but even with this in mind, there are opportunities for improvement.

Early in the pandemic, provincial and federal governments provided daily updates on the number of confirmed Canadian cases of COVID-19, including the number of patients who recovered or died. However, depending on the source, one would either find new daily cases, or a cumulative summary. The data were presented in aggregate, with no information on age,

gender, race, socioeconomic status, or other variables typically included in epidemiological studies. No information was provided about the status of the case (e.g. asymptomatic, self-quarantining, intensive care, intensive care with ventilator, deceased).

Data limitations led scholars to scour media reports to extract information that might help frame our understanding of the disease². Age and gender data, along with disease status have been extracted from these stories; a time-consuming process susceptible to errors. As the number of confirmed cases grew, it is easy to see how this process became intractable.

As reports from around the world provided new information about the disease (e.g. subpopulations at higher risk), it became clear that some vital data to curtail the spread of the disease and treat the infected were not being collected. At the time of drafting this document, there was at least one petition requesting that the Ontario Government consider adding racial data to the list of data being collected from patients³. Failing to collect these data puts already

marginalized communities at greater risk because we can't know how the virus is affecting them, nor how to best support them.

Beyond these specific data needs, there is a lack of contact and tracing data available. This may be due to a lack of resources to collect these data, or there may be unknown issues preventing them from being shared and/or centrally stored. These data may also not be made public due to privacy issues, but researchers are accustomed to working with data of this nature. Methods for contract tracing without compromising privacy is the subject of active research.

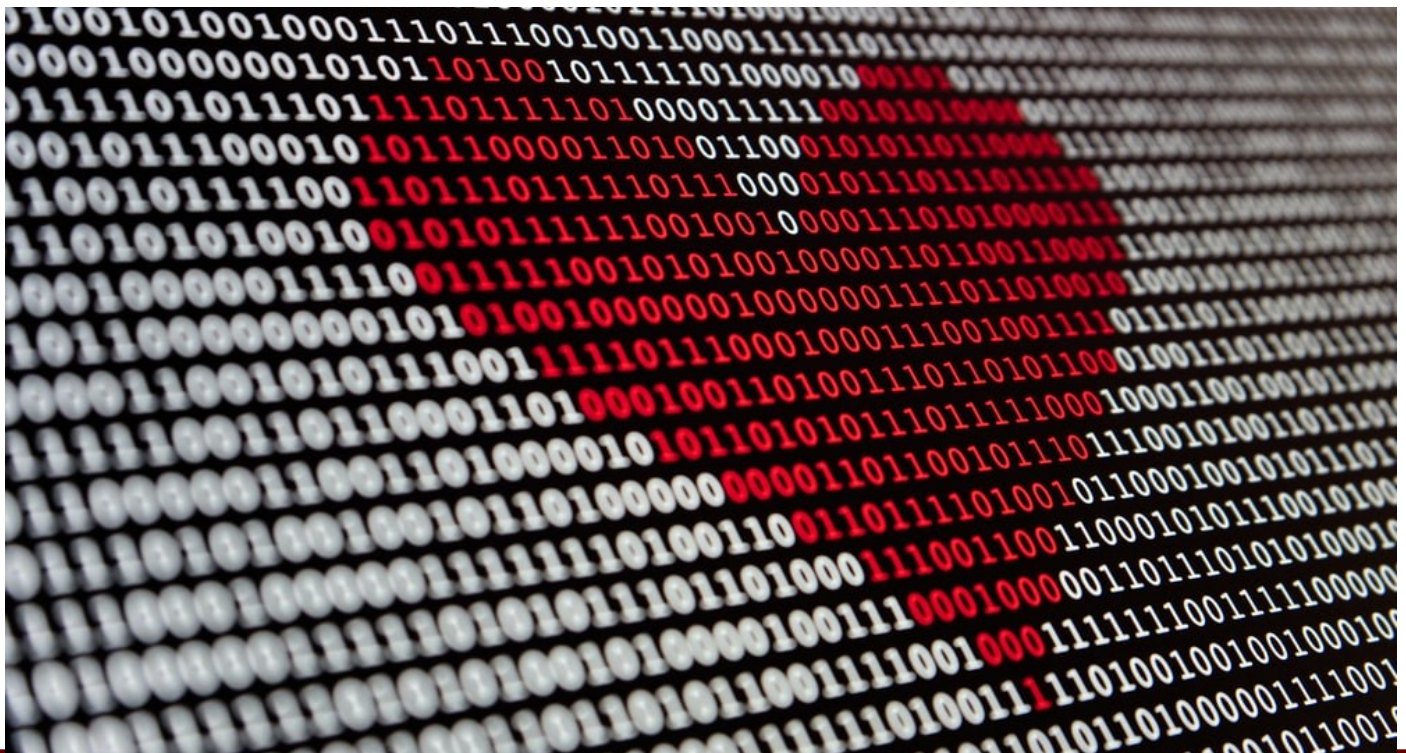
As the pandemic has progressed, the type and format of data made available have also changed. Using the Wayback Machine⁴ we know that as of March 20th, Canada.ca's dedicated page to the novel coronavirus⁵ listed summary data per province and territory along with an epidemiological report. It wasn't until March 30th that some of these data were made available to download in CSV format. Still, much of the additional information introduced remains incomplete or inconsistently updated, thus not viable for meaningful analysis. Before this, those wishing to track the pandemic were reliant on manually transcribing the numbers, using website scraping tools, or using the Wayback Machine to generate a complete data set. Similarly, Ontario introduced [https://covid-](https://covid-19.ontario.ca/)

[19.ontario.ca/](https://covid-19.ontario.ca/) in late March, but prior to this, data were presented first as aggregated summaries, then as a list of the daily new cases at Ontario.ca. While these data included columns of age, gender, likely source of transmission, current status, and other information, much was listed as pending.

These changes were clearly created to better serve Canadians. Going forward, the Canadian pandemic data plan needs to include standards for how data are to be presented, including specific naming conventions. Canada did develop a plan with data in mind, but it hasn't been updated since 2015⁶. It should include data that are easy to find and that can be accessed in common file formats (e.g. CSV). Lastly, we need to develop better data sharing processes between the various levels of government so that the data presented are consistent, complete, and timely; even more essential to gauge the progress as we gradually move away from reliance on physical distancing to control the pandemic.

We must learn from COVID-19 and improve our Canadian pandemic data plan to fully capitalize on the scientific expertise in this country. Canadian lives are at risk.

References available in online version at <https://sciencepolicy.ca/response-covid-19>



Clinical Data Sharing and Transparency in the Time of COVID-19

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The sudden emergence of novel coronavirus COVID-19 in Wuhan, China in November 2019, resulting in a global pandemic is one of the most serious human health emergencies in recent memory. This crisis triggered a huge increase in global research efforts – the viral genome was rapidly sequenced in China (1) and RT-PCR test kits were developed in several locations worldwide by February 2020 (2). Pharmaceutical companies and academic institutions all over the world have mobilized and to date, over 960 clinical trials with a focus on vaccine or treatment development have been registered (3).

While the fear of revealing trade secrets or losing academic credit usually shrouds research in secrecy, the COVID-19 pandemic has seen unprecedented collaboration from across the scientific community (4). Robust and defensible data sharing strategies that can be implemented quickly may shape the efficacy of pandemic response efforts. Indeed, the importance of the timely exchange of clinical data was highlighted during the 2014–2015 Ebola epidemic in West Africa, resulting in a statement from the World Health Organization (WHO) to that effect in November 2015 (5).

A movement toward greater clinical trial transparency has been slowly gathering momentum for over two decades, with requirements that clinical trial sponsors provide summary and trial outcome information for studies conducted all over the world (6).

More recently, initiatives like the European Medicines Agency's Policy 0070 (7) and Health Canada's Public Release of Clinical Information (8) have necessitated the publication of clinical documents on open-access portals. These policies have brought not only clinical trial information into the mainstream, but also the concept of anonymized participants and the importance of protecting patient privacy.

Both of the initiatives above require that patient information is anonymized such that there is reasonable assurance the information is non-identifiable (8) which can be achieved most effectively through the utilization of a quantitative, risk-based approach to anonymization. Such methods, properly applied, ensure that it is unlikely that a person can be identified, which has been demonstrated empirically through rigorous testing (9). Briefly, this strategy can be applied to ensure that patient information is transformed sufficiently to preserve privacy while maximizing data utility.

Timely anonymization of large clinical datasets such that they can be released quickly to contribute to COVID-19 research efforts is likely to prove a challenge for most data custodians. It is generally accepted that to derive as much usefulness from anonymized data as possible, a risk-based approach that considers not only the data but the release context is the optimal strategy (10,11). Realizing that expert de-identification services could be leveraged to expedite

COVID-19 clinical trial data sharing, Privacy Analytics announced that they would waive fees for anonymizing pivotal and vaccine trials data (12).

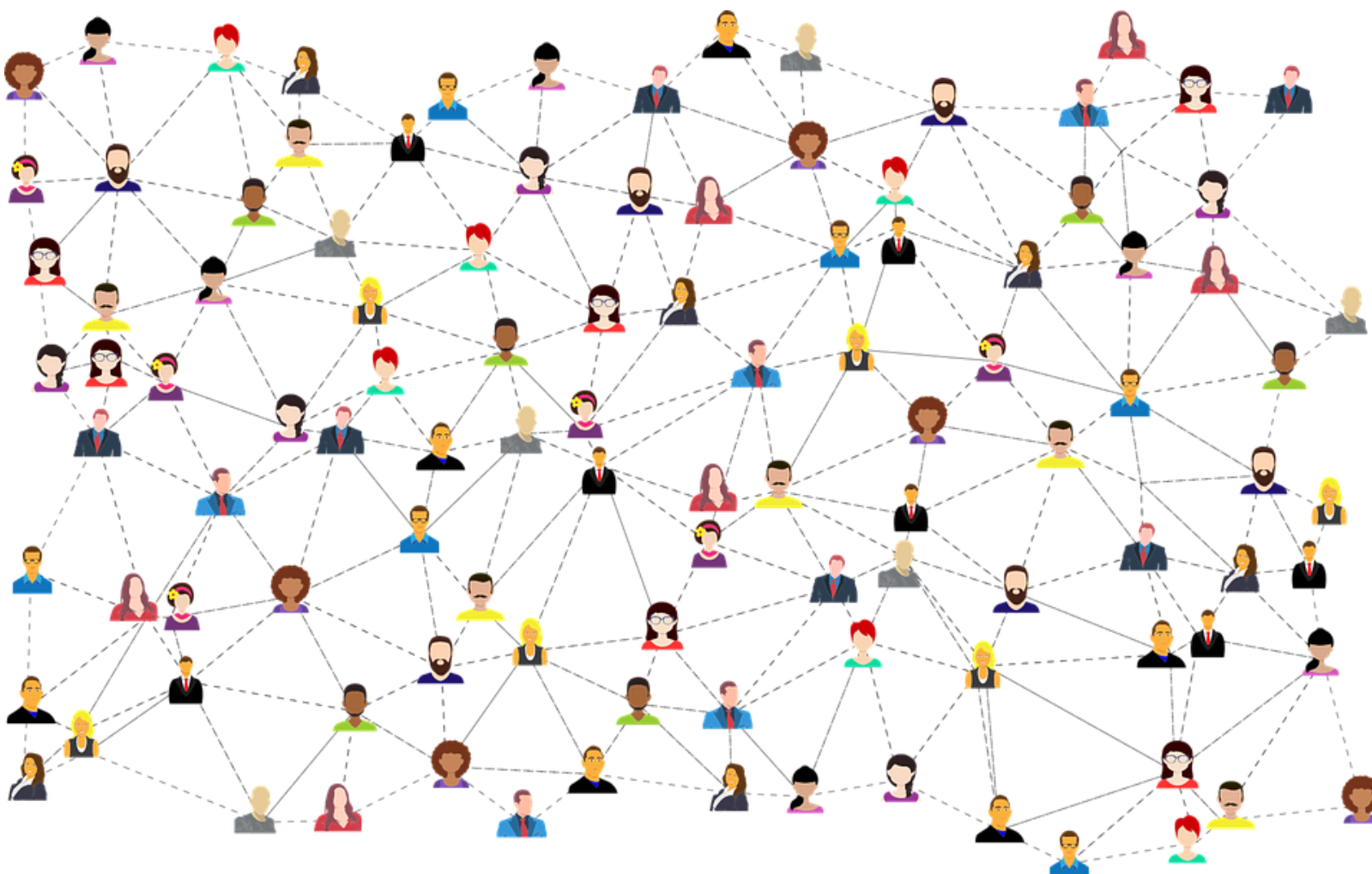
In contrast to mandated publication of anonymized clinical documents under global regulations, structured clinical trial data is predominantly shared on a voluntary basis. Organizations like Vivli, who facilitate data sharing and analysis on their secure platform, are instrumental in enabling re-use of clinical data to serve the global research community and contribute to positive health outcomes. Vivli currently has 24 members and has shared data pertaining to over 5,000 clinical trials, representing some 2.7 million participants (13). To further their contribution to the global research landscape, Vivli has also announced the launch of a dedicated COVID-19 portal for sharing clinical trial data, on which all data will be hosted free of charge (14).

Privacy Analytics and Vivli are contributing their respective expertise and resources to a COVID-19 response consortium (12). Together, both organizations

are committed to accelerating the anonymization and sharing of vitally important COVID-19 clinical trial data such that it can be used most effectively to combat this pandemic.

COVID-19 is likely to have far-reaching effects across the entire clinical research community which will be felt for years to come. A potential positive to come from this would be for this spirit of collaboration and voluntary sharing of data to remain entrenched in the ethos of each pharmaceutical company and academic institutions, to better meet human health challenges in the future. Privacy is not a barrier to information sharing and can in fact ensure trustworthy relationships are established between society and the research community when the appropriate protections are put in place (15).

References available in online version at <https://sciencepolicy.ca/response-covid-19>



How COVID-19 is Revealing the Gaps in Science Communication.

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The world is experiencing disruptions in every aspect of life because of the COVID-19 pandemic. The uncertainty of the future causes anxiety amongst the general public, which can be further amplified by disinformation and misinformation being spread about COVID-19. Some examples of this include recent attacks on 5G cell phone towers and articles questioning whether the Coronavirus is a result of drinking Corona beer. The resulting distress can lead to fear as the information from experts is often not delivered effectively and/or is not laid out in an understandable way for the general public. Tackling this problem can be done by breaking down complex information, from experts to content that is understandable by the general public and providing comprehensive action points with accessible explanations. This ultimately builds trust between the public and science which is key to minimizing the spread of the virus.

One lesson we can learn from this pandemic is the importance of science communication in our society. Open-access journals and pre-prints have made sources of essential information more accessible than ever. However, direct communication from scientists is a more effective way to engage the public with scientific content as it eliminates a step in the chain of information. Consider playing a game of telephone, the fewer stops along the way, the less likely the message is to be misconstrued. In the research community, both scientists and institutions

produce significant amounts of information and are seen as one of the most credible sources of scientific information. For scientists to engage with the general public about their research, institutions can play an important role. Aside from funding and promoting science communication, institutions could lift some of the burden of the administrative work that falls on scientists. This would motivate them towards engaging with the general public without reducing their research capabilities.

We have heard about the benefits of following guidelines such as social distancing, washing hands properly, and disinfecting surfaces to “flatten the curve”. However as reports of packed beaches and people going about their days as normal appear, it is clear that in some cases these recommendations are not being taken seriously. It is crucial to distribute information about social distancing and other guidelines, however, it is also essential that the distributed information is actually understood. This is just one of the reasons why science communication is more important than ever.

Conveying the reason behind the message is as important as the message itself, which is possible through effective communication. Key components of effective science communication with the general public are keeping it accessible, accurate, and aiding in understanding. People are unlikely to register and follow applicable information when they cannot answer why, when, where, and how they should use it.

The general public might not know that the improper use of PPE can increase the risk of infection. For example, people often use their phones while wearing gloves, however, they may not be aware of the risks of cross-contamination. If the virus is present on their gloves, it will now be on their phone, leading to the potential spread of the virus. Something as simple as the process of wearing gloves needs a clear technique with the reasoning behind it. Otherwise, gloves only provide a false sense of security leading to an increase in risk.

It is essential that health experts provide a clear message in regards to the following guidelines. Providing clear recommendations and explanations builds the public's trust of the government and science while increasing the likelihood of the guidelines being followed. That being said, it is imperative that the public be made aware of evidence alongside the new guidelines. This will allow the public to have confidence in health experts when new recommendations are made, as well as in their newfound knowledge. We saw this with the Canadian Government's recommendations on face masks. On March 28th, Canada's Chief Public Health Officer announced that there was no need for healthy people to wear face masks as they will not necessarily reduce the spread of infec-

tion. This advice changed on April 6th, non-medical masks were recommended, as it became clear that asymptomatic carriers could spread the virus. This may cause confusion or loss of trust amongst the public despite the guidelines being changed as more information became available. This shows the importance of communication; when there is confusion, a chance to build trust is lost, which means that public cooperation may be reduced.

In a public health emergency, cooperation from the population as a whole is essential. Science communication can be a bridge between the general public and scientists. It increases the likelihood that measures such as social distancing and isolation will be taken seriously. Research institutions and scientists should increase involvement with their local communities, by increasing engagement, more opportunities to build trust will present themselves. It is in everybody's best interest that the message from experts reaches the general public, which is more achievable with effective science communication.



Canadian research and collaboration is key to Canada's COVID-19 response

Iain Stewart

President, National Research Council of Canada



The Government of Canada is taking immediate, significant, and decisive action to help Canada and the world in this new reality marked by the significant and rapid spread of the novel coronavirus (COVID-19). The National Research Council of Canada (NRC) has the capacity and expertise to help our country in this time of need.

We are ready to respond, as we have been since our inception: influenced by the need to build a new country, and respond to two world wars and the Great Depression. Our early research focused on industrial, military, and natural resource development in response to those turbulent times. Since then, our researchers continue to dedicate their careers to solving some of the world's most pressing challenges. In healthcare alone, we fostered innovative breakthroughs like George Klein's electric wheelchair, which helped veterans of the Second World War regain independence; John A. Hopps' discovery of the electrical cardiac pacemaker; and Harold Jennings' meningitis C vaccine, which has been saving the lives of countless infants and children for more than 30 years.

Today, we are working hard to protect the health of Canadians and our workforce, and support our clients, collaborators, and Canadian businesses so they, too, can carry on in these difficult times, continue providing essential services to Canadians, contribute to the fight against COVID-19, and ensure our country can put its best foot forward when we emerge from this global crisis.

PROTECTING OUR WORKFORCE

Our top priority is the health and safety of our employees, stakeholders, and communities. Without them, we would not be able to do what we do. One of

the most important actions we are taking as a group to slow the spread of COVID-19 in our communities is staying home.

The NRC started shifting operations to telework on March 16; as of March 27, an unprecedented 90 percent of us are working remotely, which took great effort from many hands to achieve. The roughly 10 percent of employees who remain onsite are playing key roles by keeping our facilities safe and secure, monitoring equipment so we have the data required to continue working offsite, receiving important shipments of material, and— perhaps most urgently now— working on COVID-19-related projects. We are working every day to keep these essential employees safe so they can continue to make it possible for us to help our clients, collaborators, and country move forward.

PROTECTING THE HEALTH OF CANADIANS

The NRC exists to bring research and innovative solutions in response to societal and economic challenges. The importance of our work was brought to the forefront when the Prime Minister announced Canada's plans to mobilize industry (1) and science (2) to fight COVID-19. We are now taking to our laboratories and mobilizing on a wide range of projects and initiatives, including:

1. THE COVID-19 CHALLENGES PROCUREMENT PROGRAM (3)

Our Industrial Research Assistance Program (NRC IRAP) is building on its relationships with thousands of Canada's most innovative small and medium-sized enterprises (SMEs) to expedite technology development and quickly bring solutions to the market or for government procurement. NRC IRAP and Innovative

Solutions Canada launched calls for proposals (4) to Canadian SMEs to find and fund the development of solutions that address current and future COVID-19-related needs.

More than 1,100 Canadian companies with promising technology relevant to the COVID-19 effort registered with us to participate, and NRC IRAP hosted “pitch sessions” for promising applicants to present their companies, teams, innovations, and technologies for consideration before a panel of experts. Successful applicants will soon receive funding to develop a proof of concept for their solution, following which additional funding will be allocated to those with the best concepts so they can develop a working prototype.

2. THE PANDEMIC RESPONSE CHALLENGE PROGRAM (5)

The NRC has a long tradition of collaborating with the public and private sectors, and bringing together experts to collaborate on solving big challenges. Our newest challenge program will form teams of researchers from across government, academia, and industry to address challenges and accelerate R&D in priority areas in the fight against COVID-19, with funding available for eligible participants to help cover research costs. The Pandemic Response Challenge Program is structured around four main research pillars: rapid detection and diagnosis; therapeutics and vaccine development; digital health; and enabling adaptive responses. Projects under the fourth pillar are already underway on sanitizing and certifying N95 masks, as well as producing reagents and other consumables needed to secure Canada’s supply chain for diagnostic testing.

3. INCREASING BIOMANUFACTURING CAPACITY AND VACCINE DEVELOPMENT (6)

We are working with our partners to develop and scale up production of potential vaccine candidates against COVID-19. The Government of Canada’s \$15 million investment in our biomanufacturing facility in Montréal will allow us to establish Good Manufacturing Practice compliance in months— as opposed to years— to ensure we are ready to scale up production once a viable vaccine is found. An additional \$29 million was recently allocated (7) to allow the research centre to begin the second phase

of critical upgrades in view of preparing to produce vaccines for clinical trials. We are also in discussions to assist our collaborators in advancing vaccine candidates to clinical trials in Canada.

The NRC also has a unique opportunity, given our range of expertise and capacity, to support businesses of all sizes, academics, and governments in their efforts against this devastating virus. Our stakeholders are organizing themselves to manufacture ventilators, mix enzymes for test kits, test mask quality, and explore alternate sterilization techniques for personal protective equipment— among many other projects that seem to multiply every day. We are proud to continue providing our best advice and technical support to help them.

SUPPORTING CANADIAN BUSINESS

While many businesses are able to retool their processes and facilities to respond to COVID-19, there are many more who are struggling with supply chain disruptions, cash flow issues, a collapse in demand and a lack of access to COVID-19 business support. In addition to advising and supporting our SME clients, as NRC IRAP has been doing for more than 70 years, the government’s recent \$250 million injection into NRC IRAP (8) allowed us to launch the Innovation Assistance Program. This program will help protect the next generation of Canadian entrepreneurs and the people they employ so we can have the best chance at emerging from this pandemic in a position to move forward.

The world we were in little more than one month ago is vastly different from the one in which we find ourselves today. The key to Canada’s response, and our strength as a nation, is collaboration and application. Developing therapies, vaccines, and industrial capacity at home requires the efforts of a broad array of experts across government and industry. Working together to achieve shared goals enables us to turn research and ideas into viable solutions to our most pressing problems.

This must now be our focus. If we are to be successful in the fight against COVID-19, this has to be a truly collective effort as we do everything in our power to change this world for the better.

I know we can, together.

Social Impacts





Public participation, planning, and COVID-19

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The introduction of physical distancing directives in mid-March 2020 means that a critical tool in the public planners' toolbox is unavailable for the foreseeable future. Urban planning processes in Canada and around the world rely heavily on public meetings to engage stakeholders and uphold democratic ideals. Since the 1960s, planners have used instruments such as Arnstein's ladder of public participation to promote meaningful consultation with the public. Meetings outlining proposed developments and new policy initiatives are one of the most important opportunities that planners and decision makers have to ensure that citizens have a say in the shaping of our cities.

Without the option of face-to-face meetings, online platforms have emerged as the best way to engage people in planning discussions. The same tools that governments and businesses are using to let workers self-isolate in the safety of their homes also provide new avenues by which members of the public can participate in the planning process. However, Canadians do not have equal access to these tools or to the Internet connections required to make them work. For example, one might expect significant differences between stakeholders of different ages or between rural and urban dwellers with vastly different access to broadband connections.

The Ontario Government passed the COVID-19 Support and Protection Act with several amendments to

planning and related legislation. This legislation makes it possible to suspend certain municipal planning decision timelines during the state of emergency, as well as changes to the Development Charges Act. The Planning Act amendments authorize the Ontario Minister of Municipal Affairs and Housing to suspend specified timelines associated with land use planning matters. However, municipalities and planning boards can still make decisions on land use planning during this time of suspended timelines and they can consider using electronic and virtual channels to engage with public stakeholders. With these circumstances in mind, we provide the following insights based on our research with stakeholder engagement.

Research we have recently undertaken in Halton region provides some interesting insight into the question of how new tools will affect stakeholder engagement. Over the course of 2018-19, we carried out over 200 web-based surveys, 20 phone- or computer-enabled interviews, and 2 widely-advertised physical workshops with planners, workers, and residents of Halton region. This work - originally designed to ask questions about incorporating ecosystem services into Natural Heritage System planning - thus provides a very interesting set of insights into the power of different engagement methods to bring groups of stakeholders to the table.

One of our first key insights is that internet- or phone

-enabled engagement with stakeholders can bring a wide diversity of people to the table. Our work targeted industry (including farmers), residents, planners, government officials, and ENGOs.

We found that we were able to solicit the views of each of these groups in meaningful ways in our surveys and interviews. In part this is because these tools were flexible; respondents could choose to answer a survey over an extended period, and interviews were scheduled to respect people's schedules. By comparison, our workshops were dominated by residents who took time out of their schedules to attend; we had no representation from industry (despite scheduling meetings at different times in the day), and far less representation from government and the planning community. If our work were to rely solely upon public meetings, we would miss important viewpoints from key stakeholder groups.

Another key insight is that different tools provide stakeholders with different kinds of opportunities to engage. Some stakeholders respond well to question-and-answer formats that provide structure and guidance throughout the interaction; others prefer more open styles of engagement. We observed some stakeholders that were comfortable engaging in all forms of communication (workshop, survey, and interview), but others restricted their engagement to a single pathway. While not definitive, this suggests that opening different kinds of channels for public

participation is critical to ensure that different viewpoints are heard.

A critical takeaway from our work is that tools for remote engagement have emerged that are far more powerful than what might have been available even ten years ago. Our ability to conduct sophisticated surveys is far better and cheaper today than it was in the past, thanks to free or low-cost online tools. Surveys and questionnaires can be developed such that participants can rank choices, pick from multiple choices, use sliders along a scale or answer open-ended questions. These tools provide qualitative and quantitative data that is important to inform the planning process.

Our ability to remotely conduct meaningful interviews is dramatically increased by the potential to observe stakeholders via skype or similar tools, and this enriches the feedback received through these interviews. Emerging video conferencing tools should allow virtual meetings to be held with members of the public in ways that will allow them to interact, not just with the planners, but with each other. However, the use of these types of tools also raises important ethical questions; should meetings be recorded for future viewing? Are individuals as comfortable with remote connections as they are in person, and does the nature of the connection affect their responses?

These are questions to be answered.



Medical Education Post COVID-19



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The COVID-19 pandemic has demonstrated that most countries and their health systems were not prepared to deal with a health emergency of this kind. We also know that there will be other such disasters, perhaps another pandemic or a climate change emergency. In response to the COVID-19 pandemic, medical schools and universities around the world have also been disrupted and have had to modify their teaching models. While these adaptations are likely temporary, we believe undergraduate medical education (UME) programs should carefully consider fundamental changes to better prepare for the next emergency.

Some short-term changes:

Medical school curricula will respond to this pandemic by placing greater emphasis on public health and preventative medicine and the social determinants of health. While anti-oppression education and community outreach initiatives are already part of the socially accountable mission of Canadian medical schools, their place of importance should be significantly expanded to more effectively serve populations who are

severely affected during public health crises.

A fundamental realignment of the UME program is desirable:

The COVID-19 pandemic has clearly confirmed the need for a rapidly deployable reserve of clinically prepared medical students to augment the health care workforce. When the next local or global crisis confronts us, our students must be better prepared to assist physicians and other frontline healthcare providers. We realize that there are many reasons why medical students have not been immediately utilized to support the health care workforce. However, given that these issues can be resolved, our medical students will need to be prepared to assume a meaningful and supportive role alongside licensed health professionals when need requires it.

There is evidence that we have not prepared our medical students very well (John, 2017). We therefore need to engage our students in learning basic medical practices at the start of their training. By

this we mean applied knowledge, skills and attitudes in areas such as:

- distinguishing between normal and abnormal presentations and viral and bacterial infections for common and/or critical patient situation
- establishing a therapeutic relationship and conducting an effective patient interview using the most effective communication skills (especially non-verbal)
- helping patients, families, colleagues, and self manage grief and trauma (particularly important during disasters but always useful in health care)

Responsive leaders can proactively improve medical education in the long term with more clinically relevant and rewarding student experiences that better meet our social contract. Medical practice first, some argue (Weston, 2018), is a more effective way to form, educate and train medical learners: it is more motivating and allows for successful integration of biomedical science with clinical presentations and treatments. Furthermore, when the next emergency occurs, learning these basic medical practices will not be interrupted since they will already be in place. As we have witnessed, learning about the biomedical and social sciences can be accomplished online during a pandemic. Learning the basics of medical practice at the outset will also better prepare students for their clinical learning experiences in later phases of training, and it will make the MD degree more accessible for students with diverse educational and personal backgrounds (rather than favouring those with biomedical science degrees). It will also mean that, when needed, our medical students will be ready to provide respite and aid to an exhausted and overwhelmed medical workforce. UME will experience less disruption of educational programs and student progress when the next disaster falls upon us.

The Association of Faculties of Medicine Canada has been working on an initiative to focus on and reorganize the teaching and assessment of core professional skills to facilitate the transition to residency. (AFMC, 2020). The COVID-19 pandemic will inject some urgency into their efforts. To this welcomed transformation we add only the recommendation that these be introduced, taught, and assessed as early as possible.

Conclusion:

After SARS we heard calls for heightened readiness of public health and health systems for the next pandemic (Thompson, 2003) and for better preparation for disasters generally (Smith et al, 2012; John et al, 2017; Kim et al, 2018). But, with few exceptions (Krane et al. 2007), they went unheeded. After the tandem tragedies of the Spanish Flu and WW I came the Roaring 20s. After WW II, wartime practices of admitting students from diverse backgrounds and women were abandoned (Ludmerer, 1999). While COVID-19 has been and will continue to be a significant catalyst for change in UME, it will be challenging to ensure that the adaptations will be sustained over time (Coyne, 2020).

This moment in history calls for bold thinking supported by robust evidence and a renewed commitment to the social contract between medical schools and the populations they serve. Undeniably, current and future medical students are learning firsthand what we cannot forget or ignore, that they need to be prepared to respond rapidly to the next global or local disaster.

References available in online version at <https://sciencepolicy.ca/response-covid-19>



Microbial Health Risks Facing Migrant Farm Workers in Canada: The Realities that Pre-date COVID-19

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As the world battles an ongoing pandemic, it is hard not to notice all of the changes happening around us. From changing daily routines, to ever-evolving policies, change seems to be the only constant over the last couple of weeks. One major change that has the potential to impact many agricultural communities is the closing of international borders. For many farmers, this would limit their ability to bring in migrant farmworkers through the Seasonal Agricultural Worker Program (SAWP). In an effort to safeguard trade, health and food security for Canadians, the Government of Canada provided an update on travel restrictions, with exemptions that include seasonal agricultural workers. As we try to navigate the details of these new changes, it's important to address the structural issues that currently already exist within the SAWP. Precarious working and living conditions, coupled with weak enforcement of workplace and housing standards, are long standing issues that pre-date and exacerbate the risks associated with the arrival of COVID-19. Circumstances that can put seasonal farmworkers at a greater risk of contracting COVID-19.

Seasonal workers, mainly from Mexico, Jamaica and other Caribbean countries, work in specific on-farm primary agricultural activities. These activities include care, breeding, and sanitation of animals, and the planting, harvesting and preparation of crops. This

seasonal labour force is a vital part of the food system, Canadian food security, and the economy. Migrant workers can make positive contributions to a farm's performance, and productivity, bringing in culturally unique skills. In Canada, they fill a labour gap on an annual basis, making them an experienced, reliable and consistent work force. Workers coming in under SAWP have the opportunity to financially support their families and livelihoods back home, while also heavily contributing to the flow of remittance in their home countries.

However, despite the requirement for health screening prior to arrival, research has shown that migrant farmworkers face a range of known specific health threats during their tenure in Canada. These include physical trauma causing musculoskeletal disorders, and microbial exposures causing gastrointestinal illnesses (Orkin et al., 2014). Previous studies have also shown that migrant farmworkers face increased vulnerability to infectious diseases (Oren et al., 2014). The factors driving the microbial health risks facing this population are already present, making the quarantine measures necessary to curb the spread of COVID-19 difficult to achieve.

Potential factors contributing to farmworker microbial health most notably include preharvest sources of microbial contamination. Some of these sources

include: the irrigation water source used, crop type, soil applications, animals husbandry on site, and inadequately composted manure (Stine et al.,2005). Although many of these large farms allow for worker separation on fields, and in greenhouses, they lack adequate hygiene and sanitation facilities in these workplace settings. Insufficient toilet and handwashing facilities at worksites, may heighten the risk of migrant farmworkers developing and spreading microbial diseases (Hennebry and Preibisch.,2011). Risks can be managed through the delivery of appropriate training, provision of adequate worksite hygiene and sanitation facilities, and supply of proper personal protective equipment (PPE).

The temporary nature of their working and living arrangement is also a risk driver, where temporary infrastructure and high occupational densities can accelerate the rate of secondary transmission of microbial disease. These elements can be better managed through strong housing guidelines and frequent inspections to ensure compliance. The Foreign Agricultural Resources Management Services (F.A.R.M.S), responsible for facilitating and coordinating requests for seasonal agricultural workers, provides a document outlining seasonal farmworker housing guidelines. The limits identified note at least 18-inches between bunk beds, and 10 workers to a single toilet, making it difficult to maintain safe social distance un-

der normal conditions, and nearly impossible during a pandemic. For some incoming travellers the government has provided accommodations in hotels, or isolated military bases, to properly carry out the mandatory 14-day isolation. As for migrant farmworkers, we have left them to variable living conditions, and have unfairly relinquished the responsibility with very little guidance to employers.

Ultimately, as we have seen unfold in the last few weeks, “the participation of temporary foreign workers on our farms and in our food businesses is absolutely necessary”, as noted by Minister Claude Bibeau. Given the current circumstances, we need to highlight in our broader policy development the need to protect migrant worker health. To start, we must address the microbial health risks that pre-date COVID-19 facing this group of workers. Ensuring worksite hygiene and sanitation facilities, compliance of housing guidelines, and access to health care, will ensure lasting positive change - change that will contribute to better management of microbial health risks, and improved Canadian food and public health security.

References available in online version at <https://sciencepolicy.ca/response-covid-19>



Policy Development



Us versus Them - The fight against SARS-CoV-2

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The Chinese general, military strategist, writer and philosopher, Sun Tzu, is believed to have said, “Know thy self, know thy enemy – a thousand battles, a thousand victories”. While I am certain Sun Tzu was not thinking about a coordinated attack by an invisible enemy on the entire human race, what I am certain about is that he understood the Art of War. The current pandemic crisis has pitched humans against SARS2-CoV-2, the virus that causes the disease COVID-19. Just as the strategic use of war tactics have influenced many important battles throughout history, the secret to our success will be tied to how we approach to defeat this deadly virus.

Like any war, while it is important to understand the force of the enemy, it is equally important to understand one’s own capability and capacity to fight. Just as it is important to understand the genetic evolution of the virus, it is imperative that we also understand the host (human) genetics response to this particular enemy. Now is the time to take advantage of our collective scientific knowledge of the viral and host genetics to protect communities around the globe.

The obvious starting point is the comparison of the genomes of people who have experienced serious and life-threatening symptoms, to those experiencing mild or no symptoms. The goal will be to understand the variation in disease severity as a direct function of the version of the human genome one carries. As evidenced by our understanding of the human genome role in response to the SARS outbreak, disease severity and outcomes may be attributable to the host genetics profile. Early studies on COVID-19 patients also point to the fact that the difference in disease severity might be predominantly rooted deep into a per-

son’s own genetic makeup. In this global fight against SARS-CoV-2, we must understand how we respond to the many tactical (genetic) variations the virus throws at us.

Studying coronavirus-host interactions will not only yield valuable insights into the molecular function of the replicative cycle and pathogenesis, but will also be a starting point for the development of antiviral strategies to complement the efforts of vaccine development and disease control. In the last two months, the scientific community has rallied together to highlight the importance of understanding the role of the host genome. Recognizing the importance of the pressing need to build a database of Canadian host genomic information, the Canadian Federal Government recently committed \$20 million in funding to CGEn, Canada’s national facility for genome sequencing and analysis, to lead a nation-wide Host Genome Sequencing Initiative with the aim to sequence genomes of 10,000 Canadians affected by COVID-19. For this initiative, CGEn has been specifically tasked to sequence the genomes of individuals affected by COVID-19 and build a Canadian genomic data resource that is accessible to Canadian researchers and will aid in studying genetic risk factors associated with

the severity of COVID-19. Such a resource will help scientists discover host genetic susceptibility factors, inform public health decisions regarding COVID-19 and bring us closer to enabling personalized risk prediction and precision therapeutic strategies.

The only way to claim victory is to predict future moves of the (mutating) enemy while understanding our own strengths and weaknesses, so that we can effectively respond today and stay ahead during any future outbreak.

This pandemic has no doubt encouraged collaborations and coordination at a global scale. Govern-

ments, provincial jurisdictions and local health authorities have been forced to rethink their policies around information sharing and data exchange. I believe that there is life after COVID. In that life, it will be essential that we, as a collective, look at how we evolve our policies that allow us to think, not just as one nation, but also as a united human race.

In this war of us (humans) versus them (virus), we have to win – the future of humanity depends on it!





COVID-19: Science, Policy and Politics

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The current COVID-19 pandemic is caused by SARS-CoV-2, a novel human coronavirus. The latest reports show that in less than 4 months, the virus has infected more than 3 million people worldwide, killing more 200,000¹ and has impacted the whole planet in unprecedented ways. Communities are decimated, travel and commerce nearly halted, and the world economy has reached a standstill with record-breaking job losses all over the world and a global recession at our doorsteps. Although there is a perception that the International public health community was caught by surprise, I would argue that a major contributor to the current catastrophe is the divide and the complicated relationship between science, policy and politics.

According to data published in academic peer-reviewed journals and government reports, the pandemic is thought to have started in November or in early December 2019 in a wet animal market in Wuhan, Hubei Province, China.^{2,3} This is a classic example of cross-species transmission, where the virus is purported to have jumped from bats (animal reservoir) to pangolins (Intermediate host) and finally to humans, and thereafter transmission within human populations have been exclusively person to person. The current state of science indicates that the virus is transmitted by inhalation and ingestion of viral particles. COVID-19 has unusually high primary and secondary attack rates⁴ and case fatality rates (range 1 % to 15 %).¹

Despite many weeks of mounting evidence suggesting the rapid spread of a new virus, it was not until December 31st 2019 that the World Health

Organization (WHO) was informed of a cluster of cases of pneumonia of unknown etiology in Wuhan. From Dec 31st 2019 through January 3rd 2020, 44 such cases were reported to the WHO. The causative agent, a coronavirus, was identified on 07/01/2020 and the genetic sequence of the virus was made public on 12/01/2020. The first case outside of China was suspected on 08/01/2020, confirmed on the 12/02/2020 and formally reported in Thailand on 13/01/2020. Shortly afterwards (20/01/2020) Japan and South Korea reported their first cases and soon thereafter the pandemic started unfurling in other South East Asian Countries. Most of the hard hit countries registered their first cases in late January: Germany (23/01/2020),⁵ Italy (28/01/2020),⁵ Canada (27/01/2020),⁶ USA (24/01/2020),⁷ France (24/01/2020),⁸ UK (26/01/2020),⁹ Spain (29/01/2020)⁸ and Belgium (04/02/2020).¹

Based on of the high number of peer-reviewed scientific papers on Covid-19 published in the past 3 months and the sequence of events as reported by reputable institutions such as the World Health Organization, the Chinese Center for Disease Control and Prevention (CDC), the US CDC and Eurosurveillance, it is plausible to assume that by mid February, scientists had already gathered robust data on the epidemiology, the biology of the virus, and the disease severity in humans. Given the current scale of the pandemic, we can only infer that massive research output on COVID-19 was not effectively translated in public health policies, recommendations, and actions in an efficient and timely manner across the world.

It is unclear why travel restrictions in and out of Hubei Province were not enforced early in the first week of January, rather than on January 23rd, when more than 5 million people in this province had already travelled from Hubei into other areas of China. We can only speculate that the hesitation was most likely due to the upcoming celebration of the Chinese New Year.¹⁰ Given the current scale of the pandemic and its dire consequences around the world, it is not surprising that some Western mainstream media outlets are critical in the way China handled the initial outbreak and are questioning whether the WHO is really empowered to investigate and address deadly pandemics like COVID-19. The recent revision of the number of deaths by Chinese authorities, can only boost this skepticism.¹¹

Data from Europe and North America show that there is, on average, 35 days between their 1st and 100th case, which seems to be a reasonable time for governments to take appropriate actions, proportional to the biological characteristics and the epidemic behavior of COVID-19. How far and how fast does implementation of science-driven public health policies, impact morbidity and mortality can be exemplified by the relatively low incidence and case fatality rates in Canada and Germany, compared to North American and European counterparts.

In light of the above, there are a few pertinent themes that the International public health community, international law scholars and world leaders should seriously reflect on.

1. There is no doubt that infectious diseases are emerging and re-emerging at an ever-increasing frequency in different parts of the world, with the potential to decimate populations, triggering economic havoc and destabilizing societies way beyond the geography of the initial outbreak. Is there a need to create a solid and internationally funded Epidemic Intelligence Unit within the World Health Organization? Within this framework, scientists and clinicians from around the world could have the authority under international law to have a presence on the ground and investigate disease outbreaks based on reliable and verified whistleblowing. The Regulatory



Inspection Programme of the International Atomic Energy Agency can possibly be adapted to the context of emerging infectious diseases.

2. By and large, public health response to disease outbreaks essentially involves 4 stages - early detection, containment, mitigation and eradication. It is increasingly clear that for visible and sustainable progress is to be made, community involvement and buy-in is imperative at every stage. During the current pandemic, irrespective of the type of government in place, different countries have had varying degrees of success in getting their populations to adopt and practice public health recommendations. Given the significant non-compliance rate with public health advisories, local, provincial, and federal authorities in Canada had to quickly and swiftly move from educating the public on best practices to have special public health orders and enforcing them. One of the gaps that the current pandemic has exposed is the lack of a comprehensive and structured strategy of risk communication during emerging infectious disease outbreaks, when the science is constantly evolving. With a view of preparing and consolidating the next generation of public health leaders, academic public health programs should seriously consider integrating concepts of risk assessment, risk tolerance, risk communication and risk

management as part of their core curriculums.

3. Over the course of the past 3 months, from a small outbreak in Wuhan to a full-scale pandemic around the world, leaders in Western democracies have demonstrated different approaches to handling the evolving science around COVID-19 and epidemiological data. With regards to the trust in science and data, some leaders have been plainly dismissive, others have had to re-adjust their positions a few times, and a handful of leaders were very attentive to infectious disease experts. For example, Canada was instrumental in using the expertise of the Public Health Agency of Canada, created shortly after the 2003 SARS outbreak, to drive policies based on objective, up-to-date and reliable data.

How the course of the epidemic unfolded in each jurisdiction depends in large part on how the scientific advice was delivered, received and acted upon. How we manage the relationship between science, policy and politics in the foreseeable future will have a major impact on how much scientists can influence evidence-based public health policy.

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Unify the Cause: Labor Policy is Health

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Policy areas are problematically compartmentalized. For instance, labor policy is generally taught separately from other disciplines, has dedicated think tanks, and consists of interest groups that seek money to fund narrowly focused projects. This is not an indictment of labor policy nor its practitioners; it is a widely true phenomenon for all policy areas. Money, and certainly time, are zero-sum. Every would-be policy expert, every hour of research, and every dollar that goes to one area does not go to the rest.

While compartmentalization has always been academically problematic, in practice it worked well. After all, it is just ‘specialization and division of labor’ when you get down to it. However, COVID-19 has given us a fine reference point of compartmentalization becoming a practical problem. Of all the barriers between policy areas that COVID-19 might invite us to break down, including imagined walls that keep the value of experts in the humanities (e.g. bioethics) and social sciences (e.g. political science and sociology) out of the policy conversation, the imagined palisade between labor and health policy needs to go first.

I anticipate the automatic response from those not already sympathetic to the idea will be to suggest that labor and health policy are already deeply interwoven. Look no further than employer-based health insurance and the existence of the Occupational Safety and Health Administration (OSHA) within the U.S. Department of Labor. Unfortunately, OSHA and the U.S. health insurance system often perform sub-

optimally, to say the least. Moreover, while the Canadian system is better, it nevertheless has shortcomings of its own.. Sick leave entitlement ranges from 3 days in Manitoba to 26 weeks in Quebec, all of which are generally unpaid. The Canadian government expects support might come from the Canada Pension Plan and/or from Employment Insurance.

That said, these are more the health aspects of labor policy, whereas my aim is to suggest that we see parts of labor policy as health policy. Health is cumulatively affected by sick leave, wage protection, maternity and paternity leave, and tools for absorbing the impacts of personal emergencies. While this is no secret, those effects were often seen as indirect and couched in ideas like work-life balance and overall quality of life. What we can now see clearly by the light of the swamp gas flares over humankind’s newest mass graves is that these things impact not just having a high quality of life, but rather having life at all.

Around the world, millions must work because of their financial circumstances, employer demands, or government classification of their work as ‘essential’ service. When labor policies and culture lead one to a forced choice of accepting huge risks of infection, and even death, often in exchange for very little pay and otherwise poor treatment, something must be done. I am confident that in the absence of these pressures most people would take appropriate precautionary measures and would exhibit an abundance of caution in regards to their own health and

wellbeing, and that of others.

Unfortunately, we do not have the option of testing this hypothesis in a controlled experimental setting. Interestingly, the popular online game World of Warcraft (WoW) offers us a rare, and oddly relevant, 'natural' experiment from which to gain insights into COVID-19. In 2005, WoW saw an accidental plague (known as the Corrupted Blood Incident, and actually used as a model by epidemiologists today) wipe out all its major population centers and other population knots. Here, without work pressure, people did everything correctly: abandoned densely populated cities, self-isolated, started clean zones where one had to be cured or proven to be clean before even approaching others, and so on. Policy needs to protect these good instincts. Work should not make one 'risk it' and policy needs to step in to control for self-interest, even greed, within the hearts of some corporate entities

and their leadership.

But policy needs to go a step further. Notice I said that (1) WoW's players did everything right and (2) that cities were wiped out. Quarantine is a start. WoW saw programmer-imposed quarantines, but it was not enough. It took a treatment. A cure.

Of course, it is not the role of politicians and policy-makers to propose cures - especially not cures found in a cleaning supplies aisle - but it is on them to make sure the people are protected and research is supported. It is on them to ensure that the truly needed work is done and that those deemed 'essential' are never required to risk their health for profits they do not share.

It is time to cast off our conceits and come together. After all, labor policy is health policy.



Reconciling the incompatible: numbers, humans, and COVID-19

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It can become overwhelming as one looks at the images of coffins laid out in various venues, listens to exhausted health care professionals, and sees body bags being loaded onto vans while reading stories about the people who have been hospitalized and/or have died.

In this sea of information, it's easy to forget that COVID-19 is one in a long history of pandemics. For the sake of brevity, here's a mostly complete roundup of the last 100 years. The H1N1 pandemic of 1918/19 resulted in either 17 million, 50 million, or 100 million deaths depending on the source of information. The H2N2 pandemic of 1958/59 resulted in approximately 1.1 million deaths; the H3N2 pandemic of 1968/69 resulted in somewhere from 1 to 4 million deaths; and the H1N1pdm09 pandemic of 2009 resulted in roughly 150,000 -575,000 deaths. The HIV/AIDS global pandemic or epidemic, depending on the agency, is ongoing. The estimate for HIV/AIDS-related deaths in 2018 alone was between 500,000 - 1.1 million.

It's now clear that the 2019/20 pandemic will take upwards of 350,000 lives and, quite possibly, many more lives before it has run its course.

On the face of it, the numbers for COVID-19 would not seem to occasion the current massive attempt at physical isolation which ranges across the globe and within entire countries. There is no record of any such previous, more or less global effort. In the past, physical isolation seems to have been practiced on a more localized level.

We are told the current 'flattening the curve' policy is an attempt to constrain the numbers so as to lighten the burden on the health care system, i.e. the primary focus being to lessen the number of people needing

care at any one time and also lessening the number of deaths and hospitalizations.

It's an idea that can be traced back in more recent times to the 1918/19 pandemic (and stretches back to at least the 17th century when as a student Isaac Newton was sent home from Cambridge to self-isolate from the Great Plague of London).

During the 1918/19 pandemic, Philadelphia and St. Louis, in the US had vastly different experiences. Ignoring advice from infectious disease experts, Philadelphia held a large public parade. Within two or three days, people sickened and, ultimately, 16,000 died in six months. By contrast, St. Louis adopted social and physical isolation measures suffering 2,000 deaths and flattening the curve. (That city too suffered greatly but more slowly.)

In 2019/20, many governments were slow to respond and many have been harshly criticized for their tardiness. Government leaders seem to have been following an older script, something more laissez-faire, something similar to the one we have followed with past pandemics.

We are breaking new ground by following a policy that is untested at this scale.

Viewed positively, the policy hints at a shift in how we view disease and death and hopes are that this heralds a more cohesive and integrated approach to all life on this planet. Viewed more negatively, it suggests an agenda of social control being enacted and promoted to varying degrees across the planet.

Regardless of your perspective, 'flattening the curve' seems to have been employed without any substantive consideration of collateral damages and

unintended consequences.

We are beginning to understand some of the consequences. On April 5, 2020, UN Secretary-General Antonio Guterres expressed grave concern about a global surge in domestic violence. King's College London and the Australian National University released a report on April 9, 2020 estimating that half a billion people around the world may be pushed into poverty because of these measures.

As well, access to water, which many of us take for granted, can be highly problematic. Homeless people, incarcerated people, indigenous peoples and others note that washing with water and soap, the recommended practice for killing the virus should it land on you, is not a simple matter for them.

More crises such as pandemics, climate change, as seen in extreme weather events and water shortages along with rising sea levels around the world, and economic downturns either singly or connected together in ways we have difficulty fully appreciating can be anticipated.

In addition to engaging experts as we navigate our way into the future, we can look to artists, writers, citizen scientists, elders, indigenous communities, rural and urban communities, politicians, philosophers, ethicists, religious leaders, and bureaucrats of all stripes for more insight into the potential for collateral and unintended consequences.

We have the tools - what remains is the will and the wit to use them. Brute force analysis has its uses but it's also important to pay attention to the outliers. "We cannot solve our problems with the same thinking we used when we created them." (Albert Einstein)

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COVID-19 Resiliency, Indigenous Protected and Conserved Areas, and Essential Economics

Bare shelves at the grocery store. A nationwide rush on toilet paper. Businesses shuttered, millions of Canadians laid off work, and a massive and unprecedented public relief program announced by the federal government.

Truly, this is a remarkable moment in history.

We acknowledge that people are hurting, and people are scared. The COVID-19 pandemic continues to bring suffering and great upheaval around the world, especially to disadvantaged communities who lack access to universal healthcare, clean water, and other necessities of life that many in Canada take for granted.

There is also much that society can learn from Indigenous Peoples at this time.

COVID-19 affects everyone. People in Canada and around the world face drastic changes to their daily routines. The current crisis invites us as Canadians and global citizens, to reflect on the social and economic systems that we have all too often taken for granted, and to collectively ask ourselves some core questions:

- Why are our social and economic systems structured the way they are?
- Whose interests do these systems serve?
- What are the alternatives?

COVID-19 exposes the vulnerability and lack of resilience of the current world economic system. In Canada, our staples economy has long depended on raw

resource extraction and global trade circuits to provide the necessities of life such as food. At few times in recent history has this dependency appeared so fragile. We are reminded that we cannot eat timber, oil, natural gas, or the myriad minerals that are mined in Canada. What's more, industrial practices have fragmented and degraded natural ecosystems across Canada, which have been stewarded for abundance by Indigenous Peoples for generations out of mind. Even formerly abundant Pacific salmon fisheries are threatened by industrial fishing, open-net fish farms in the ocean, and deforestation in the watersheds.

As a society, in Canada and globally, we are faced with a choice. We can collectively choose to throw money and energy into shoring up the old broken economic system, bailing out fossil fuel companies, airlines, and other big polluters, in an effort to get 'back to normal.' That would be a tragedy and a missed opportunity: 'normal' has brought us the biodiversity crisis, the climate crisis, economic inequality, poverty, and the dispossession of Indigenous Peoples' lands.

Alternatively, we can collectively seize this opportunity to begin shifting our society into new economic models that promote resilience, abundance, and well-being of both ecosystems and human communities.

One model that is leading the way in Canada is Indigenous Protected and Conserved Areas (IPCAs). According to the [Indigenous Circle of Experts](#) for the

Pathway to Canada Target 1, IPCAs are “lands and waters where Indigenous governments have the primary role in protecting and conserving ecosystems through Indigenous laws, governance, and knowledge systems.” Reflecting the Indigenous value of interconnection between human communities and all life, IPCAs are also models for sustainable community development and land relationship planning at a watershed level.

As models for collaboration and reconciliation on the landscape, IPCAs are uniquely positioned to promote greater

resiliency to disruptions such as the COVID-19 pandemic. IPCAs embody the principles of Ethical Space, drawing on the best of Indigenous knowledge and western science to develop sustainable and locally adapted solutions.

COVID-19 is not the first pandemic Indigenous Peoples in Canada have faced. After Europeans first set foot on Turtle Island, successive waves of smallpox, influenza, and other diseases decimated an estimated 90% of the Indigenous population, a demographic disaster on a global scale. The experience of pandemic is embedded in Indigenous knowledge systems. In Tla-o-qui-aht Nation territory on the west coast of Vancouver Island, the Ha'uukmin Tribal Park protects a hidden valley where, five generations ago,

the people took refuge from the ravages of smallpox and other European diseases. Many Indigenous Nations have emphasized the need to protect these places of refuge in case the people need to quarantine again.

However, IPCAs do more than just protect these places of refuge. They also foster human relationships with these places. IPCAs are poised to become foundational elements renewed local economies based on stewardship for abundance and essential economics: things like clean water, clean air, and healthy food, reducing dependence on global markets controlled by huge transnational corporations. Unlike industrial resource extraction, the emerging IPCA economy is planning for long-term benefit, not only for the present generation, but for the grandchildren's grandchildren.

In conclusion, COVID-19 presents a rare opportunity to take stock of our social and economic systems. We can choose to become stronger and emerge from this crisis into a resilient future informed by the holistic values of Indigenous economics. Now more than ever, Canada needs a well-connected network of IPCAs stewarded for abundance that provide safe refuge and support resilient local economies, especially the essential economy upon which humans and all life depend: clean water, clean air, clean food.



Limiting the negative impact of the COVID-19 pandemic on Canadian postdoctoral scholars

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Every day as a postdoc counts. As such, the slowing of research and teaching, and the closing of work spaces such as laboratories, university classrooms, conference venues, and field sites due to the COVID-19 pandemic have rather unique and potentially career-altering repercussions for postdocs.

A postdoc is a temporary position awarded in academe, industry, nonprofit organization, or government primarily for gaining experience conducting research and other scholarly activities towards establishing an independent research/scholarship career. Postdocs bolster the research productivity of universities, and contribute to the teaching and research training of undergraduate and graduate students across all academic disciplines.

Why is the time aspect so crucial for postdocs? Con-
strued as a winnowing period for weeding scholars out of academia, the postdoc is normalized as one of the most productive and important periods in an academic career trajectory (Müller, 2014). Contracts have clearly defined start and end dates. Postdoctoral scholars, by the very nature of their contracts and the normative expectations of their positions, must focus on accumulating maximal academic capital per unit time (Müller, 2014). This is particularly true given that most funding agencies and institutions in Canada have now adopted 3-5 years (depending on discipline) after the attainment of a PhD as the maximum duration that any individual can hold a postdoctoral position. Thus, delays of lab experiments and fieldwork, cancellations of summer courses and



CAPS ACSP

conferences, or their conversion into virtual-only events, can have very real and detrimental consequences for postdocs whose career prospects are largely contingent on data collection, research production, teaching experience and the development of professional contacts under very real time constraints.

Our recent survey of 220 Canadian postdocs confirms the importance of pandemic-related interruptions (CAPS, 2020). For example, 77% of respondents have had to cancel travel plans for conferences, meetings and lab visits (Figure 1A), 37% note that their current

position has been or may be impacted (Figure 1B), and 31% have had or expect disruptions in their job search (Figure 1C).

The competitive nature of academia, coupled with individuals' professional goals and systemic expectations of intense productivity, mean that postdocs are unwilling or unable to slow down. Postdocs fear long-term impacts on their careers, and with good reason, since they are at an especially vulnerable position in the faculty career trajectory, so the COVID-19 pandemic is likely to be career-altering for many of them. Our survey data indicated that while 47% of postdoc respondents are able to work remotely and 35% have been able to adapt to remote work, 16% of respondents are unable to adapt their work for home, and 2% cannot work remotely at all (Figure 2).

COVID-19 has professional and personal impacts on postdocs. Over 70% of respondents ranked their research activities as "affected" to "very affected" by the pandemic (Figure 3). Concerns include: disruptions to ongoing research projects and the costs of resuming halted projects in the future; difficulties in accessing laboratories and locally-networked data; and forgoing travel funding. Postdocs also encounter teaching challenges, such as rapidly converting courses designed for classroom-based instruction into online courses. In addition to these professional challenges, postdocs must manage social isolation and juggle multiple roles at home - including providing 24/7 care labour for children while continuing professional responsibilities for some. Finally, access to mental health services is always critical for postdocs (Van Bentham et al., 2020) and problematic due to variable employer-provided benefits (Jadavji et al., 2016), so the pandemic may exacerbate challenges related to wellbeing.

Variation in postdoc status further complicates access to critical benefits during the pandemic. Depending on the source of postdoctoral funding and the policies in place at the institution where a postdoc holds their appointment, a postdoc may be variously classified as a 'student', 'trainee', 'employee', 'visiting researcher' or other (Sparling, 2019). Benefit eligibility is generally determined by status. Currently, many postdocs who do not have employee status (e.g., those funded by external funding agencies) are not eligible for Employment Insurance. Many of

Figure 1. Postdoc work interruptions

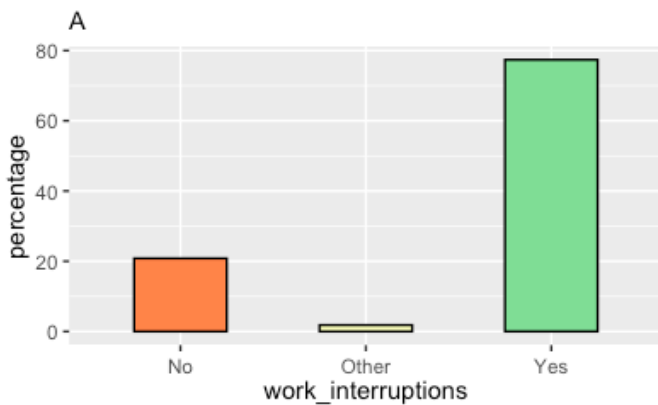


Figure 1. Postdoc fellowship interruptions

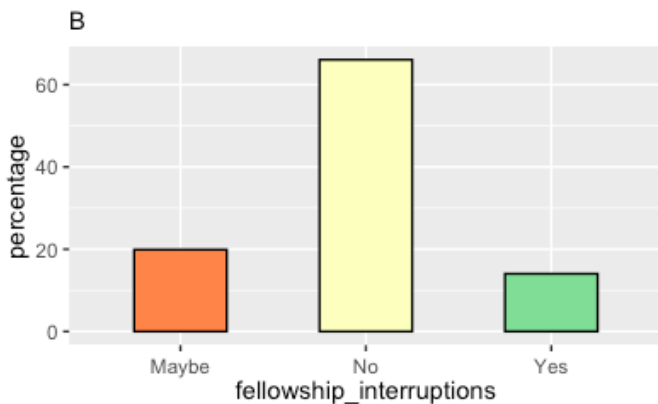
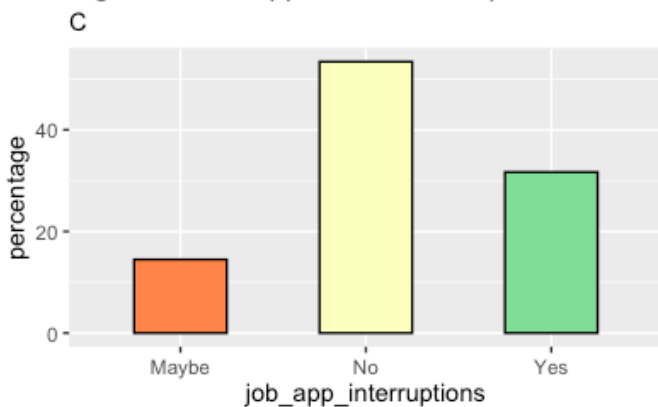
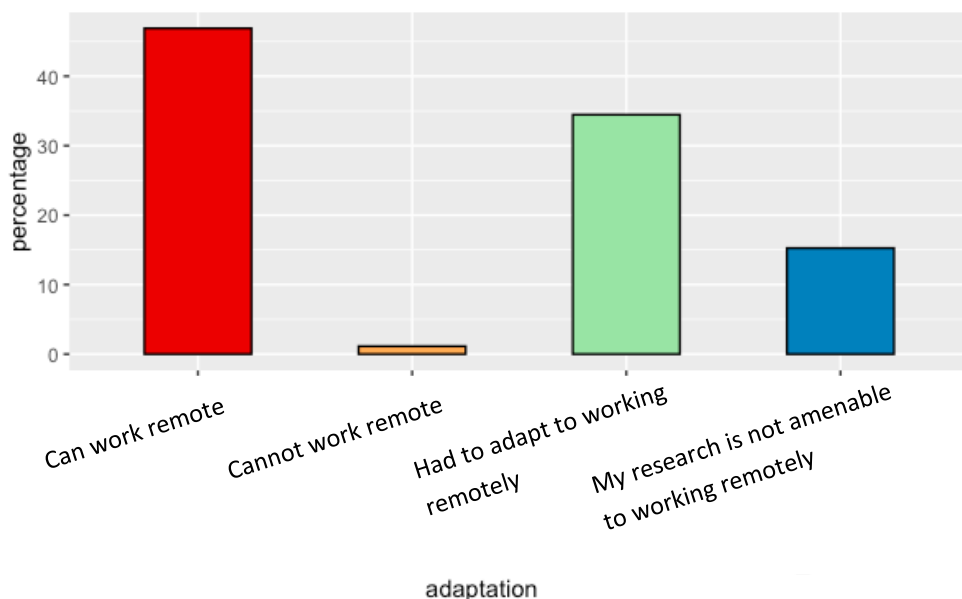


Figure 1. Job application interruptions



source: CAPS-ACSP COVID-19 Postdoc Survey

Figure 2. Amenability of postdocs research to remote work



source: CAPS-ACSP COVID-19 Postdoc Survey

severely exacerbated by the COVID-19 pandemic and these challenges now need to be addressed or we risk losing an entire cohort of postdoctoral scholars.

In the short-term, the Canadian Association of Postdoctoral Scholars (CAPS) recommends:

- Paid extension of fellowships, including access to university facilities, for a period at least equivalent to the length of university, school and daycare closures;
- Continuity of benefits during the pandemic and fellowship extension;

these postdocs will be eligible for the federal government’s other key financial aid program to help Canadian workers weather the pandemic - the Canadian Emergency Response Benefit (CERB). However new postdocs who have not yet earned the minimum income of \$5,000, will be ineligible for the CERB.

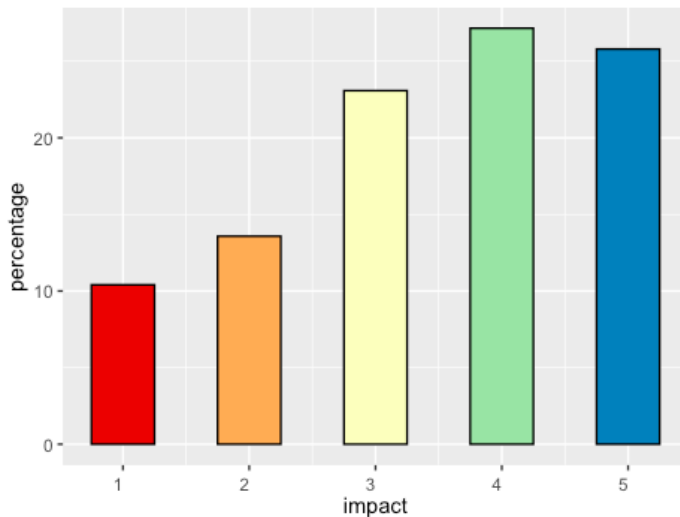
Canada’s postdoc talent comes from around the world, and the pandemic aggravates problems related to the existing patchwork of immigration policies for postdocs, ranging from institutional and funding agency policies to variability in federal work permit requirements and rules (Sparling, 2018). For example, as foreign workers, international postdocs must leave Canada at the end of their fellowship or risk becoming ‘illegalized’ in this country. The strict within-Canada and international travel restrictions in place at present make this process difficult and potentially dangerous, if not impossible. Even if international postdocs whose positions end during the pandemic manage to stay in Canada, work options are limited due to the overall slow-down of the economy and the closed nature of their work permits. Without a position, many international postdocs will find themselves and their families without health and dental insurance, and because their temporary social insurance numbers expire with their contracts, these postdocs are ineligible for the CERB.

The challenges facing postdocs in Canada have been

- Free and automatic extension of visas for international postdocs;
- Extension of deadlines for use of funding earmarked for fieldwork, conferences, or other scholarly endeavours for a period at least equivalent to that of the work interruption;
- Clear and timely dissemination of COVID-19 policies to postdocs from funding agencies, higher education institutions and postdoctoral unions;
- Appropriate accommodation of work expectations given the particular situation of individual postdocs;

Adequate support for home-based telework

Figure 3. COVID-19’s impact on postdoctoral work
Score of 5 being the most affected and 1 not very affected



source: CAPS-ACSP COVID-19 Postdoc Survey

- options for postdocs, including appropriate technological tools.

In the longer term, CAPS calls on higher education institutions and funding agencies to address the variance in postdoc status across disciplines, institutions and locations in Canada by granting postdocs employee status. Not only will this help mitigate challenges faced by postdocs in times of crisis, but it will also ensure adequate compensation and benefits for all postdocs outside crisis periods. Finally, CAPS implores future employers of today's postdocs to be compassionate in reviewing this particular period on our CVs when our productivity may appear significantly lower than usual.

Nation-wide, scholars, higher education institutions, funding agencies, unions and governments have responded to the current crisis with unprecedented speed, creativity and collaboration. We urge these stakeholders to address the particular needs of Canadian postdocs in their immediate and long-lasting responses to the COVID-19 pandemic.

References available in online version at <https://sciencepolicy.ca/response-covid-19>

The Canadian Association of Postdoctoral Scholars / l'Association Canadienne des Stagiaires Postdoctoraux aims to improve the lives, training, and work experience of all Canadian postdocs - including international postdocs working in Canada and Canadian postdocs working abroad. The vision that guides this mandate is one of a strong community in which all Canadian postdocs are provided fair and reasonable compensation, benefits, rights, privileges, and protections, as well as a supportive social network and effective support, training, and career development opportunities.



Cracking down on fake COVID cures: Is the government doing enough to protect the public?

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COVID-19 opportunists are capitalizing on the fear of Canadians by offering a variety of products to prevent, diagnose, or treat the disease, such as unapproved masks or testing kits and unproven vitamin or homeopathic treatments. In fact, Health Canada has not approved anything that will prevent, treat, or cure COVID-19, although several trials are underway. Regulators are working hard to keep harmful products off the market, but are they doing enough?

According to the *Food and Drugs Act*, it is an offence to advertise or sell products such as drugs or medical devices in a manner that is false, misleading, or deceptive, or likely to create an erroneous impression regarding efficacy. Although the Act contains a variety of sanctions for these activities, Health Canada's primary response is to direct companies to remove false or misleading claims from websites and advertising materials. Health Canada has cracked down on a variety of products alleged to treat COVID-19 including disinfectants, plant-based elixirs, mushroom blends, UV lamps, and oregano oil.

Canadians are also protected by the Competition Bureau, which is responsible for enforcing the *Competition Act*. This legislation prohibits deceptive marketing practices, such as false or misleading claims about a product's ability to prevent, treat, or cure COVID-19. Violators can be subject to significant fines. The *Criminal Code* also prohibits fraud, and can be used to prosecute COVID scams. In one of the rare prosecutions relating to COVID-19 health

products, an individual was criminally charged with fraud after attempting to import unapproved testing kits.

Perhaps even more dangerous than unapproved products sold over the internet or in stores are those peddled by health professionals. The concern is that individuals may not be appropriately skeptical, given that these are trusted experts. Although some self-regulatory bodies have cautioned their members against recommending COVID-19 cures, the problem persists. For example, the College of Chiropractors of Ontario has directed dozens of its members to cease claiming that chiropractic care boosts the immune system (thereby guarding against COVID-19). As with Health Canada, self-regulatory bodies have approached this problem by issuing warnings and directions, although they can also impose sanctions such as license suspensions.

Limited proactive enforcement reflects a gaping hole in how regulators address false or misleading health products or claims. Bogus therapies propagate faster than enforcement actions, particularly during a public health crisis, when people may be desperate for cures. So far, regulators have not implemented tools to get ahead of the lies and deception. Truthful advertising laws depend primarily on consumer complaints to trigger enforcement, and purveyors of fake or unproven cures have become very adept at generating enough consumer support to keep complaints at bay by preying on consumer fears.

Proactive regulatory tools, such as fraud prevention and awareness campaigns and regulator-driven monitoring, are often not deployed by Canadian regulators, largely due to a lack of enforcement capacity and resources. The unfortunate truth, therefore, is that those selling fake products can stay ahead of the regulatory game. And with the increasing use of artificial intelligence to target consumers, regulators are far behind in marshalling technology to detect and stop fraudulent electronic advertising.

Fragmentation of regulatory authority also enables the proliferation of fake or unproven health claims and products. While the federal government regulates health products and related advertising, provinces/territories regulate the delivery of healthcare services and health professionals. One strategy used by purveyors of unproven health products is to claim that they are providing a healthcare service and, as such, should be exempt from Health Canada regulations. This strategy has been used, for example, by physicians marketing unproven cell therapies. Health Canada recently sought to close this loophole by clarifying and strengthening regulations for new and

innovative health products. The involvement of health professionals such as chiropractors in COVID-19 opportunism should serve as a test of the updated framework. Greater collaboration between federal and provincial regulators is also needed to address the overlapping jurisdiction over false and misleading practices.

It is crucial that regulators are vigilant in cracking down on dangerous claims that products will prevent, treat or cure COVID-19. These products may not only be ineffective but could have serious side effects. If patients think that an at-home treatment will cure COVID-19, they may delay seeking testing or medical treatment, thereby putting their health at risk. And if an at-home test suggests that they are not infected or they believe that a vitamin treatment will protect them from contracting the disease, they may be less vigilant about social distancing or other infection control practices, thereby risking spreading the disease.

References available in online version at <https://sciencepolicy.ca/response-covid-19>



Pandemics Mitigation: Building Emergency Surge Capability (ESC)

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Pandemics are low-probability high-consequence events that inevitably occur, confirming Murphy's Law: If something can go wrong, it will. It is difficult, if not impossible, to anticipate when a pandemic will strike and how it will unfold.

The COVID-19 pandemic in the winter and spring of 2020 started in China and quickly spread into almost every country causing illness, deaths and disruptions to the world economies costing trillions of dollars. It is not possible at this time to make an assessment of the economic cost.

This brief editorial, written for the Canadian Science Policy Centre, focuses on what I believe is the main lesson learned: it is important to build Emergency Surge Capability (ESC) into the system by selective stockpiling of critical equipment and by contractual arrangements with selected companies to manufacture such equipment early in the crisis.

A brief incident between US President Donald Trump and US-based company 3M provides an example of dysfunctional relations between government and business during a crisis. When it became apparent that 3M was exporting N95 respirators to foreign countries, including Canada, when there were critical shortages within the USA, President Trump intervened requesting that 3M halt all exports and re-direct supplies to domestic needs. It was further requested that 3M will supply 150 million medical

masks for domestic US distribution. This incident shows that Canada cannot rely on imports of critical supplies during an international crisis. We need to secure domestic supplies of critical equipment during an emergency.

Canadian Prime Minister Justin Trudeau said in early April that more than 11 million face masks had arrived in Canada in recent days. He said workers were trying to quickly assess that they met the needed standards and that 10 million masks were already being distributed to provinces and territories. He also said the government had ordered hundreds of thousands of face shields from Bauer, the company that normally makes hockey equipment. "We need to make sure that equipment that is destined for Canada gets to and stays in Canada," he said, noting that's a concern the government is working to address.

This brings up two important issues that are central to the development of the ESC plan.

1. No time should be lost during the crisis in ensuring that the standards are adequate. This will have been ascertained through the ESC contractual agreements with the selected manufacturers.
2. ESC contracts must be made with Canadian companies to ensure they will not be subject to crisis emergency regulations of a foreign country.

A stockpiling program is also necessary to ensure the

availability of critical supplies during the first few days of the crisis, while the ESC program is being activated. The size and scale of the stockpiles will depend on the lead time required between ESC activation and availability of ESC-produced supplies. A short lead time is economically advantageous in order to minimize the scale of the stockpiles.

In addition to ESC, the overall strategy must include the ability to maintain critical services at normal levels. Agricultural production, for example, could be impacted by illness of personnel working in close proximity, causing ripple effects forward and backward along the production chain and leading to shortages in food supply. The security of food supply must be integrated as top priority in the preparedness plan.

As school closures may become necessary, schools

must take steps now to integrate online education as a complementary element of regular education. In situations of pandemic or other national crisis, the education system will be ready to cope without shutting down the educational process.

This editorial has not addressed the important issue of federal/provincial administration of ESC and the more general issue of federal/provincial coordination during the crisis. These matters will certainly need to be defined in detail based on pre-established agreements between the federal government and the provinces.

Emergency preparedness is about saving lives and reducing the economic consequences of a crisis. The best response is a good plan.



Lessons Learned From Managing Global Health Challenges



When If Not Now? Crisis Lessons from COVID-19 for Climate Action



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From a climate change perspective, the COVID-19 pandemic is both a challenge and an opportunity. Earth seems to be getting a planetary respite from human activity during the lockdown. Wildlife wanders through empty urban streets, carbon dioxide emission levels have fallen significantly, and oil prices are at record lows. As governments across the world discuss billion-dollar relief packages to kick-start struggling economies, some, like the EU and Canada, are taking the opportunity of the recovery to stimulate green economies, speed up low-carbon transitions and increase resilience. Extended periods of isolation may have caused individuals to introspect and perhaps rethink individual consumption habits and lifestyles.

Yet, the impacts of the pandemic on human well-being and wider society translate into a temporary dent on society's adaptive capacity in the face of climate change. Moreover, the possibility of post-COVID-19 global emission rebound is very real, as was the case after the 2008 global financial crash when carbon emissions shot up by 5% as a result of stimulus spending that boosted fossil fuel use. Intense competition among countries to fast-track economic recovery could see more governments relax emission regulations and inject economic stimulus into emissions-heavy sectors. The popular will to address climate change may have received a hit, since many would, for instance, argue that addressing unemployment is more urgent than climate agendas –

apparently oblivious of the fact that the two issues are not mutually exclusive.

However, global crises like the current COVID-19 pandemic tend to be watershed moments for societies. They leave lasting impressions, and they enlarge the window of the possible. Perhaps the more profound connections between societal response to the current pandemic and climate action are in the opportunities for learning. Lessons from our response to the pandemic could significantly re-shape public perspectives and experiences in ways that strengthen climate action over time.

We suggest two major shifts through which public climate change discourses and actions may benefit from global experience of the current pandemic. One is that courses of action previously thought to be too drastic no longer appear impossible. The other is that seemingly small numbers in describing crises no longer seem insignificant.

Procrastination, short-termism, free rider benefits and scientific denial have been the hallmarks of lukewarm climate action for decades. But now, virtually the entire globe has witnessed swift and drastic collective action against the COVID-19 pandemic, including a sudden halt of what was previously thought to be unchangeable structures of our economies and entrenched habits that we have linked to our very existence. What if this has left us with a deep impression and collective acceptance of what could all be

accomplished when a proximate, serious and urgent threat is identified? Many things we thought to be impossible to this point – dramatic governmental measures despite economic concerns, immediate public support, and social media momentum with a sense of collective and moral urgency despite drastic costs for the individual (e.g. #stayathome) have marked public response to the pandemic. Might this subtle but profound shift be preparing societies for the kind of action that climate change demands?

Such levels of mobilization (by governments, communities and individuals) relied on a strong risk appreciation, which in the case of COVID-19 (like climate change) includes an appreciation of such seemingly small numbers like '1.4% death rate' – numbers that confound our ordinary sense of magnitude. Like COVID-19's estimated death rates, climate change is expressed in deceptively small numbers such as a 1.5 degrees Celsius of global warming. Small degrees of change related to COVID-19 have become increasingly explained in public news coverage, creating a broader awareness that very small changes in numbers can still make dramatic differences over time - and cause alarming levels of impacts. Similarly, a world of 1.5 degrees Celsius of global warming will look tremendously different than a world of 2 degrees Celsius of global warming. The latter, as the Intergovernmental Panel on Climate Change Report 2019 estimates, would expose around 420 million more people to heat waves than the 1.5 degree scenario, up to 270 million more people to water scarcity, and coral reefs would become basically extinct. After the COVID-19 pandemic, there is a glint of hope that these small but important numbers with their vast differences for our planetary future would be a bit easier for the public to appreciate and act upon.

In short, the pandemic can, perhaps, be a learning moment for climate action. We also have a rare opportunity to rebuild and re-structure societies and economies differently. The coronavirus pandemic will likely be remembered as a pivotal moment in modern human history. The 14th century Bubonic Plague pandemic profoundly shook and transformed society, but marked the beginning of the Renaissance. We hope that the tragic COVID-19 pandemic also leaves something good behind, with lessons on how to best act in times of crisis.

References available in online version at <https://sciencepolicy.ca/response-covid-19>



Public Health Agencies and Emerging Infectious Diseases: Lessons Learned from Past Outbreaks



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Over the past two decades, the world has faced several infectious disease outbreaks. SARS, Ebola, Influenza A (H1N1), MERS, Zika virus, and most recently COVID-19, have all had a massive global impact in terms of economic disruption, strain on local and global public health resources – and above all, on human health. To provide insight into the role of a national public health agency in supporting the response to an outbreak, we have used SciVal and Scopus data from 1996 to 2018 to analyze scholarly output and citation impact of Canadian research on emerging infectious diseases and health security. We hope that this data and the conclusions we have drawn from it will strengthen our understanding of how research from public health agencies can sup-

port society in the face of infectious disease outbreaks.

Across the world, emerging infectious disease research has seen an average growth of 6.9% annually over the past two decades. In general, research on an infectious disease tends to spike following an outbreak. For example, Figure 1 shows the sharp increase in Ebola research publications following the 2014 epidemic. This rapid growth demonstrates the research community’s ability to respond quickly to public health needs and help countries prepare for future outbreaks. (See our Infectious Diseases Infographic for more global data and trends.)

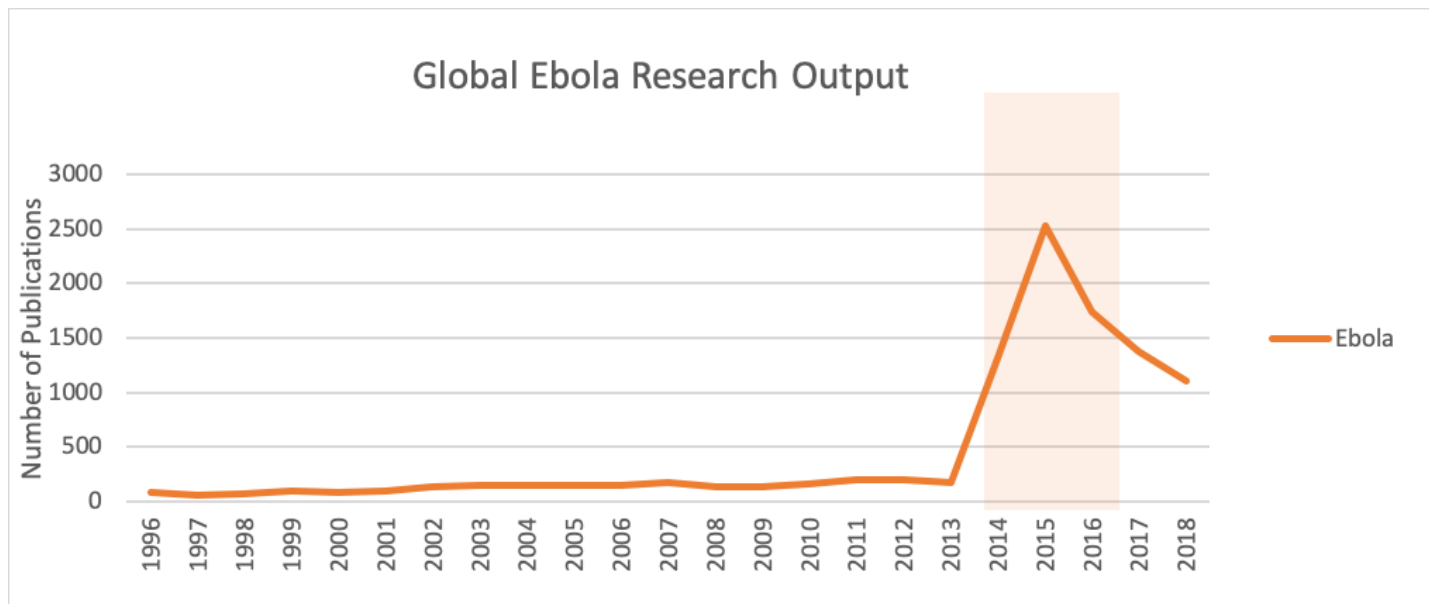


Figure 1.

Since the SARS epidemic of 2002-4, Canada has also increased its capacity to respond effectively to the public health challenges of serious infectious disease outbreaks. Following the recommendations of the National Advisory Committee on SARS and Public Health, several cornerstones for public health emergency response were established – including the Public Health Agency of Canada (PHAC), which is responsible for much of the research that is needed to increase national preparation for future outbreaks.

Among this type of research, the fields of emerging infectious diseases (EID) and health security, a subset of EID, play an important role in supporting planning for the next pandemic. Figures 2 and 3 show the rise in Canadian publications related to EID and health security, as well as the significant proportion produced by PHAC since its creation in 2004. The growth of publications within these research topics suggests an increased focus on the country’s public health preparedness.

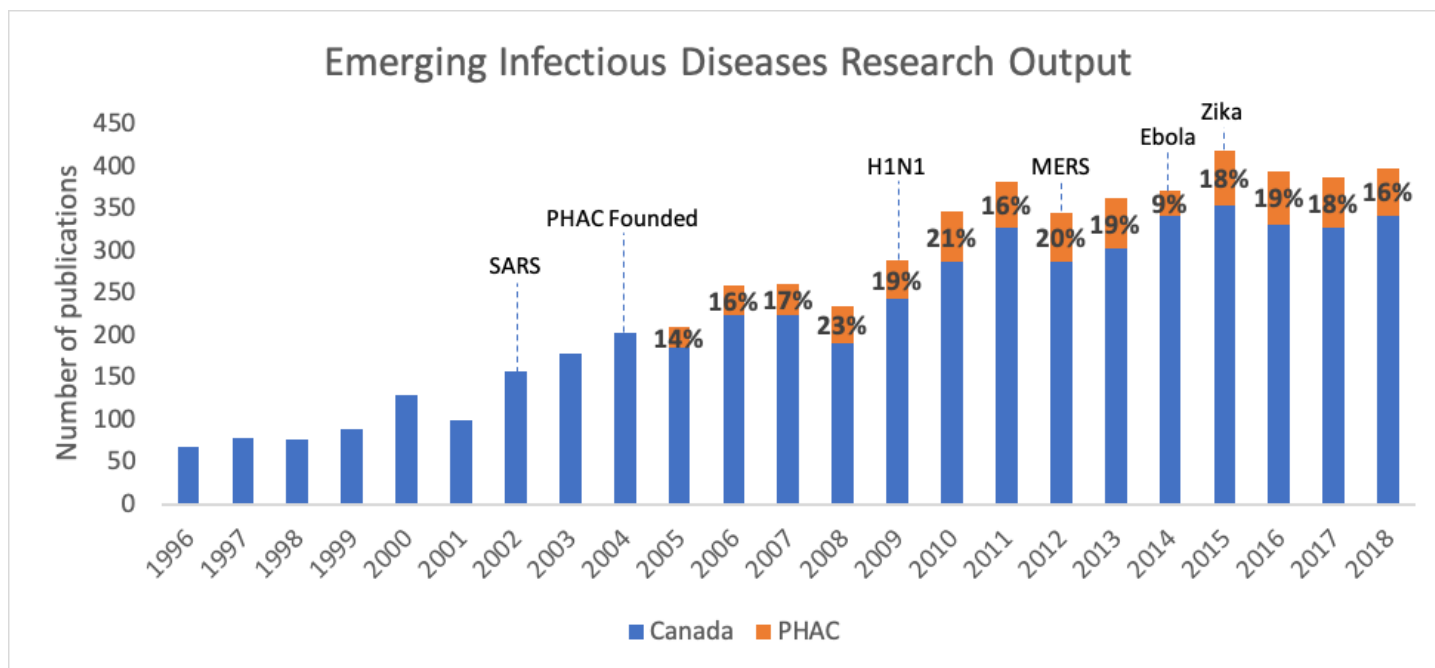


Figure 2. Output from Canada and PHAC in Emerging Infectious Diseases research (with the starting year of significant outbreaks)

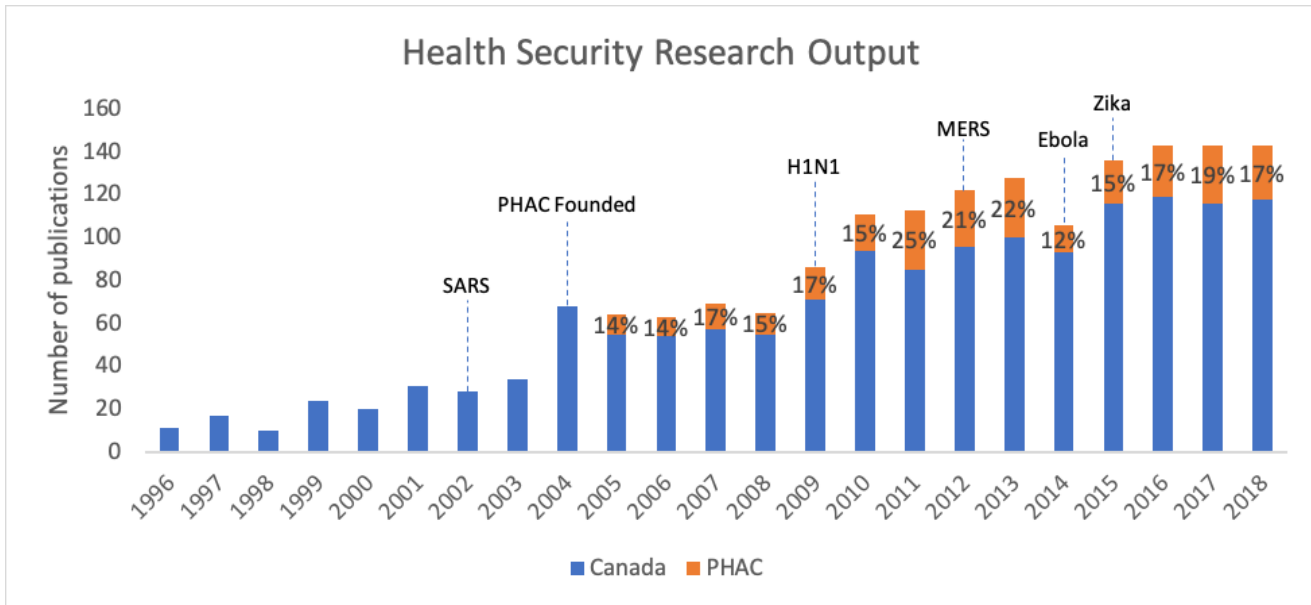


Figure 3. Output in health security research (with the starting year of significant outbreaks labeled), which includes the analyses of policies and efforts at the surveillance of emerging diseases, plays an important role in supporting preparedness for the next pandemic.

Lessons Learned from the Past: Canada’s Response to the 2014-16 Ebola Outbreak

As the COVID-19 situation continues to develop around the world and our understanding of the disease is still limited, it may be useful to analyse the past for lessons for the future. We will explore one noteworthy Canadian example here, to demonstrate the importance of public health organizations like PHAC and the research they produce.

break had a devastating human and socioeconomic impact in West Africa and beyond. Fortunately, Canada had long been conducting research on the Ebola virus. Researchers at PHAC’s National Microbiology Laboratory, based in Winnipeg, had developed an experimental vaccine called the Vesicular Stomatitis Virus-Ebola Virus vaccine – known as VSV-EBOV – as early as 2001, although there was little interest from the pharmaceutical industry until the outbreak

From December 2013 to March 2016, the Ebola out-

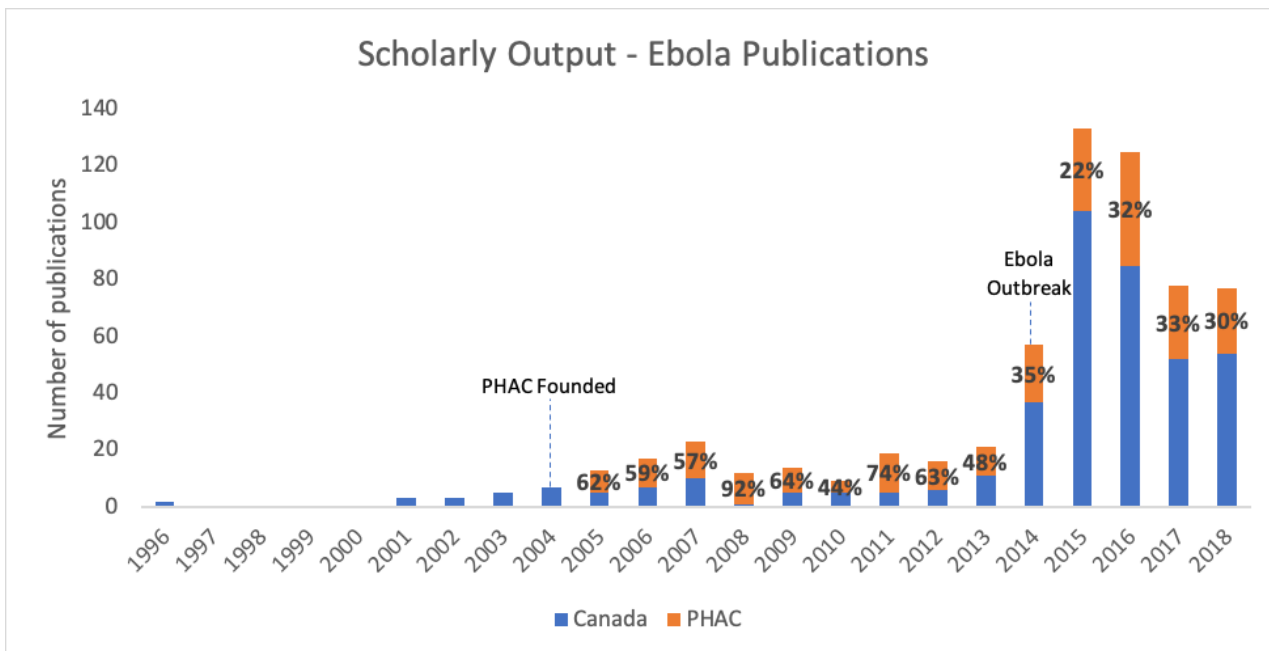


Figure 4. Output from Canada and PHAC in Emerging Infectious Diseases research.

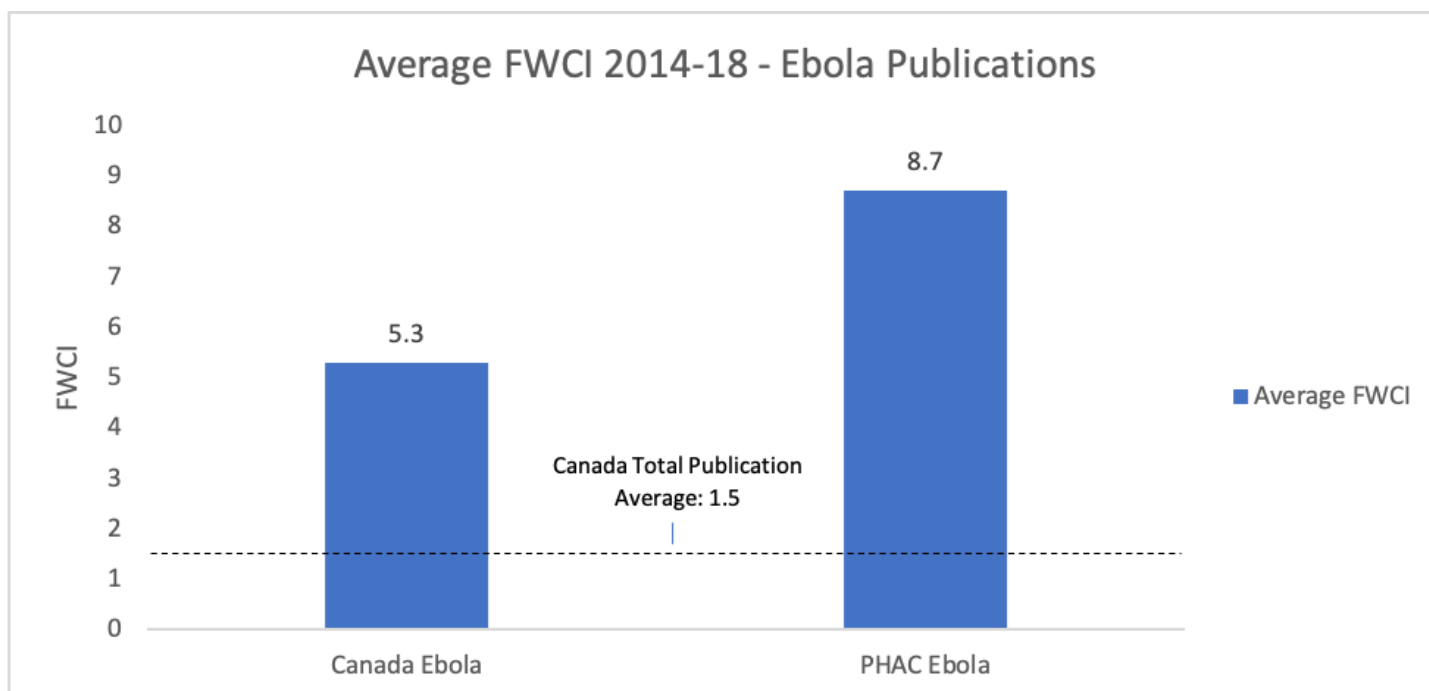


Figure 5.

began (1). In August 2014, Canada exported 800 doses of the experimental vaccine to the World Health Organization, who had ruled that it was ethical to use untested vaccines on Ebola patients (2). In November, working with other government agencies, PHAC began conducting clinical trials of the vaccine (3). After over 4,000 doses had been administered to patients in Guinea, researchers concluded that VSV-EBOV had proven its effectiveness and became the first FDA-approved vaccine against the disease (4). In July 2015, this result was published in *The Lancet*, which described VSV-EBOV as “highly efficacious and safe in preventing Ebola virus disease.” (5). Since 2014, the Canadian vaccine has been used to immunize tens of thousands of patients in the Democratic Republic of the Congo, in both the 2018 outbreak in Équateur (6) province and the present-day outbreak in Kivu (7).

It was thanks to PHAC’s longstanding and high-quality research on Ebola that the vaccine could be developed so quickly – which is also supported by Canada’s publication data. Figure 4 shows PHAC’s critical contribution to Ebola research since PHAC started publishing it in 2005. Before the 2014 outbreak, PHAC was responsible for 63%, on average, of all Canadian publications on Ebola, and 30% after it.

Figure 5 demonstrates that while Canada’s average Field Weighted Citation Impact (FWCI) – an indicator of research impact – was higher for Ebola publications than for all publications between 2014-18, PHAC’s FWCI was still significantly greater than both of these metrics.

The Ebola outbreak marked the first test of Canada’s rapid response clinical trials research system. It was a success and can be applicable to other public health crises, like COVID-19, that require vaccine testing. The Ebola case study illustrates the need for continuous baseline research on emerging infectious diseases to facilitate pandemic preparedness – not just research on cutting-edge research topics – to be produced by public health institutions like PHAC, which have the mandate to support emergency preparedness (8). Unlike academic institutions and industry, public health agencies take on the crucial role of conducting this type of research. For COVID-19 and other pandemics in the future, organizations like PHAC and the crucial work they do will help increase countries’ ability to respond more quickly to outbreaks.

References available in online version at <https://sciencepolicy.ca/response-covid-19>

A Global One Health Initiative to Combat Future Pandemics

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When the dust settles in the summer of 2020, tough questions are going to be asked about where the COVID-19 pandemic came from and, most crucially, how we can prevent anything like this from happening again? Answering these questions is crucial to inoculate society from future pandemics and will take us straight into the heart of society's relationship with the natural world. Often decried as a frivolous luxury, secondary to economic growth, one of the things we must learn from COVID-19 is that a healthy, well-managed environment is crucial to controlling disease.

For instance, Ebola, avian influenza, rabies, West Nile, SARS and now COVID-19 all find their origins in situations where humans and animals come into contact. Based on some estimates, around 75% of emerging diseases in humans are of animal origin. History, as well as the present predicament, teach us that whenever we humans take too many liberties with the natural world, we get - in the most literal way possibly imaginable - sick.

The current pandemic is no exception and seems to have emerged in the largely unregulated trade of wild animals in wet markets of China. While we don't yet know for certain, it is likely that the virus originated in bats (many viruses do, so this isn't a bad guess) and

then hopped into some animal that a human hunter caught and butchered before selling and marketing. At some point, the COVID-19 virus managed to migrate into a human host and somewhere along the way mutated just a little bit so that the new strain was able to be transmitted between humans. And once that happened, our hyper-connected world did the rest.

Of course, the bad news is that there is nothing to say this won't happen again. In fact, it's quite likely that as awful as the current predicament is, the next one could be much worse. Imagine if the virus that causes avian influenza mutates in a way that becomes transmissible between humans? Such a nightmarish scenario might see 30% or 40% mortality and mostly affect young people.

One way to protect ourselves against this apocalyptic scene is to invest heavily in the basic science of what is known as "One Health." One Health is a discipline that finds its roots in a mixture of ecology, veterinary medicine, and the study of human health. The key tenet of One Health is that much like a three-legged stool needs all three legs to be strong, human health, environmental health and animal health are all mutually dependent; you cannot have one without the other two, the world simply doesn't work that way.

Although One Health may sound novel, the concept is not and has been practiced for decades. In fact, some of our biggest successes in fighting off infectious disease are indebted to the One Health approach. For instance, controlling rabies in humans is not possible without controlling the disease in the environment. That is why there has been a concerted effort by veterinary organizations and governments to vaccinate animals against rabies.

There are current global initiatives to organize efforts and focus on diseases at the human-animal-environment interface across the world. Now more than ever there is an urgent need for governments around the world to invest in these sorts of programs and ensure that a global One Health initiative is developed as a core component of planning preparedness for future pandemics.

We can no longer ignore the fragility of our world and the vulnerability of our systems, including our food, education and healthcare systems. Without a global One Health approach, we are bound to deal with yet another pandemic in a not too distant future that could be far more devastating. We have to know why pandemics happen and predict where and when they happen. We do have pieces of the puzzle but have not been able to put the puzzle together.

The dust will settle on the current predicament, COVID-19 will fade, and we will be given an opportunity to reflect on what we have learned. The test that we all face is the following: Will our behaviours, our governance, our economic practices in the future acknowledge the stark reality of living in a world where pandemics can happen? Or will we blindly go back to the way things were and squander this opportunity to make ourselves safer and more resilient in the long term?





Response to COVID-19 Pandemic and its Impacts

The Canadian Science Policy Center is looking for (600-800 word) opinion pieces on:

1. Policy Development

- Government funding packages deployed to help fight COVID-19
- Perspectives and context of policy decisions surrounding COVID-19
- How policy is developed during the pandemic
- Evidence-based decision making and the role of science advice in policy development
- Impact of policy developments and response by the public
- Federal, Provincial and Municipal coordination of policies during pandemics

2. Lessons Learned from Managing Global Health Challenges

- From managing previous outbreaks and pandemics (SARS, H1N1, Ebola, etc)
- Ongoing policy lessons from local and global initiatives on COVID-19

3. Scientific & Economic Impacts

- Open Science of COVID-19 Pandemic
- Research funding
- Industry & Innovation
- Evolution of workforce
- Public communication of science & crisis management

4. Social Impacts

- Climate change and environment
- Behavioural and societal
- Travel and globalism

If interested in writing an editorial, email editorial@sciencepolicy.ca

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