Response to COVID-19 Pandemic and its Impacts

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Ready to fight: Long-term investments in research mean Canada is equipped to respond to the pandemic

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It goes without saying that these are uncertain times. But Canadians can find some reassurance knowing that our country is a world leader when it comes to health-related genomics research. In 2003, Canadian researchers spearheaded the sequencing of the SARS genome. Today that group is joined by many other talented research teams across the country in tackling COVID-19.

While the most pressing priorities are the care of patients and the safety of front-line workers, a variety of research targets are simultaneously being tackled. The development of rapid testing, gene sequencing (viral and host), serology tests, clinical trials, treatments, therapeutics and vaccines are all under immediate examination. In equipping Canada's research community with new funding initiatives, the federal and provincial governments are positioning Canada to play a leading role in all these areas.

So too are collaborations with industry partners that can produce solutions to address critical gaps. These combined efforts have been impressive and show a community-driven response being led by world-class researchers who are openly sharing their information and collaborating across borders.

The fast-moving field of genomics is central to much of this work. It only took 10 days for Chinese scientists to sequence the genome of SARS-CoV-2 – the virus that causes COVID-19. This rapid sequencing ability helps us understand how the virus works, sheds light on modes of transmission and allows us to generate strategies for containment and drug and vaccine development.

Genomics researchers are also looking at how SARS-CoV-2 interacts with patient genomes to understand why some patients get very sick and others do not. This information will help steer us toward therapies. Alongside national efforts in the UK and the United States, Genome Canada is leading a pan-Canadian consortium involving academic researchers, provincial public health agencies, the National Microbiology Lab and the major gene sequencing centres across the country for COVID-19 genome sequencing from virus to patient. This initiative will ensure better data coordination, information sharing, and a variety of analyses to inform Canada's response to virus containment, treatment and long-term management. Getting this data in place now will help collate the data we need today and ensure we are better prepared for future outbreaks.

And thanks to the federal government's quick response in supporting new research efforts, Genome Canada was able to get involved early as part of a co-ordinated effort with other organizations including CIHR, NSERC, SSHRC, CRCC and IDRC. Together we've invested $54.2 million in funding a first round of 99 fascinating Canadian research projects looking at medical, social and policy countermeasures to help stem the spread of the virus (1).

Among other efforts, Genome Canada is funding work at the University of Calgary led by Dr. Dylan Pillai in developing rapid diagnostics (2). The goal is a handheld testing device that could be brought to a patient's bedside and eventually deployed globally. Genome Canada, in partnership with six regional genome centres, also launched a regional genomics

initiative to catalyze rapid response solutions across the country (3). Genome BC and Génome Québec also hit the ground running, in partnership with their provincial governments, with additional strategic calls to their genomics communities (4),(5).An additional $40 million in funding was announced to launch the Canadian COVID Genomics Network (CanCOGeN) in partnership with the six regional Genome Centres, national and provincial public health labs, genome sequencing centres through CGEn, hospitals, universities and the private sector (6).

The reason Canada's research community can do so much during a pandemic is because Canada has been funding scientists for decades. When the crisis hit, they were ready to respond.

We need to ensure that Canada always has a community of researchers who are ready to jump into action. Challenges in sustained funding for fundamental research are well-known. But basic and fundamental research clearly demonstrate their value when a cri-

sis vaults their findings into relevancy. Suddenly the virologist's research into mechanisms for viral transmission doesn't look so arcane. The value of thoughtful and long-term investments in science serves society even if we can't predict exactly when and how.

In terms of what comes next, we will soon see increases in our ability to do rapid and widespread testing for the coronavirus that causes COVID-19. With the help of genome sequencing from virus to patient, we are hopeful we will see significant improvements in the medical treatment of those who are infected, which will help reduce mortality.

When it comes to vaccines and cures, these things take more time. As has often been said, we could be looking at 12-18 months. There are some efforts being made to shortcut that timeline, including repurposing existing drugs. We don't yet know whether this will work. But solutions all go back to that community approach: some researchers are working on the long-term 18-month plan for eradication of the virus, others are taking a more accelerated approach of using screening drugs in the short-term, still others are looking at ways of blocking the virus in humans. A variety of measures and approaches will get us closer to managing this pandemic.

We must also remember that this is not only a medical crisis. There are enormous impacts occurring in our social fabric, particularly in our collective mental health and well-being. This will almost certainly be exacerbated in the weeks and months ahead. A variety of supports from our healthcare systems and the broader social infrastructure is required.

We're also at the beginning of what will likely be a very serious and very sustained economic downturn. We need everyone to think – within their areas of expertise and agency – about how they can be part of a Team Canada approach to address major impacts beyond the virus itself.

Is there a silver lining? Personally, I'm inspired by the commitment of Canadians and people across the globe who are coming together to minimize the impact of the pandemic. We're working from home, cancelling plans to get together, making all the

necessary sacrifices for our collective well-being. Every day I'm impressed by the frontline workers in our hospitals, grocery stores, pharmacies, truck stops and take-out restaurants. To me, this brings home the value of community and the commitment that we all share in a time of crisis.

In my area of work, the silver lining is also the reminder of how strong science is in Canada and that we are a global leader in addressing this pandemic and preparing for the next one, as well as being part of the solution for economic recovery. In a time of widespread misinformation, anti-vaccine propaganda and other challenges to science, we are seeing today that when it comes to a real global challenge like this, science leads. And genomics science and innovation will continue to lead as we find our way out of this very difficult situation.

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

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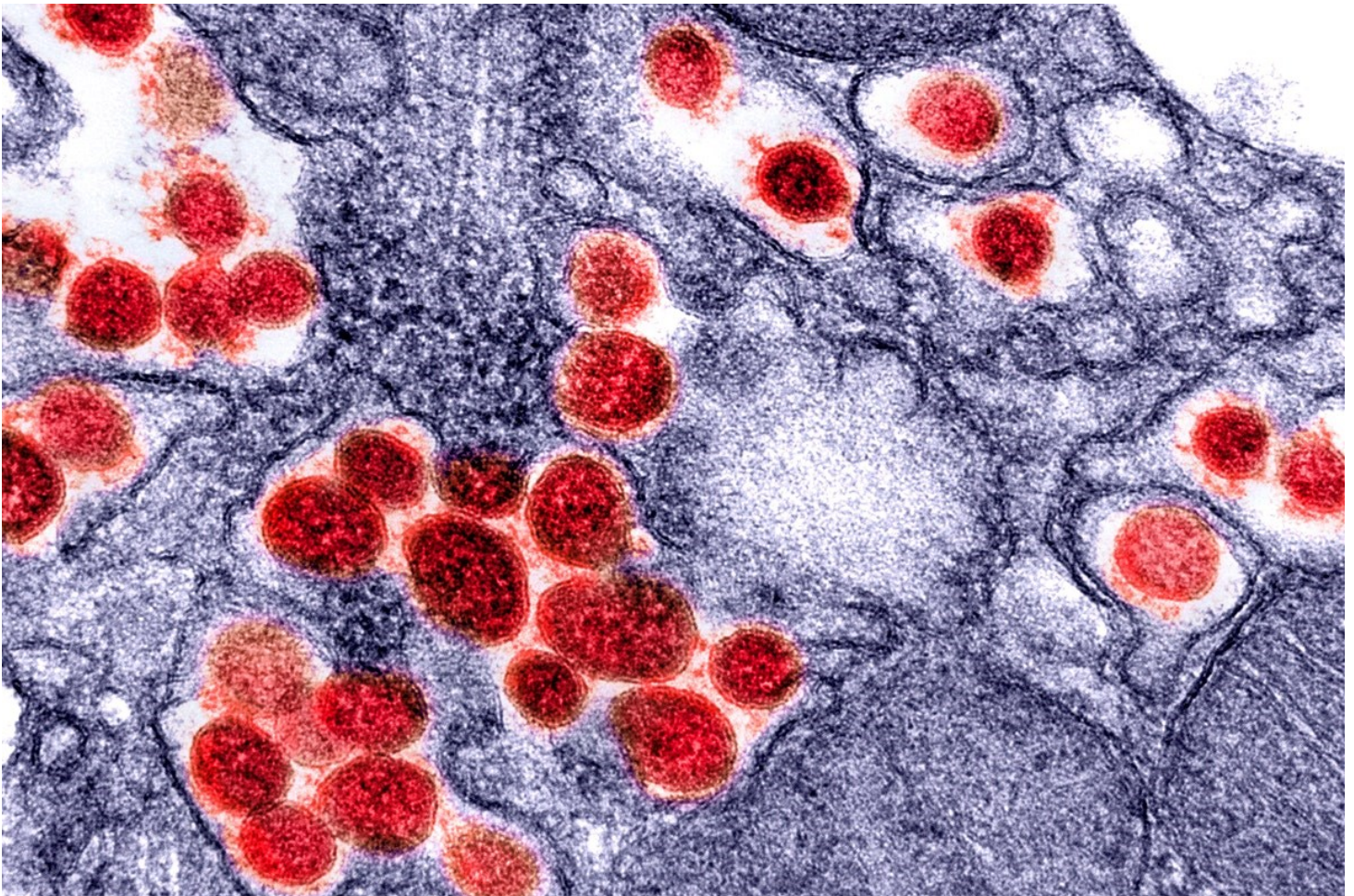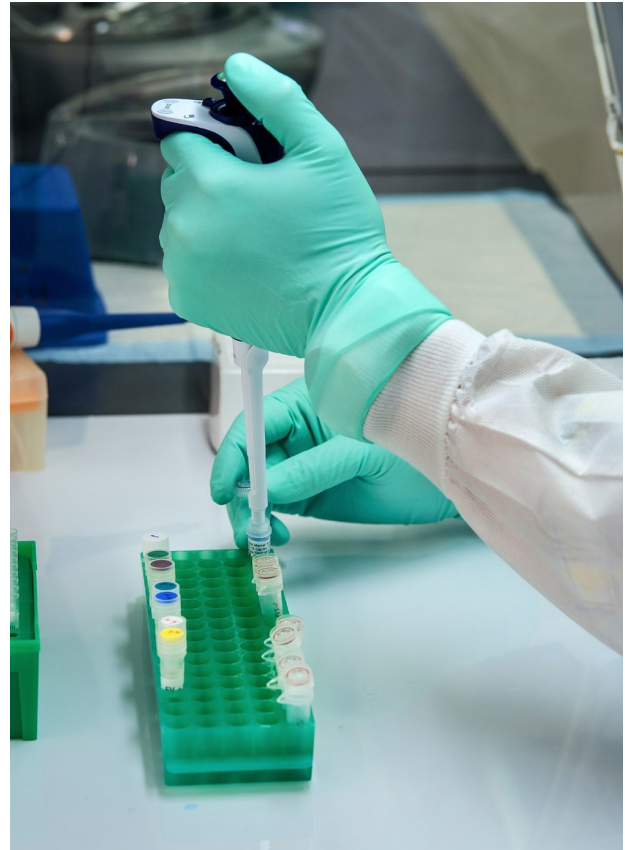
How COVID-19 can catalyze a shift towards a more localized, transparent seafood industry

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Do you know where your fish comes from?

It may come as a shock to learn that the majority of Canadian seafood is exported and the small percentage of the catch that does stay in the country is mostly destined for restaurants. With COVID-19 cutting off access to major export markets, and restaurants across the country remaining closed for the foreseeable future, fishermen from coast to coast are finding themselves with hundreds of pounds of fresh catch, and nowhere to sell it.

Canadian fisheries have already been pushed to the brink over the years due to climate change, industrialization, and globalization. Now, COVID-19 is exposing more cracks in the seafood supply chain.

The globalized seafood industry that encourages Canadians to eat farmed shrimp from Asia while locally caught B.C. prawns are shipped abroad, is ultimately unsustainable. I'm not the first to call out this fundamental flaw of global food systems. Others have pointed out the instability of global supply chains and called for supports to promote greater self-sufficiency within our local food systems.

This is not to expect that local food systems should feed us all of the time. Global supply chains and export markets will al-

ways exist, but more robust local systems offer insulation from the volatility of global markets, while providing fishermen with more options to offload their catch.

Being a fisherman has never been an easy job and COVID-19 has exacerbated the risk and uncertainty that comes with the gig. Fishermen assume a lot of upfront personal and financial risk in order to provide us with fresh seafood: they need to pay for licensing fees, deckhand wages, bait and fuel, just to be able to get out on the water and hope that they can catch something. When they do, they're hoping to return to a market where they can sell their catch for a fair price in order to recuperate those costs.

With those markets unavailable due to COVID-19, fishermen are taking matters into their own hands. We're seeing Canadian fishermen adapting by establishing local consumer markets where there haven't been any before – pushing them in the role of not

only harvester, but also processor, marketer, and re-tailer overnight.

These kinds of direct-to-consumer arrange-ments have tremendous benefits including reduced operating costs for fishermen and the ability to get a fair price for their catch. Consumers also reap the benefits by gaining access to a diversity of high-quality protein and contributing to building the resili-ence of our food system.

By keeping locally caught seafood in local communi-ties, these models also shorten the normally convo-luted supply chain of seafood products, reducing their carbon footprint and increasing transparency – a criti-cal step towards eliminating problems like fraud within Canada's seafood market. In November, I received the Youth Science Policy Award of Excel-lence for my policy proposal to eliminate seafood fraud in Canada. With 44% of seafood sold in Canada being mislabeled, a shorter supply chain and more localized seafood market could lower that number, helping to rebuild consumer trust in our food systems and support the sustainability of local fisheries.

A robust local seafood market can be the key to elimi-nating problems like seafood fraud, supporting the Canadian economy by providing opportunities for small-scale fishermen, strengthening our local food systems and re-connecting consumers to their food and building relationships with those who harvest it.

But in order for these local markets to be more than a short-term solution, we need infrastructure and strong policy from our country's decisions makers.

The fishing industry is dependent on infrastructure to process, cut, ship, distribute, market, and sell sea-food. Infrastructure that supports seafood product flows within the country would give fishermen the option to build relationships with local processors and distributors to have their locally caught fish processed and sold in Canada. Fishing communities on our coasts have been calling for this reinvigoration of the Canadian processing industry for a while, in order to give them the opportunity to keep Canadian seafood in Canada.

The seafood industry is integral to the economic and social fabric of this country. This time of hardship has shaken fishing communities in a significant way, but along with the difficulties comes an opportunity to breed resilience and create space for robust local sea-food markets to thrive. Now, we just need to make sure it lasts.

Has COVID-19 driven scientific research and development?

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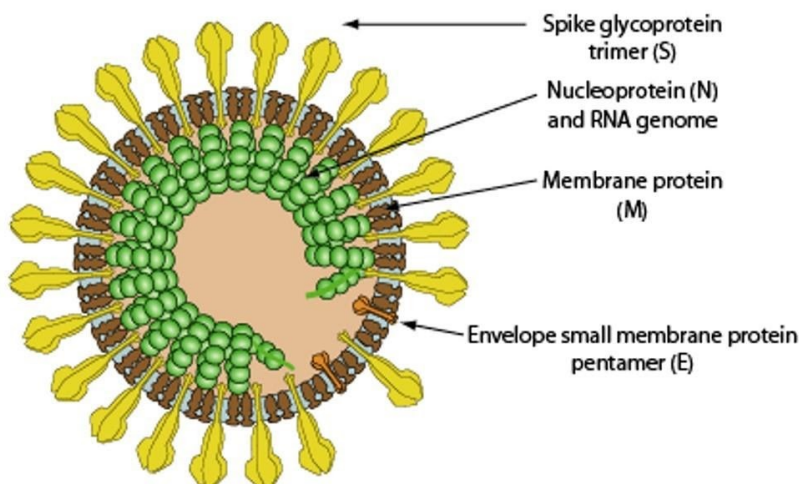Senior Scientist, Medicago

To effectively develop countermeasures for emerging and re-emerging (viral) pandemics, a significant collaborative effort between industry, government and academia, at a global level, is necessary. Scientific countermeasures include the development of diagnostic tests, a strong research effort in vaccine and therapeutic development and the constant surveillance of virus strains for structural variations. For example, the WHO's (1) Global Influenza Program (GIP) (2) collects global epidemiological and virology data on circulating influenza virus strains; on careful watch for any signs of emerging virulent strains (3). Data from here, sets the global standard for selection of strains for flu vaccine production (4), twice per year, for immunity against these selected strains. This is vital as the influenza virus genome (or any virus genome) can change via antigenic drifts and shifts (5,6).

The result is a change or mutation(s) in surface proteins (antigens); antigens are molecules recognized by the immune system and capable of triggering an immune response (including antibody production) (7).

Unprecedented is the global scientific impact as the race for a vaccine and therapeutic development against the novel coronavirus (SARS-CoV-2) proceeds. This includes, testing of old candidates (8), developing new ones and improved diagnostics. To put this transformation into perspective it is necessary to revisit the past. The 1918 influenza pandemic was the deadliest in the history of the world (9). Initial vaccines were made from bacterial formulations as some experts believed that bacteria caused the infection (10). It was deduced until the 1930s that the causative agent was a virus; the first effective experimental influenza vaccines were then tested (11). To date, there are no approved vaccines or therapeutics against SAR-CoV-2 (disease: COVID-19) however there are 67 candidates in preclinical and three in clinical evaluations across the globe (12) . Candidate therapeutics include antibodies and, repurposed and in-development antiviral drugs (13). Over 200 clinical trials are ongoing not only with candidate vaccines and therapeutics (13), but also with traditional medicines and plasma from recovered COVID-19 patients (14); the idea is that plasma comprises antibodies which would be able to mitigate infection by blocking virus attachment to target cells, neutralizing the virus (15).

Novel Coronavirus (SARS-CoV-2) virion

- Spike glycoprotein trimer (S)
- Nucleoprotein (N) and RNA genome
- Membrane protein (M)
- Envelope small membrane protein pentamer (E)

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SIB Swiss Instute of Bioinformatics

The SARS-CoV-2 virus genome was sequenced and made available on January 10th 2020 less than a month after the WHO was informed of pneumonia cases from an unknown disease in Wuhan (16,17); the causative agent was identified as the SARS-CoV-2 virus on January 7th. Genes which encode twenty nine proteins have been identified including the CoV spike (S) glycoprotein surface antigen (18,19); research shows it is a target for antibodies and there-

Coronavirus S Protein (Spike)

The virus Sars-CoV-2 binds to human cells through its spike glycoprotein, a trimeric class I fusion protein, making this protein a key target for potential therapies and diagnostics.

A dense cover of attached sugar molecules (glycans) acts like a stealth shield to hide from the host's immune system.

Target of antibodies

Structure data source:

Receptor-binding domain (RBD, trimer)

Fusion peptide (FP, hidden) — PDB ID 6CRV

Heptad repeat 1 (HR1, hidden)
Target of fusion inhibitors

Subunits
S1
S2 — ~20 nm

Heptad repeat 2 (HR2) — PDB ID 2FXP

Viral membrane (lipid bilayer)

Transmembrane domain (TM) — no data (model)

Cytoplasmic domain (CP)

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fore a target for diagnostics, vaccines and therapeutic development (20). For the 1918 influenza pandemic, scientists were only able to sequence part of the influenza virus genome 79 years later (21); it was done using preserved lung tissue from a victim who died in 1918 pandemic. In 1999, sequencing of the full length haemagglutinin (HA) gene (encodes HA, a surface protein) was achieved, pioneering vaccine and drug development with HA as a target (22,23). By 2005, with advancement in genomics technology, the entire genome of the 1918 virus was sequenced (24). This allowed the live virus to be reconstructed at the CDC and fully studied to determine properties that contributed to pathogenicity and virulence, further aiding vaccine and drug development (25,26). To date, at the CDC, SARS-CoV-2 has been grown in cell culture for similar research purposes (27)

Real Time reverse transcription-Polymerase Chain Reaction (rRT-PCR) is the main technique used to identify SARS-CoV-2 (28); what most media and public reports on testing is based upon. Half a Nobel Prize was awarded in (1993) for the development of the PCR method (29). SARS-CoV-2 is detected by its specific viral (genome) signature in nasal secretion samples usually taken from the back of the nose or throat. Biopharma researchers are working on different versions of this test and different instrumentation (30). A main limitation of this test is that it only detects SAR-
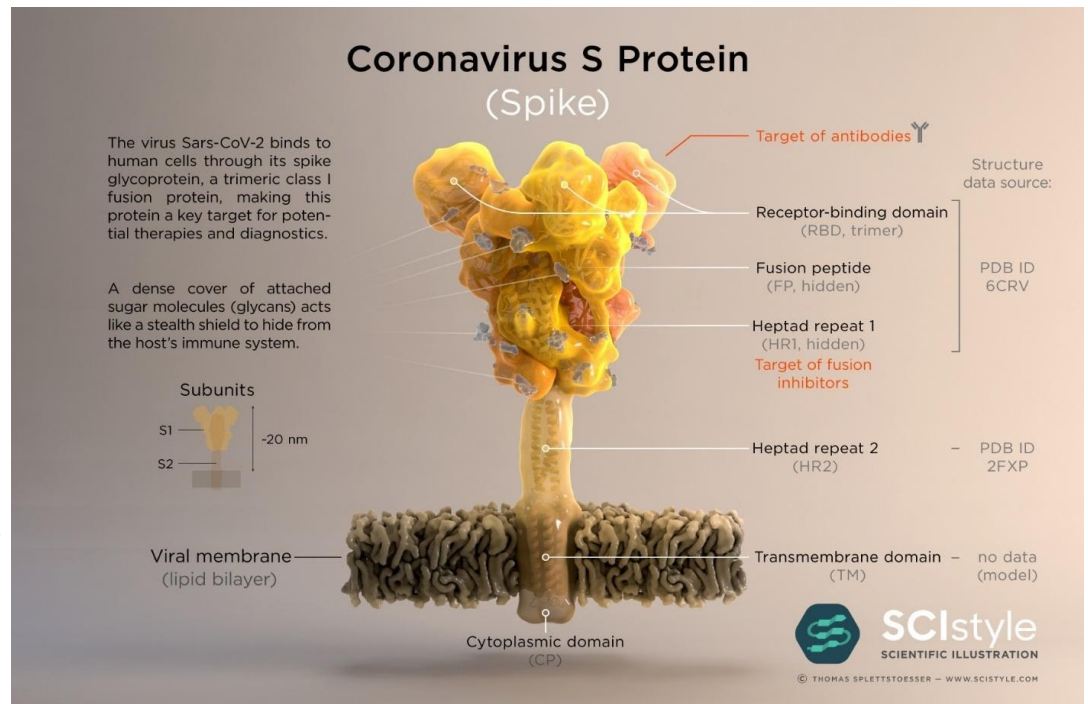
CoV-2 in samples taken from patients with active infections and not from those who have recovered. Hence the need for serological tests (already in development) which would allow a more comprehensive tracking of COVID-19 progression beyond the infectious stage (31). Serological tests measure the amount of antibodies present in the blood as the body responds to an infection (the immune response) and as the disease progresses. It would be an invaluable tool when used in combination with the diagnostic rRT-PCR test in assessing how widespread COVID-19 is and who may have developed immunity and for how long.

Overall, research and developments efforts targeted towards COVID-19 have moved at a significant pace, supported by technological advancement in genomics, proteomics and analytical methodologies. Although a lot has been achieved in a short period of time, I think the challenge for scientists is to provide high quality results at a rapid pace while trying to understand essential fundamental science; the challenge to meet societal needs and expectations and endure scrutiny without compromising scientific standards.

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

Sacrificing current consumption of leisure and work generates greater future consumption of leisure and work for everyone

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Public health officials have been insisting that we need to stay at home and maintain social distancing with people who are not part of our immediate household in order to slow down transmission of the COVID-19 virus within the community. The sooner and the more comprehensively we implement this, the sooner the COVID-19 virus could be defeated. And the sooner our faltering economy and the Canadian stock markets recover, the sooner we can reduce the government bailouts that would otherwise lead to higher deficits that burden our next generations of Canadians. Our economy is otherwise fairly sound, and can withstand a short window (e.g., 14 days) of disruption in both supply (employee absenteeism) and demand (customer absenteeism).

At an extreme, imagine if 100% of Canadians could stay at home for 14 straight days with only our immediate household members and practice social distancing. Then, the virus would have nowhere to go and would eventually die. The COVID-19 virus survives and thrives only by transmitting from one human to another.

Each infected person can transmit the virus to an average of three people. In the absence of a vaccine or antiviral therapies, the only means to defeat this virus is by reducing transmission to levels that can be treated by our healthcare system. This is what we mean by flattening the curve.

Staying home for 13 days would not be as good as staying home for 14 days, but it would be better than staying home for 12 days.

If 90% of the households stayed home, it would not be as good as 100% of the households staying home, but it would be better than if 80% of the households stayed home. This constitutes the benefit of the herd effect. A recent study from the Institute of Disease Modeling shows that a 75% improvement in social distancing practice could reduce COVID-19 deaths in the Seattle area by over 90%.

Starting to stay home today would be much more effective in halting the transmission than starting to stay home starting tomorrow. Each day that we delay in isolating ourselves at home increases the number of Canadians inflicted with the COVID-19 virus, and further reduces our ability to flatten the curve. Furthermore, the later we start isolating ourselves, the longer we would have to isolate.

This sounds like paying down credit card debt with high interest rates that compound rapidly over time. The longer we postpone paying our credit card debt, the longer we have to continue paying for it and the more interest expense we incur. Paying excessively high interest rates for a long period of time can financially cripple households. Conversely, the sooner

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we isolate ourselves and sacrifice current leisure, social or work commitments, the larger the return we will see in being able to enjoy future leisure, social, and work opportunities. For these opportunities, the effective interest rate at which current consumption sacrifices are rewarded with future consumption abilities is extremely high.

Furthermore, the rewards accrue to society at large rather than just to the individual because of the positive herd effect. The health and economic beneficiaries from ending the COVID-19 disruption early could very well be members of our own household. Canadians need to understand the nature of the sacrifice and investment requested by the public health authorities. By implementing their advice right away, it is extremely profitable to ourselves and to society at large in both health and financial terms.

Slowing down or spreading out new infections over time rather than peaking all at once will reduce the burden on our health care system and reduce the fatality rate. Flattening the curve will make the outbreak milder while lasting longer, allowing the burden on the health care system to stay within its capacity limits. The returns in the form of avoiding greater isolation in the future are tremendous. But then so are the returns to paying down credit card debt rapidly, and still some of us don't do it. The fatality rate from COVID-19 without efforts to flatten the curve will be astronomical. If only we could fully understand the compounding effect of high transmission rates, because the window to fight this war is short.

"Canadians need to understand the nature of the sacrifice and investment requested by the public health authorities. By implementing their advice right away, it is extremely profitable to ourselves and to society at large in both health and financial terms."

Scientific and Economic Impacts

Investing in Ecosystems and Green Infrastructure: the Way to Go for Post COVID-19 Recovery

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The COVID-19 crisis is now-- rightly-- occupying virtually all our mental and media spaces. To protect ourselves from the virus, the isolation and complete shutdown of "non-essential" economic activities are contributing to other worries, including those related to how economies and international trade will recover. In view of the scale of the crisis, the G20 has expressed its readiness to inject more than five trillion dollars to stimulate the economy.

However, many hope that lessons can be learned from the current situation to rethink our world and lay the foundations for a new approach to economic development. Why not consider prioritizing our ecosystems and green infrastructure as one of the desired collective responses and a positive legacy of this global crisis? States are presented with a historic opportunity: to put the protection and restoration of ecosystems, the conservation of biodiversity, and the development of green infrastructure at the heart of the economic recovery strategy. This investment would improve the long-term resilience, food security, and health of our communities.

As was the case in addressing the 2008 financial crisis, major investments are expected, particularly in infrastructure. We will likely repeat the recipe that swept away the last recession and fostered growth that propelled stock markets to unprecedented heights. However, the last decade has also led to an expansion of development and consumption modes that have exacerbated socio-economic inequalities, as well as climate and environmental changes. Will

our next approach to economic recovery accelerate the train that will drag humanity towards its own downfall, plunging us into even deeper abysses? The question deserves to be asked because, unfortunately, the discussions around the climate crisis that focused some of the world's attention and mobilized young people around the world have been swept aside by the pandemic.

Research is underway to explain the causes of COVID-19. Some point to a mechanism of animal-to-human transmission, known as zoonoses. They are responsible for other major health crises, including SARS, H1N1 and the Ebola virus. Other zoonoses, such as the Lyme disease and the Zika fever, appear to be linked to climate change, urbanization and the degradation of our ecosystems. Several researchers believe that the destruction and looting of ecosystems, which has become systemic in some countries, will precipitate the climate crisis and increase the risk of future pandemics. The World Health Organization is unequivocal: climate change is the greatest threat to human health in the 21st century.

In his book Collapse, Jared Diamond reminds us that major environmental problems have played a crucial role in the demise of human societies throughout history. He discusses issues that are currently disrupting our ecosystems: deforestation, habitat destruction, soil degradation, contamination of drinking water sources, overfishing, overhunting, and the introduction of invasive species. These problems

are aggravated by our lifestyles and production patterns, including unsustainable agricultural practices that are widespread across the globe. For several decades, the earth's non-renewable resources have also been recklessly exploited, and natural environments have been destroyed in the process.

During this alarming time when COVID-19 has intruded into our lives, we must not lose sight of the issues related to the collapse of biodiversity and the health of ecosystems that are essential to the survival of humans and other species. The experts meeting under the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services clearly demonstrate that we are reaching a point of no return. To paraphrase Greta Thunberg, returning to normal after COVID-19 would mean plunging headlong back into the climate crisis which, by 2050, promises economic and societal upheavals and millions of refugees. At a time when our humanity is facing one of its greatest challenges, will we once again leave our collective destiny and that of future generations in the hands of a neoliberal economic model that requires an endless supply of costly new infrastructure and calls for infinite and unsustainable GDP growth?

The United Nations reminds us in the preamble to its resolution on the 2030 Agenda for Sustainable Development that economic, social and technological progress can be achieved in harmony with nature. We seem to have a historic opportunity here: putting the principles of sustainable development at the heart of economic stimulus packages to reconcile nature, society and culture.

To boost our economy, let's focus, for example, on investment programmes that will create decent and well-paid jobs for the protection and restoration of ecosystems, the conservation of biodiversity, and the creation of green infrastructure, including those contributing to food security. With the trillions announced, we can lay the foundation for a new "Environmental Marshall Plan" or "Green New Deal". However, this would require making fundamental societal choices and agreeing to change our lifestyles to prioritize the satisfaction of basic needs for all.

Heading this way would mean looking beyond concrete, bitumen, and steel to consider the multiplicity of natural environments that are essential to our survival and to the fragile balance that has always existed between humans and nature. We have come to forget the "goods and services" that ecosystems and biodiversity provide us throughout the year, on physiological, psychological, and cultural levels.

Investments must focus on protecting and restoring the vast "natural infrastructure" represented by the many parks and terrestrial and marine protected areas, including those under the governance of Indigenous Peoples. Their number must be increased to meet post-2020 biodiversity targets. Let us leverage the many sites designated by UNESCO, such as biosphere reserves, global geoparks and world heritage sites. They already serve to protect unique ecosystems and mobilize local and regional actors, including those in the education and research sectors, to advance common goals for biodiversity conservation and sustainable development. Finally, let us focus on protecting, revitalizing, and reintegrating natural environments in urban areas, drawing on the ideas and talents of our architects, designers, and builders.

It is very difficult for human beings to learn from history. The same is likely to be true of this COVID-19 crisis, which will be remembered for quite some time. Let us imagine for a moment that we all agree to direct some of the investment toward ecosystems and green infrastructure. This would not only guarantee our economies and our communities much better returns on investment, but it would also strengthen our self-sufficiency and our resilience over the long term. Above all, it would be an ambitious and visionary way to change the course of the yet-to-be-written human story of the fight against climate change--while safeguarding, according to the traditional invitation of many Indigenous Peoples, the interests of the seven generations that will hopefully survive us.

Social Impacts

Government COVID-19 guidelines gamble on the lives of migrant agricultural workers

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Government must regulate accordingly or cancel the entry of additional workers.

Recently published federal government guidelines put too much responsibility on employers to protect the health and safety of migrant agricultural workers during this unprecedented pandemic. Adequate oversight, clear standards, and enhanced coordination with public health are needed to keep workers and the public safe. In the absence of these measures, further entry of this workforce into the country should be put on pause.

Over 69,000 temporary migrant agricultural workers came to Canada in 2019. Central to Canada's food supply, these workers come from Mexico, the Caribbean and many other countries under specific migrant worker programs. Despite the announcement of border restrictions in mid-March, the prime minister announced that some Temporary Foreign Workers would be allowed entry. The exemption took effect March 26th.

The next day, Employment and Social Development Canada (ESDC), the agency that oversees the program, published Covid-19 guidelines outlining expectations for employers of migrant workers.

These guidelines fall short, leaving too much to the discretion of employers. They also fail to outline strong regulatory measures necessary to protect workers and the public during this unprecedented crisis.

Employers are tasked with ensuring that newly-arriving worker cohorts can self-isolate, and that social distancing be observed. Yet employers are not required to prove that they have appropriate housing in place to do this. No specific or concrete expectations are provided in terms of the maximum number of workers per handwashing station, washroom, or bedroom. If we have any chance of providing safe homes and workplaces for migrant agricultural workers, the federal government must regulate accommodation and sanitation measures to ensure this highly

infectious disease is not transmitted among workers.

Federal agents can also work with local health authorities to ensure adherence to these standards both before and during workers' time in Canada. This is necessary to ensure that employers have provided adequate housing and other practices to ensure distancing between workers. Without proof of these requirements, employers should be prohibited from hiring migrant workers this season.

Barriers that have always existed for migrant workers to seek help and medical care are now exacerbated by the current pandemic.

Communication between workers and their bosses can be challenging for many migrant agricultural workers because they may not speak English. It also can be intimidating to report symptoms to an employer who can decide both the future of these workers' livelihoods as well as their ability to stay in the country. The Government of Canada must provide direct lines of communication with workers, not mediated by employers and in their preferred languages so that they can report unsafe conditions that expose them to COVID-19 transmission.

ESDC's guidelines suggest that the 14 day self-isolation, access to medical care, and daily monitoring and documentation of this workforce's symptoms will all be the responsibility of the employer. Employers are not well positioned to fulfill this role. And workers often have unique cultural and language needs that are best addressed by community and primary care agencies.

Because self-isolation measures intended to limit the risk of spread within households may be difficult to implement, workers should be tested within days of arrival to help mitigate the risk of transmission. The federal government must work closely to coordinate these medical services with health authorities and facilitate alternative housing and employment for workers if employers fail to cooperate with these practices.

It is important to send a clear message to migrant workers that we will take care of them if they become sick. If not, workers will be more reluctant to come forward if they experience symptoms. Through coordination of workers' access to Employment Insurance, Canadian Emergency Response Benefits or relevant wage subsidies when and if workers become ill, ESDC can play an essential role in protecting workers' lives and stopping the spread across Canadian communities.

In this current international crisis, we cannot go forward with further entry of migrant agricultural workers into Canada without strict regulatory measures that will keep workers safe. We have already started to see outbreaks on farms in BC and more are sure to follow. Canada must act now to mitigate risk and protect the lives of migrant workers and the broader communities in which they live and work.

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Addressing a Global Pandemic within a Global Pandemic

Bill Gates told us we were not ready--and he was right. In 2015, he issued a warning that if anything were likely to kill over 10 million people, it would not be missiles but microbes (1). "If we start now, [he said,] we can be ready for the next epidemic." But we were not ready and, as a result, we have scrambled to address the immediate health and social needs of those affected by COVID-19 without always recognizing some of the harmful secondary impacts of the SARS-CoV-2 virus or its impacts on specific populations such as women.

It is clear that there is a gendered aspect to the epidemic. International as well as numerous grassroots organizations have identified that women have been experiencing additional challenges during the pandemic (2, 3). Much of this extra burden is the result of socially prescribed roles and responsibilities--particularly those related to home, family, and caregiving. As a result, more women than men are employed part-time or in casual positions with low wages. The resulting economic insecurity, among other issues, contributes to challenges in escaping an abusive partner and finding safe accommodation.

In the mid-1990s, the United Nations and World Health Organization declared violence against women as one of the most pernicious and pervasive human rights violations and public health concerns of our time. The most prevalent form of this violence, globally, is intimate partner violence with almost one-in-three ever partnered women having experienced physical or sexual assault at the hands of an intimate partner (4); 35% of women who were intentionally killed in 2017 were murdered by an intimate partner (5). The fallout of intimate partner violence, particularly in the context of health, is striking; 42% of women abused by their partners are physically injured. They are also twice as likely as those who are not abused to experience depression and have issues with alcohol use and 1.5 times as likely to contract a sexually transmitted infection, including HIV (4).

In the context of COVID-19, where 1-in-10 women are concerned about violence occurring in the home, intimate partner violence, the "Double Pandemic" or "Shadow Pandemic", is front of mind (6). In fact, with lockdowns increasingly common and recommendations/orders to isolate in one's home to prevent the spread of the virus, rates of intimate partner violence against women, have skyrocketed. Noted in a series of media reports:

- Intimate partner violence was three times higher in February 2020 than February 2019 in a county in Hubei province, China (7).

- During a 16-day period in March, an American national domestic violence hotline received more than 1200 calls that mentioned COVID-19 being used as an abusive strategy (8).

- Police in York Region, Ontario, Canada, reported on April 1, a 22% increase in intimate partner violence incidents during the pandemic (9).

- Within 11 days of lockdown in France, reports of intimate partner violence soared by 30% (10).

- Between the first documented case of COVID-19 and March 24, Google searches related to intimate partner violence had increased by 75% in New South Wales, Australia (11).

- In Cyprus, in a one-week period in March, calls to an intimate partner violence helpline rose by almost one-third (12).

- Fourteen women were murdered in Turkish homes within 20 days of the March 11 lockdown (13).

These reports of escalating rates of intimate partner violence during COVID-19 have been attributed to an increase in men's feelings of impotence, incompetence, desperation, and depression due to stress and anger related to confinement, loss of social supports, and unemployment with attendant income loss. Importantly, overlooked in many of these data reports are those most marginalized in our societies: homeless, migrant, and refugee women.

What has been the immediate impact of the soaring violence? Having tracked the news stories, read the blogs, followed the twitter accounts of activists, service providers, and women reaching out for help, it is clear that shelters--where available--are stretched to capacity, helplines are responding as best they can to the increased volumes in calls, while other services-- where there are other services--have been trying to adapt to virtual modes of delivery.

How can women experiencing intimate partner violence be supported in the current reality of having to isolate or be quarantined and with resources taxed to the limit? Some possible strategies in moving forward, a few in the early stages of implementation in different locales, include developing social media campaigns to widely share existing or modified web-based applications that help women determine whether they are being abused, assess the situation for potential lethality, and access relevant services. Particularly important to these web-based applica-

tions is the need to adapt safety planning to include an emphasis on de-escalation strategies to defuse a partner's abusive behaviours. In addition, activating pharmacies, grocery stores, and markets as sites of disclosure outside the gaze of the abusive partner can serve as gateways to emergency police intervention. Organizing local telephone-based safety programs could aid in ensuring the well-being of women and assisting in any need to escape. In implementing these strategies, it will be necessary also to develop emergency housing plans to help relieve shelters, potentially leveraging available motel or hotel rooms, as well as creating up-to-date lists of empty homes or places of worship that could shelter women. Ensuring women's safety must always be paramount.

It is critical that a group of worldwide experts comes together to address intimate partner violence now while in the midst of a crisis--women with lived experience, frontline workers, researchers, and policymakers--to fully develop these strategies and explore other innovative ways of responding to the needs of diverse women, including those most vulnerable, as well as men willing to modify or address their abusive behaviours. A priority consideration for the group would be to develop standardized measures for documenting the scope of intimate partner violence globally as a baseline to monitoring progress. In the longer term, this group could advise on the best means of changing cultures of male privilege and dominance and advocate for the advancement of legal and legislative frameworks to better protect women.

Violence against women is as old as time itself, but as a society we can do better in supporting abused women by heeding the lessons learned during the present crisis and applying these to the next wave of the virus, future pandemics and, as well, times of non -crisis. In doing so, it will finally signal our commitment to addressing and preventing intimate partner violence. This time, let us pay attention!

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

Growing Resilience Through Crisis: Building Community on the Run

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Is it possible that a global pandemic can deepen our local ties and even strengthen our communities? There seems to be a lot of discussion about this possibility. A pandemic may touch every country, but as with nearly all aspects of our lives, the day-to-day effects immediately around us are primary and deeply significant.

We are actively responding as local communities, and the limits on travel, calls for social (physical) distancing, and the cancellation of many of our common collecting points require us to take stock of what we have available nearby. How much of what you need is within walking distance? Short driving distance? Or maybe, in the case of self-quarantine, within distance of your slippered feet?

Local disasters like flooding, fires, and tornadoes have often left behind local communities both deeply damaged but also more cooperative, aware of each other, and resilient. We're experiencing something much more than a local flood or weather event as states of emergency are announced.

The ability to recover from a shock and to adapt is a factor of the pre-crisis resilience of our social systems, including the strength of local community groups that serve many formal and informal group activities. We know from studies of complex adaptive systems that some aspects of resilience might grow as both individuals and groups respond to a crisis.

We are not powerless.

The power of governments and large corporate entities like sports leagues means they can cancel, suspend, and limit various functions and activities. In a crisis leading to chaos and disorder, strong top-down intervention can bring an immediate sense of order. That same top-down approach may become a disaster of its own if needed directives are not carefully integrated with local people and organizations. This will become particularly important if the crisis extends over a long period of time.

We need ranges of response at a street and community level. We need the dialed-in sensibilities of charities, places of worship, neighbourhood clubs, hobby circles, and our actual street-level neighbours. Governments and corporations simply can't get that level of fit.

Our responses can shift the balance in ways that strengthen local communities. Canada can't hold a referendum on whether to suspend international travel and how we should direct our limited medical

resources. Our participation, however, is vital as citizens – we do need local communities, streets, and neighbours to cooperate.

That cooperation can be as simple as choosing to limit our own movements, to self-quarantine, not simply for our benefit, but as a means of caring for others. Our changed habits could serve some aspect of a common good. A crisis may nudge us past the usual social barriers into a mode of watching out for each other, sharing what we have or checking in on those who need extra care even if that is by phone or email.

The actions of large scale organizations are vital. If they do well, operating with transparency, with the common good in mind, our trust in them will increase. This will build our institutional social capital – stock that will be needed beyond the crisis. If greed and power are primary drivers, we will remember that long after the crisis.

One of the safeguards against misuse of power lies between the very big and the very local - the institutional spaces of small businesses, community organizations, and charities. Imagine Canada has flagged the essential nature of these organizations in a recent letter to the Government of Canada. We will need these civil society organizations as brokers that run both ways, advocating upward where needed, and serving among our communities where individual efforts are not enough.

This pandemic has brought, and will bring, suffering. But we can be actively hopeful, bridging the gaps and supporting those around us, especially if they might fall through the cracks. True resilience comes from coordinated responses at all levels so that everyone's unique capabilities – from government down to you and me – are able to meet the escalating demands we're facing.

Don't sprint –

Avoiding emotional exhaustion in social isolation

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Canadians want to do everything they can to help in these uncertain times. Fortunately, we were given clear instructions from Prime Minister Trudeau through one of his daily briefings to the nation which are sorely needed and appreciated: "Listening is your duty, and staying home is your way to serve."

I agree with this message and take social distancing very seriously but like many Canadians, I have some questions.

For how long will staying home be necessary?
This pandemic isn't showing signs of slowing down and unfortunately, we don't know how long we will have to remain in a state of social isolation owing to a lack of data and challenges related to testing. While it is a difficult problem with many unknowns, some medical professionals are weighing in. Health Minister Patty Hajdu has predicted that the social distancing measures will last months while others predict that intermittent social distancing measures may be needed for eighteen months or more [1, 2]. The government of Ontario announced on April 3rd that the province expects that the pandemic could last between 18 to 24 months depending on the adherence of the public to social distancing recommendations and our collective ability to reduce the reproductive rate of the virus [3, 4]. American researchers suggest that unless interventions such as vaccines become available or hospital capacity increases, intermittent social distancing recommendations could remain until 2022 [5]. This is a marathon and we need to avoid

sprinting.

How should we listen?
We need to remain informed of the rapidly evolving situation to ensure that our daily actions are guided by the most relevant and up-to-date evidence available. We all know the basics: socially isolate, wash our hands regularly, and maintain a physical distance of at least two meters with others who are not part of our household. Many of us have a strong desire to remain well versed in all developments related to the SARS-CoV-2 virus and the global and domestic responses to the pandemic. It is important that we read reliable sources and educate ourselves about the nature of Covid-19 so that we can protect ourselves and our communities, particularly seniors and those who are immunocompromised. However, I think that it is possible that many of us will succumb to some level of emotional exhaustion before the situation returns to normal in this country. Especially given the added stress that self-isolation imposes.

With so much information (and misinformation) out there from a variety of sources, one can become overwhelmed and inundated. We parse through the noise and are left with the apparent obligation to spend much of our days reading articles that are relevant to the global pandemic but are perhaps not essential to our daily lives. This can be dangerous. A person who experiences emotional exhaustion may tune out news for a few days or more which can leave them susceptible to missing critical instructions in this rapidly changing climate. It is simply not possible to absorb everything published on this topic, and

that is okay. Indeed, the Canadian Psychological Association and the Centers for Disease Control and Prevention both suggest that exposure to news and social media should be limited if one is feeling anxious or stressed [6, 7]. Be kind to yourself and allow for some leniency.

My strategy for avoiding emotional exhaustion has been to continue to stay informed primarily through the CBC, Health Canada, and the daily briefings from PM Trudeau and to allow myself the option to pass on an article if it is not relevant or does not interest me. I let some articles slip through the cracks guilt-free because it is important that in prioritizing our physical health, we do not ignore our mental health in this stressful situation.

If you are feeling overwhelmed, please give yourself permission to take breaks from the media for extended periods of time each day. Give yourself permission to let some articles go unread. Give yourself permission to narrow the breadth of news outlets that you follow. There is no need to sprint.

It is encouraging to see the response from Canadians and their willingness to help give front line health care workers the best possible chance at controlling the outbreak. It is also encouraging to see Canadians engage in the public discourse and remain informed with quality evidence-based sources. If Canadians remain engaged and continue to follow the advice of experts, we will make it through this together and will be stronger for it.

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

Universities Remain Open for Instruction, but Closed for Most Other Services

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By the end of January 2020, most Canadian universities were publishing updates on their websites about COVID-19. Most said they were monitoring the situation closely. Some institutions posted regularly after that, while others mentioned nothing until the beginning of March 2020. The first Canadian university to announce the cancellation of classes effective immediately was Laurentian University [1], in Sudbury, Ontario. They cancelled afternoon classes on March 11th and announced that they would resume classes online on March 12th [2]. Thus, there was no break to allow instructors to transition to online teaching. Most universities did not respond in this way. Most universities began by announcing restrictions to travel that aligned with the restrictions announced by the federal government. Then universities cancelled large events, work-related travel, and academically-related travel. By March 13th, many large institutions had announced that all face-to-face course delivery will be suspended and courses would continue to be offered in an alternative format. Some provided instructors with time, ranging from 2 days over a weekend (e.g. University of Toronto [3]) to 1 week (e.g. University of Guelph [4]), during which they could smoothly transition their courses. While instructors raced to learn new technologies, teaching support offices became inundated with requests for assistance; residences were shutting down or reshuffling students who could not go home; counselling and health services were shutting down or moving online; cafeterias, restaurants and athletic centres were closing; bookstores, libraries, and galleries were locking their doors. *Though universities remained open for instruction, most other services were closed.*

While maintaining instruction will allow many students to get through the semester, the lack of instructional and other support services during this especially stressful time will widen the existing gap in access to post-graduate education for many others. We do not know how closing prayer rooms, gyms, grad lounges, or student clubs will affect academic performance or student mental health. We do know that we are increasingly feeling the stress of isolation as a society. We do know that a positive 'sense of belonging' is often the leading variable in studies looking for

institutions cautioned students about the implications of choosing a PASS/FAIL predictors of academic success. We do know how heavily these programs and services are accessed and that they are a ubiquitous feature across all Canadian campuses. Finally, let us not forget that many of these support programs serve students with special needs. Surely they play a vital role and surely they are intimately tied to academics, especially for students from equity-seeking communities.

Within a day or two of their announcement to transfer courses online, most universities announced a revised grading policy. In an analysis of Canada's top comprehensive universities and top universities with medical schools, as identified by Maclean's University Rankings 2020, we found three different responses with two variations of the most common approach (Table 1).

All of the aforementioned approaches have serious implications for student equity. The Standard Choice approach provides individual students with the opportunity to choose whether to keep their letter or number final grade or exchange it for a PASS/FAIL designation (also referred to by some institutions as CR/NCR). The letter or number final grade would count in the calculation of the GPA but a PASS/FAIL would not. Many universities identified specific programs or courses where the choice would not be

Table 1: Grading policies in response to COVID-19.

Response	Institutions
Standard Choice A choice for students: graded as usual or change grading to a PASS/FAIL record on their transcript _after_ they have viewed their final grade.	Calgary, Carleton, Concordia, Dalhousie, Guelph, Laval, Manitoba, McGill, McMaster, Regina, Ryerson, Sherbrooke, Simon Fraser, Toronto, UQAM, Victoria, Western, Windsor, York
Standard Choice – plus As above, but with modifications that might include: 1) instructor could opt for a course PASS/FAIL grading scheme, 2) student could opt for a deferred exam with a graded as usual final grade.	Queen's, Memorial, Waterloo
Standard Choice – uninformed A choice for students: graded as usual or change grading to a PASS/FAIL record on their transcript _before_ they have viewed their final grade.	Montreal, New Brunswick
Business as usual With little to no modification from pre-pandemic policy. Students required to self-declare the need for any accommodations.	Ottawa*, Saskatchewan**, Laurier, UBC * deadline to withdraw extended ** instructors could opt for course PASS/FAIL
No Choice All courses adopting a PASS/FAIL grading scheme.	Alberta

permissible. Far too few with respect to their future applications to professional programs or graduate school.

The trouble with a choice is that many students would not feel as though they truly have one. Since the beginning of the switch to online learning, we have documented reports from students that describe significant challenges to their ability to succeed in their courses. These include, but are not limited to: reduced or no access to internet and technical equipment, family members to care for, changes in employment (usually increasing workload, especially for service industries like grocery stores), changes in mental health status, loss of childcare and a shift to full time parenting, loss of access to medical support for existing conditions, loss of income, and food insecurity. Anxiety has also increased notably. The reasons include poor communication from administrators to faculty and then faculty to students, uncertainty about graduation or program completion, the use of invasive digital proctoring technology, deferring exams, lack of contact with family, and changes to study environment/personal privacy and space. The COVID-19 pandemic spread students from our university campuses around the world, isolating students, changing their living conditions, increasing their stress, and eliminating their access to instructional and other support services. After all of that, only those students that are financially secure, without family to care for, and without existing medical

conditions still truly have a choice. How many of our students are this privileged?

Furthermore, how many graduate and medical schools will preferentially admit those students with letter or number grades on their transcripts over those with only a PASS/FAIL? By allowing students to choose, we will be widening a gap in access that Canadian higher education has been working so hard to close.

The only model found in which there is some equity in their approach is that adopted by the University of Alberta. Here all choice was removed from individual students and a university-wide PASS/FAIL policy was adopted. No matter what the individual circumstances, students who passed the course, or did exceptionally well, would all appear equal on their transcripts. And though this is a solution to the equity gap that is currently widening, it cannot be limited to only one school. If all Canadian universities did the same, then all students would be equal across the country. If all Canadian universities adopted a system-wide PASS/FAIL then we would not see a widening equity gap due to COVID-19. Alternatively, we could assign a grade of 100% for all the remaining assignments due after the switch to remote learning to ensure that the final grade reflects both the work to date and what students could have achieved had their learning not been disrupted. Professional and graduate schools would be forced to judge applicants based upon other time periods or other achievements. Students with children could focus on their families. Students in need of medical support could be less burdened by the need to study. Students would not put their health at risk to save their futures.

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

The Transition to Online Education at Canadian Universities

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The execution of education at universities experienced a great shift over the month of March 2020. The last face-to-face lessons at Ontario Tech University took place on March 12, which was near the end of the winter semester. The first online lessons began just four days later, on Monday, March 16. For many faculty members, the rapid and immediate transition to online education was a terrifying task.

Being a sessional instructor at the Faculty of Education, my own students, called teacher candidates, were finalizing assignments and preparing to go out on a practicum at this time. It was to our absolute disbelief that in the hour following our class on March 12th, the Ontario Minister of Education, Stephen Lecce, would announce that publicly funded schools would not be reopening after the March Break. In addition, as a PhD Candidate in the Materials Science program, the time spent at the Faculty of Science that evening was just as alarming. The undergraduate students who work in the research laboratories claimed that their classes were empty; students were staying home because they were scared of virus transmission. This fear was very reasonable, as students who commute to campus dominate our university population. Thus, the risk of COVID-19 virus transmission arose from people coming to campus from the entire Greater Toronto Area and beyond. The following morning, like Ontario's schoolboards, Ontario Tech University announced that it was cancelling face-to-face classes for the day. As restrictions in the province were ramping up daily, it was not surprising to learn the following workweek that students would not be returning to campus to finish the semester. We were not alone in our closure; universities and businesses began to close as the push to work from home accelerated.

Faculty and students were not ready to make an immediate adjustment. However, education could move forward, despite the cancellation of in-person classes.

There is a lot of screen-recording software available, and the financial cost is frequently paid for by the university. However, the concept of learning new software, in addition to all of the other changes happening, was creating obvious anxieties across the campus. Thus, educators such as myself came forward with resources to inform instructors and their students about how they could give presentations electronically using learning tools that they were already comfortable using. For example, newer editions of Microsoft PowerPoint have screen-recording capabilities, and it enables the addition of subtitles to promote equitable accessibility of content. Allowing people to tackle tasks without learning new programs reduced the fear behind transitioning to online education. In addition, many instructors had arranged for their students to deliver in class presentations at the end of the term. Now, they were able to inform their classes that these assignments would unfold online, with the same learning opportunities, in the comfort and safety of their homes.

My own course made a slightly different transition. In the upcoming week, my teacher candidates were going to execute the teaching of a mini lesson on a senior chemistry topic. Almost all of the learning opportunities were possible, in some manner, online. They were to record themselves giving lessons where they would implement best teaching practices, including questioning skills and good diction. They were encouraged to include electronic activities, such as the incorporation of a video or interactive simulation, to promote retention of content. Then, they had to create a discussion forum where their students could ask questions or provide feedback. The teacher candidates excelled at the task. They created online quizzes for follow up assessments, electronic exit tickets to review which of their students participated, and created interactive activities within the discussion forums. The quality of work was outstanding.

The best piece of advice for any instructor making a rapid switch to online education is be flexible with all deadlines, and keep your students informed; silence promotes fear. Thus, all students remained up-to-date regarding expectations through daily e-mails with new information as it arose from the Faculties to minimize any anxiety that they were experiencing. Students understood that difficulties at home, such as having children, sick family members, weak internet connections and so on, would not affect their assignment scores, and they were not alone in these challenges. Each student knew that it was normal to feel fear during this time, and that there would be no penalties for misinterpretations. Moreover, as a scientist, it is a genuine concern that not all learning opportunities are possible through e-learning, such as advanced laboratory techniques. Therefore, in moving forward, all universities should develop contingency plans and resources for online education, in case we ever make this rapid transition again. All educators should be given online education training prior to a pandemic, and not during it.

COVID-19 Information Pandemic: Developing an evidence-based approach among youth

Dr. **Sacha Noukhovitch**,
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Information Immunity

There are not one, but two pandemics taking place at the moment. One is COVID-19 in the physical reality and another is COVID-19's information communication and interpretation that takes place entirely online. Both have significant effects on individual and public health.

Words and images shared online have shaped the behaviour of the general public and manifested itself through recent waves of toilet paper stockpiling that spread in a chain reaction across regions and countries. Online information or misinformation on COVID-19 has become a defining factor for mass decision making, money flows, and production changes.[1]

It is common knowledge that toilet paper stockpiling was caused by COVID-19 fears but an empirical comparison of regions and countries most affected by overstocking does not correlate with those most impacted by COVID-19. Based on this, I suggest the concept of innate and adaptive immunity to online data and information: how the public consumes and responds to the entire spectrum of science communication from fact to misinterpretation to pseudoscience to fake news. Innate information immunity would be based on an individual's ability for critical thinking and data analysis that correlates but does not always equate to the level of education. Adaptive information immunity develops through individual and group learning as a person experiences and processes information shared online.

Generational Gap - Digital Divide

By looking at the Canadian shoppers who stockpiled supplies due to the coronavirus outbreak,[2] it is possible to define three distinct reactions: moderate stockpiling among 25-44 year olds; a low reaction among 45-64 year olds; and the most significant among those who are 65 and up. It is obvious that the differences in consumer behaviour between these groups were determined by the coronavirus information they consumed from news and social networks and their interpretation of manufacturers', politicians' and medical professionals' assurances. All in all, we see three different information immunity reactions.

It is reasonable to assume that on average, there should not be much difference in innate information immunity between the groups. The education system has not changed much in the past 60 - 70 years, offering the same core learning subjects and teaching generally the same critical thinking techniques.

Therefore, innate information immunity should not be a factor in the difference in consumer behaviour and stockpiling between age groups.

On the other hand, adaptive information immunity that includes collective learning elements such as news media, social networks and email chains varies a lot from one age group to another. Moreover, the breakdown in consumer reactions we saw between groups of 25-44 year olds, 45-65 year olds and those 65 and up corresponds well with information consumption preferences. Facebook and Twitter use statistics roughly delimits the first group.[3,4] It is reasonable to assume that the adaptive information immunity of those over 65 would be determined by news media and what is hardly possible to quantify - email chains and forwards that are notorious for "personal experience" stories. Finally, the 45-64 year olds happen to be least hooked up on social networks and are considerably less exposed to vital information. Different collective learning sources naturally result in different adaptive information immunity that create a generation gap in information interpretation and decision making as well as a digital divide in the evidence base for it.

Perfect Storm in Science Communication

We face an unprecedented magnitude of scientific information that has drastically affected the world economy, politics, and civil life. Using an immunology model perhaps does not explain to the full extent the pros and cons of public science communication,[5] but it brings us closer to understanding how this first-of-its-kind information pandemic was caused by COVID-19.

Historically, traditional forms of communication did not allow for viral spread of information. Even at the peak of Cold War instability, the dissemination of information about the nuclear explosion and radiation had significantly less socioeconomic and psychological effects. Today, the Internet and proliferation of social networks creates a fertile ground for large scale rumors, confirmation of biases through feed-back loops and overwhelming the public with an abundance of information that stands in the way of surfacing facts. The COVID-19 pandemic is perhaps the first

time that scientific information went viral unprotected by the typical peer-review and expert assessment that has safeguarded science communication before. The COVID-19 pandemic has disrupted the peer-review process with pressure from two sides. On one side, there are predatory publishers who bypass the peer-review process and release unconfirmed research in pursuit of revenue. On the other side, bloggers and businesses who generate fraudulent and pseudoscientific theories with the intent of going viral to boost their readership or sales. The high public demand and urgency for direct connections between scientific theories and practical personal health decisions during the COVID-19 pandemic enables these pressures to shape public knowledge and decision-making.

Information Reality(ies)

Due to the difference in information sources, the three groups discussed earlier exist in different information realities. These information realities do not vary much in the part of public health and real science communication information. The real difference lies in community interpretations and misinterpretations that come with fake news. Pseudoscience is great at offering theories that sound plausible by triggering associations with known facts while passing under the radar of innate information immunity, which should otherwise cast doubt on the accuracy of the information. It offers simple solutions to complex concepts backed by seemingly popular opinion and is spread within each of the three groups. Unfortunately, real science communication typically does not take into consideration a group's information consumption preferences. As a result, it is not given priority when an individual is acquiring adaptive information immunity. One interesting flip side to pseudoscience theories that are accepted within each of the three groups - when transplanted into a different group's reality, it is easily identified as fake news.

A unique sensibility to pseudoscience is demonstrated outside of the three defined groups by 17-24 year olds who have the strongest potential for critical analysis of facts and adaptive information immunity. Their active participation in formal and informal education

naturally results in the application of the scientific method and critical thinking in forming their adaptive information immunity. Furthermore, the innate information immunity of 17-24 year olds is still under development and varies from individual to individual quite significantly. That makes the task of concocting plausible pseudoscience that will work for the majority of this age category practically impossible.

Youth as Agents of Information Immunity

Highly engaged in online communication, youth have the potential to become information immunity agents for the general public. Empowered with an evidence-based approach and relevant scientific information, they can significantly contribute to scholarly communication and the boosting of adaptive information immunity, which is a critical first-level defence against pseudoscience.

However, without an emphasis on proofs when teaching scientific theories, students learn to take new information for granted and are unable to distinguish between factual information and pseudoscience consumed online. Reinforcement of their role as agents of information immunity requires developing their natural analytical abilities. This could be achieved through student-driven and Open Data-based experiential learning programs within Open Science research fields. Students who engage in scientific fields beyond those covered in High School acquire adaptive information immunity to relevant topics they will encounter online.

COVID-19 presents an opportunity for students to use socioeconomic and social network Open Data like Twitter for experiential learning in bioinformatics and sociology. One program that offers this opportunity is the National Undergraduate Big Data Challenge: Personal and Public Health Decisions in a New Open Data Reality which runs until July 2020. Using Open Data from government, non-profit, and corporate sources, students across Canada will submit original research exploring the complexities of public and personal health decisions.

Youth involvement in science communication will be a critical element in preventing future information pandemics. Empowered by big data, youth will be able to assert factual positions among their peers and with other generations. Their adaptive information immunity that is based on the most relevant scientific findings will be spread within their communities, both physical and online, to stop the spread of misinformation, and align public decision making with scientifically-based recommendations.

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

Big Enough Questions

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Many years ago, members of our research team were sitting in a garden with Dr. Rosemary Ommer, a scholar admired for her ground-breaking multi-disciplinary approach to research. We were undertaking our own study regarding policy and institutional models and barriers for collaboration across the academy when one of us, a synchrotron scientist, admitted that before the current project, he had never thought of pursuing research with anyone from the social sciences or humanities. Dr. Ommer paused and then responded that it was simply because he hadn't asked a big enough question yet.

As we find our way through this COVID-19 pandemic - as health-care providers, lab technicians, academics and professionals working from home, among so many others - we, who engage in research wonder what contributions we might make to address this unprecedented challenge. If there's one thing this crisis shows, it's that there's a complexity to these wicked problems (to borrow Horst Rittel and Melvin Webber's 1973 phrase (1)) that demands all our attention. Every aspect of our lives is affected – health, education, the economy, transportation, entertainment, food security, labour, trade, communications, entrepreneurship, culture, housing, leisure, and the list goes on. As Bruno Latour (2) has taught us, nature and science are inseparable and irrevocably entangled with our social world, our lives and interactions within our environments.

Which raises questions, or should raise questions, about how we do our research. Do we pursue our inquiries far, metaphorically and physically, from other knowledge seekers and producers? Do we assume we can engender the sorts of answers and evidence that will be helpful to governments and decision-makers from our vantage points in isolated departments?

Theorists might argue that we've become a true manifestation of the "risk society" articulated by Ulrich Beck (3). That we're necessarily preoccupied with fear and safety while synchronously propagating the hazards that threaten us in this society-turned-experiment. Our collective effort to fight a microbe means millions can no longer pay rent, kids can't go to parks and numerous medical procedures are suspended. Meanwhile, lower-income workers including grocery cashiers, cleaning staff, bank tellers and child-care workers supporting others needed to work, are at the frontlines with nurses, doctors and epidemiologists in this so-called war. They're holding our communities and our lives together. Perhaps they always have, but these are unprecedented times with no room for perception as usual. We are experiencing society, nature and our place within them, differently. For those who one day see their lives and intellectual pursuits return to normal (whatever that means...) it will be difficult (dare we say, irresponsible?) to perpetuate any longer the presumed dichotomies,

demystified by Emily Martin and Bruno Latour, among scientific knowledge, our labs and society (4).

When we pursued our study on academic and scientific collaboration, it was clear that diverse researchers were interested in working together. Enablers like public funding were identified and fortunately governments increasingly recognize the need for cross-disciplinary approaches as evidenced in calls for research proposals relating to COVID-19. But what is still apparent as our team embarks on a follow-up investigation of successes and failures in "convergence" research – the sort of research that authentically spans disciplines so as to answer large-scale global challenges – is that the academy and investigators are often ill-equipped to think and collaborate at large enough scales to be truly effective and relevant.

Academia and society celebrate certain modes of inquiry and what might be perceived as more applicable findings. Meanwhile, the theoretical and experiential perspectives of many are silenced. The marginalized voices of the majority – those impacted by intersections of gender, age, Indigenous status, language, employment loss, family structure, physical ability – all of us, inside and outside the academy, have much to say regarding the inequalities and injustices that are sidelined or feed on crises like this global infection. The world needs to know, and may reasonably expect, that those with the good fortune of time, publically funded jobs, research capacity and yes, academic freedom, are using our resources to find comprehensive solutions to our myriad, complex challenges. Now that we see, as Donna Haraway (5)

observes, that nature, science and society are inextricably interwoven, we must recognize this hybridity and respond.

Are we in the research community bold enough to work and learn together to collectively identify priorities for consideration? Are we prepared to risk rendering visible the limitations of our disciplinary perspectives and to embrace novel methods that permit new ways of thinking and enable our research communities to support public deliberations on effective scientific and social policies that have thus far eluded our isolated pursuits? Can we reassure Canadians that we've got their backs and that great minds with privileged resources will work together to support them through this COVID-19 crisis as well as others, including global conflict, food and water insecurity, climate change and social inequalities?

Big enough questions indeed.

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

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In-Kind as a Community Resilience Strategy During a Global Crisis

Now, more than ever, people around the world are concerned about the impact that the current health pandemic will have on their daily lives and what a new form of 'normal' might look like. What is increasingly clear is that no one is ready for this degree of long-term global uncertainty — and global economies, financial markets, and communities have been hit hard.

What isn't being discussed right now is the pressing need for a responsive social impact strategy beyond loans (which risk worsening this divide) and tax breaks (that are nowhere near instant) to address the distinct socio-economic divide being exacerbated by the COVID-19 pandemic.

There is no shortage of questions.

● *How are people and communities supposed to interact when cash is tight and social distancing is encouraged?*
● *How are governments to manage and predict the needs of their citizens as the situation continually evolves?*
● *As the tax base further shrinks and companies become insolvent, how will public services be resourced?*
● *How are charities and front-line community organizations supposed to serve the increasingly vulnerable populations needing their assistance?*

Despite the critical nature of these questions, there remains a shortage of answers.

To avoid serious social equality regression, these

questions require a strategy that puts those most vulnerable first. But our cash resources are finite, and our government's bandwidth is stretched thin. To address these challenges, we need to get creative with how we allocate all of our other resources — this includes our time, our skills, and material goods.

Grocery stores have already seen a shift in what people buy and how regularly, which makes it difficult to avoid over-stocking and waste. Similarly, professionals in self-isolation have valuable abilities that risk being under-utilized in the days to come.

During times like these, big corporations and global billionaires — provided they maintain their health — have cash fluidity to weather such uncertain economic times. However, as we've begun to realize, those

who keep our economies and communities afloat — small and medium businesses and their employees, the shrinking middle class, people living paycheck to paycheck — do not have the savings, stockpiled resources, or social safety nets for the same resiliency.

Charities and community service organizations are already being called upon to address the various pressing needs coming from many places. The vulnerable in our communities have the most pressing need for support right now and this will only become more acute as time goes on.

What if we could leverage a community of professionals to help them?

We have little idea of what exactly is needed right now or what will be needed tomorrow because we don't have a coordinated communications system to map the landscape of constantly changing community needs in real-time. We have local and national news, social media and the Internet, but getting a clear view of what every community needs, based on what each charity and nonprofit serving that community is reporting, has not been scaled for times like these — but it is built.

1 Billion
acts of in-kind giving by 2030
is the PROJECT K(IN)D goal to address BIG global challenges.

Let me tell you about a Canadian-made social impact platform to help people now.

Project K(IN)D, an online technology platform made by highly skilled volunteers, was designed to address the persistent misalignment between needs and available resources during economically challenging

times, unexpected natural disasters, and climate change. At the heart of this social and environmental impact technology is a belief that if community organizations, businesses, and citizens are interconnected to help each other in times of need and in times of prosperity, they will be able to build *collective resilience* to manage any future crisis *together.*

The platform does this by matching specific needs with a pool of donors that have readily available resources of time, talents, and basic goods to fulfill the needs. This can mean the difference between someone worrying about where to get their next meal or medication and getting the help they need now. Inspired by peers sharing music and exchanging value through technology, the Project K(IN)D platform enables peers to help one another with a bottom-up societal response framework that creates efficiencies of scale and puts human lives front and centre.

We have an opportunity to rebuild a stronger and more connected social framework that not only responds to the imminent crisis but continues long after. Let's take this opportunity to build social innovation the right way, by re-orienting the systems to serve people first and bridging the socio-economic divide in creative and inclusive ways. We can come out of this crisis stronger than before and with a better understanding of our neighbours and communities. **In short, we can create a kinder and more resilient global village that puts humanity first.**

PROJECT K(IN)D

**Be a Leader.
Pledge In-Kind.**

WWW.PROJECTINKIND.ORG

To learn more about the world's first in-kind impact movement go to www.projectinkind.org and join your community at app.projectinkind.org.

Policy Development

COVID-19: Who's Afraid of Data Sharing?

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Public health emergencies create a new context in which societies must balance competing priorities. Indeed, as a liberal society with individual rights at heart, we are confronting questions regarding how to further our collective, shared interests in fighting the global pandemic. Public health emergencies give the State distinct powers foreseen in laws adopted long ago by free and democratic societies. Yet these powers generally provide for dealing with only the most immediate of concerns, such as public order.

Within this pandemic, we also have a unique opportunity to further develop and frame the often neglected human rights to: science and its benefits, health, and non-discrimination in health services. These rights are more important than ever in our current situation. Giving effect to the ideas embedded in these rights requires not only research, but also access to already existing public health research data, genetic data and to environmental and socio-demographic data, to say nothing of emerging COVID-19 clinical data. Whose data is it? What purpose should or can it serve? How to respect both individual and collective interests?

During a pandemic - a global health crisis - the sharing of individual data for the public good is indispensable. Viruses and other pathogens recognize no borders and neither should our health data. The OECD's 2017 Recommendation on Health Data Governance already emphasized the need for greater international collaboration and health data sharing. The ethical imperative to ensure coordination and collaboration has only intensified. To this end, the Wellcome Trust has called upon the scientific community to ensure that data and research related to the COVID-19 pandemic are shared rapidly and openly.

Andrea Jelinek, the chair of the European Data Protection Board, has issued a statement saying that data protection rules do not impede responses to the pandemic. To this end, European data protection rules foresee the ability to collect and share data for the purposes of public health, and for the purposes of an individual's vital interests. Certain rights that individuals have with respect to personal data may also be curtailed in these unprecedented circumstances, thus allowing data use for public health needs with minimal disruption. Despite this, data sharing may still not happen as freely as needed where international collaboration is needed. European privacy law's emphasis on protecting data, regardless where in the world data is located, means that the protections must be ensured except in very specific circumstances. For example, an individual patient's vital interests are not viewed as being furthered where data about that individual are

transferred internationally for general biomedical research not expected to immediately benefit the individual patient. Nevertheless, there is generally a recognition of the necessity of a flexible approach to the balancing of rights and interests in current circumstances.

But what then of Canada? Here, the provincial patchwork of data protection laws and the federal Personal Information Protection and Electronic Documents Act (PIPEDA) have perhaps unwittingly created barriers for direct data access. An example of this is when infectious and respiratory disease researchers have difficulties accessing securely coded individual health data–including that held by the public health agencies themselves! Moreover, while British Columbia has temporarily allowed health care bodies to transfer data outside of Canada for certain COVID-related purposes, this does not extend clearly to ongoing research. Preserving privacy protections in cross-border data flows is essential, yet one wonders if such prohibitions are misguided by not providing flexible transfer mechanisms for data transfers to countries with equivalent or more robust data protection standards.

In these times more than ever, we must turn to the balancing of interests that privacy and data protection law requires. In this vein, the Office of the Privacy Commissioner of Canada has indicated its commitment to a "flexible and contextual approach" that also protects the privacy of Canadians. Both federal and provincial privacy laws have the idea of balancing at their core, such as those that call for the public interest in conducting research to exceed the public interest in protecting privacy. In our current circumstances, it is difficult to not see the scales tipping in favour of disclosure of personal health information for invaluable research.

The federal government's plan to "modernize" PIPEDA will be a milestone for domestic and international research collaboration. Given the federal government's emphasis on notions of consent and of control in their Digital Charter, we hope that they will not forget about how changes to data processing consent may affect the availability of personal data for research purposes. In this vein, there is much inspiration to be drawn from European data protection principles that recognize broad consent as suitable for processing personal data for research purposes.

Now is the time for big ideas that not only help us make it through today and tomorrow, but that also lay the foundation for a more sharing society once the pandemic ends. The establishment of the new Quebec COVID Biobank signals a commitment to the pursuit of knowledge by facilitating partnerships for research on a national and international scale. As the past weeks have shown, now is a time of citizenship and of solidarity. Indeed, it is only by working together that we can all move forward.

InterAcademy Partnership call for global solidarity

Robin Fears
InterAcademy Partnership

Peter F McGrath
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The COVID-19 pandemic presents extraordinary global challenges affecting individuals, families, communities, health services, and economies. Research is already helping to achieve significant progress in identifying what is different about this coronavirus and its unfolding epidemiology. Research provides the knowledge to accelerate the development of novel interventions – diagnostics, therapeutics and vaccines – and to guide the effective deployment of the public health measures already available.

Among emerging challenges has been the weak commitment by many to coordinate action and share resources in the spirit of global solidarity. A recent Communique from the InterAcademy Partnership, IAP, a network of more than 140 academies of science, engineering and medicine worldwide highlights the value of international scientific and other collaborations in previous serious infectious disease outbreaks. For example, the Communique discusses HIV, SARS, Ebola, avian influenza, and other global threats such as drug-resistant tuberculosis and antimicrobial resistance. Collectively, for the global pub-

lic good, we must apply lessons from what worked and didn't work in responding to previous threats as well as learn from our accumulating experience with COVID-19 to ensure that we act on a global scale. Canada, in responding to the COVID-19 threat has committed to collaborative scientific and public health initiatives, such as rapid diagnosis and acceleration of efforts for the first-in-human clinical trials. By the end of March, as the result of funding from a variety of national and provincial agencies, nearly 100 grants amounting to $54 million Canadian have been funded. The Royal Society of Canada has initiated a multidisciplinary Task Force on COVID-19, mandated to rapidly develop informed responses to the broad societal challenges Canada may face while responding to and recovering from COVID-19.

These partnerships are welcome and can also help with the sharing of information and resources and to inform objectives for the broader, coordinated, strategy worldwide for better preparedness and responsiveness. The behaviour of some governments announcing public health policy actions at variance

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with WHO advice without publishing their evidence to substantiate such initiatives, aggravates the problems caused by fragmentation in knowledge generation and disconnects in what should be a global COVID-19 strategy. Collectively, we also need to address problems arising from antagonism between countries relating to perceived origins of the virus, conspiracy theories, and the stigmatization of minority groups. This is no place – or time – for narrow commercial or national competitiveness and self-interest at the expense of others.

Deficits in international collaboration will be particularly deleterious for those who are most vulnerable. IAP is now actively exploring with its member academies how to support them in using and sharing trusted evidence in responding to the pandemic. Many low- and middle-income countries in Africa, Asia, and the Americas have yet to report many COVID-19 cases but are now taking steps to ramp up their preparedness to detect and cope with COVID-19. In addition, it is essential for all countries to be able to contribute to the prioritization of research choices on novel interventions, and to share in equitable access to innovation and other public health measures worldwide. IAP urges a more powerful role for WHO in ensuring this equitable access, and also recognizes the importance of supporting every country in communication with WHO in an open and responsible manner to support public health security worldwide.

In building critical mass to tackle COVID-19, IAP recommends three main areas for coordinated and sustained action:

All countries to reaffirm their commitment to international collaboration based on whole-of-government and whole-of-society approaches.
This priority has multiple consequences for: partnerships in research and innovation that include participation in clinical trials to rapidly evaluate emerging therapies and, once developed, make them available worldwide; for optimizing supply chains; and for the implementation of standard public health practices. It is also essential to plan for and manage the implications of COVID-19 on the provision of health services more broadly and on other sectors essential for

health, such as agriculture. Solidarity is also required in using the scientific evidence to devise options for developing herd immunity and restoring society without exposing vulnerable people to risk. Thinking further ahead, the world must also get ready to pursue objectives for decarbonizing the economy when economic growth returns.

Communicating validated information worldwide informed by the best scientific advice.
Robust evidence is essential to counter unproven assertions, prejudice and deliberate misinformation that risks disrupting civil solidarity and equity. The scientific community must join with others in promoting responsible, transparent and timely communication of credible evidence.

Ensuring the effort to work with and support countries with weaker public health frameworks
For example, IAP is acting through its global network to enable scientists in developing countries to draw on international and regional scientific evidence, across all disciplines and including that at the scientific frontiers, to advise their own policy makers and citizens. IAP is currently surveying member academies to identify their priorities for generating and using science – for advising policy, for driving innovation, and for engaging with the public – at national and regional scale. This information will be collated, analysed and rapidly shared.

Further detail on all these points is in the IAP Communique. IAP is also working with many others in developing a repository of open access web-based resources of curated information (for example, from academy members on. We conclude by reaffirming IAP's commitment to promote the sharing of expertise and good practice to help catalyze the needed coordinated worldwide action, informed by the best scientific evidence.

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

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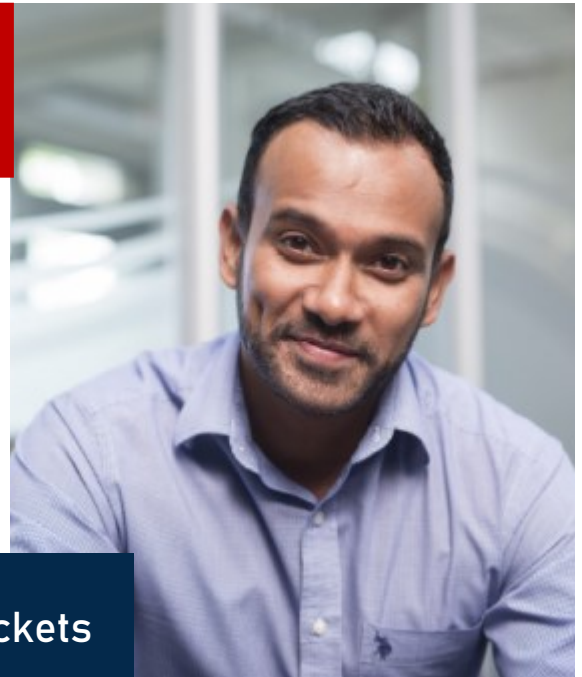
Sitting on Our Hands with Big Data in Our Pockets

When our society has faced existential crises in the past, we have banded together to overcome them. The COVID-19 pandemic is one such a threat that requires cohesive effort, as well as enormous trust, to follow public health guidelines, maintain social distance, and share basic necessities. Are democratic societies with civil liberties capable of doing this?

The answer to this question is perhaps right in our pockets. The Internet connects us all. With more than 3 billion devices currently in circulation globally, if there is one ubiquitous tool that leverages the power of the Internet like no other, it is the smartphone. The idea of smartphones being one of the primary solutions to this global problem might seem far-fetched, until we unpack its potential.

Smartphones provide us with the ability to directly reach and engage with a significant proportion of the world's population in near real-time. This has immense potential for addressing COVID-19 outbreaks via rapid detection. Moreover, smartphones have the capacity to provide big data via sensors such as global positioning systems. Smartphones can provide data about population movement patterns, which are extremely pertinent to not only understand and implement social distancing and isolation measures, but also to develop predictive epidemiological modeling

of virus spread. Finally, smartphones can facilitate real-time interventions to modify behavior and link people with healthcare services, aspects that can be used to manage both the physical and mental health effects of COVID-19. However, for such intensive and intrusive data collection measures to succeed, we need buy-in from citizens.

The policies and responses of governments across the globe have varied in speed and intensity, however, they are inherently based on evidence that COVID-19 is highly contagious. The success of government policies to detect, contain, and minimize the spread of COVID-19 lies beyond healthcare systems that are currently barely coping with the ever-increasing growth of COVID-19 positive cases. Thus, the realization of policies to contain COVID-19 outbreaks eventually depends on the willingness of citizens to follow public health guidelines and abide by laws restricting free movement, which is a challenge in free societies.

Thus, whether it is the ability to leverage ubiquitous digital tools such as smartphones or whether it is the success of government policies to manage and minimize the COVID-19 outbreaks, implementation of these strategies ultimately depends on citizen engagement. Citizen science, which is a participatory approach that ranges

from contributory and collaborative methods (data collection and analysis) to co-creation of knowledge (conceptualization and knowledge translation), paves the way for increased citizen engagement during this crisis.

With the increasing power of citizens to effect change, citizen science is earning a place in national science policies of countries such as the United States and Australia by complementing the efforts of governments and health professionals. However, there is currently no coherent citizen science policy to tackle the COVID-19 pandemic. Implementation of citizen science depends on innovative mobile health (mHealth) applications, which should be facilitated by a robust innovation policy. Nevertheless, the ultimate purpose of mHealth and citizen science, particularly from a disease risk management point of view, is to enable digital epidemiological modeling to prevent, detect, and manage the current wave of the COVID-19 pandemic, as well to predict and prepare for subsequent waves. This would require policy intersection across citizen science, innovation, and health.

Apart from the obvious benefits to population health, this approach can enable community empowerment

by connecting citizens for a common cause, manage misinformation by directly engaging citizens, and inform evidence-based decision-making utilizing big data. The obvious risks of this approach are loss of privacy and potential data breaches of data, which need to be addressed with stringent data encryption and anonymization. More importantly, ethical surveillance methods such as informed consent, the ability to drop out from participation, and control over one's own data are critical to embedding citizen science into global pandemic policies.

The big question is, why should citizens comply? The answer lies in incentivizing ethical surveillance. In other words, pay citizens to provide data that will enable enforcement of stringent public health measures necessary to flatten the curve of COVID-19. Some countries are surreptitiously monitoring their citizens' movement via smartphones. We cannot, and should not do that. At the same time, we are in uncharted territory when it comes to the health and economic consequences of this pandemic. So why not kill two birds with one stone? Let's compensate citizens for sharing their smartphone data.

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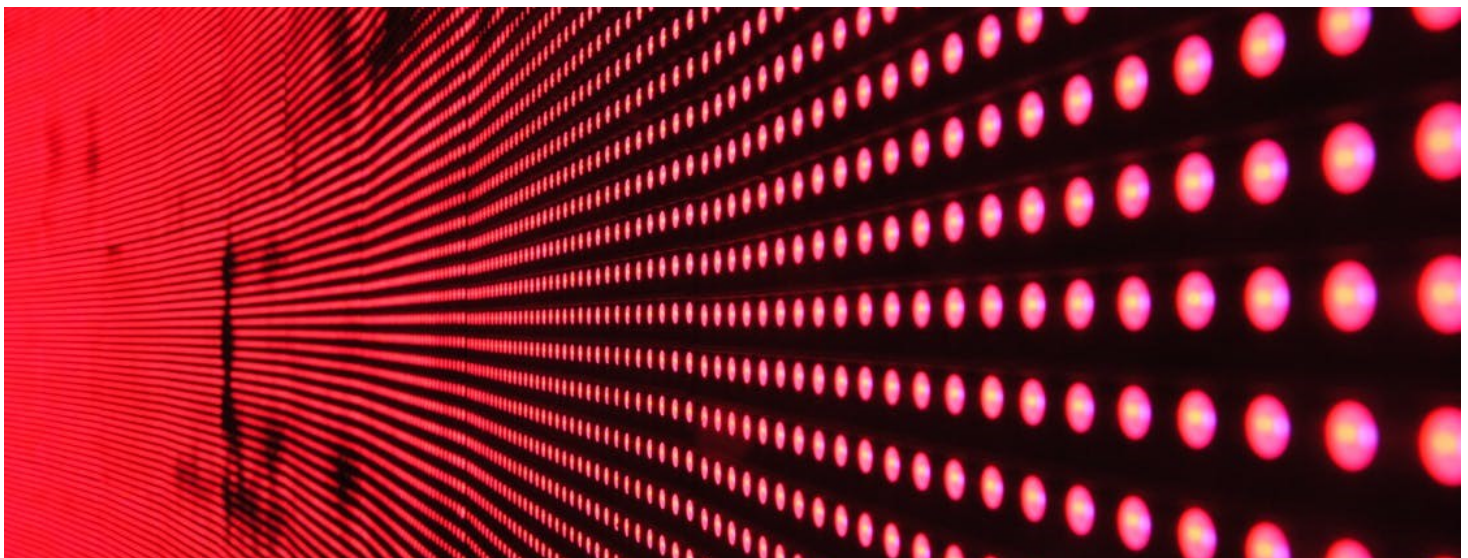
Are we really at war with COVID-19?

Peter WB Phillips

Distinguished Professor, Johnson Shoyama Graduate
School of Public Policy, University of Saskatchewan

Our leaders and media have latched onto the war metaphor to describe the public health response to the COVID-19 pandemic. I don't know about you, but I think that sends all the wrong signals and distorts the policy and public response we need.

In the recent past we have declared war on poverty, cancer, crime and disease, to name but a few. We launch these campaigns with great enthusiasm and a goal of vanquishing the enemy. Regrettably, outcomes seldom match the rhetorical goals and we often waste time and resources that could have made a difference.

The war metaphor imposes a set of assumptions that distorts how we think and act. In early days of the pandemic, the all-hands-on-deck strategy may have been the most effective way of responding.

But now we know more about the disease and have built medical capacity to assist those most in need. We now need to be exploring strategies to quickly yet safely restart our economic, social and community activities.

The war metaphor leads to a few simple yet wrong assumptions that will hurt this effort.

First, the war analogy implies there is some external aggressor. Initially that was foreigners, mostly coming from Wuhan or cruise ships, and now everyone from outside your neighbourhood. Barricades, police checks and information stop-checks between our provinces, at the boundaries of some communities,

in cottage country and in many First Nations symbolize the idea that it is others that are infecting us. That is false logic now and undoubtedly distorts our actions.

Second, wars need to have a goal, and when context changes we should reassess our actions. Already in this pandemic circumstances have shifted widely, with little or no change in strategy. Our initial goal was to vanquish the disease, first by stopping its spread, then to flatten, plank and now, crush the curve. With more than 2 million confirmed cases worldwide (and up to 10 times more undiagnosed cases), COVID-19 is now endemic. We were going to have to find ways to live with it, rather than to vanquish it.

Third, wars tend to become all-in efforts. This creates all-in thinking and decision making. In the context of COVID-19, that has led to a total fixation on the infection and death rate of this single disease. For those in our hospitals, nothing else probably matters, but in a country of almost 38 million people, this war has engaged less than 20% of our population directly. The rest of us have been asked, some ordered, to cease activities and wait for instructions. In the meantime, everything else we value is in limbo. Jobs and retirement wealth are lost, firms are folding, other diseases are not being treated, and we are doing little or nothing to address other social priorities. The opportunity cost of the current strategy is high and growing.

Fourth, wars lead to unity of command. Governments everywhere are centralizing resources to fight the disease. This leads to overreach. The Liberal government in Ottawa sought unlimited spending and taxation powers without parliamentary oversight for 21 months and mooted invoking the Emergency Act to consolidate powers in the federal executive. Provinces, regions, cities and First Nations are arbitrarily setting up border checks, with no effective oversight. Cities have attempted to impose emergency orders beyond their competence to administer. Police are exploiting their new powers to enforce the letter of the law, regardless of the context and degree of risk involved. Most of these excesses have been pushed back but on-balance power is being centralized, with few benefits.

Finally, the one certainty of war is that truth is the first casualty. Governments in the heat of battle censor, distort and mislead to boost morale and create a unity of purpose. All governments in times of war distrust citizens and don't have the time, patience or inclination to engage in normal debate. The cloak of war is well and truly in place in Canada, with most governments preferring to release only high level infection and death rates, to keep their underlying models and planning assumptions hidden and to generalize about the risks for the general population. We are only seeing what governments want us to see.

The military metaphor is especially poor as we begin to discuss the recovery and reconstruction effort that lies ahead. It is time to change the rhetoric.

Government Assistance – Let's Not Play Games as We Seek Assistance

Russ Roberts, PhD
Senior Vice president
CATAAlliance

Some 11,000 plus Canadian Controlled Private Corporations (CCPCs) claim Scientific Research and Experimental Development (SR&ED) tax incentives. They include small- and medium-sized private firms that use Canada's Refundable SR&ED tax credits each year. Canada puts over $1 billion a year into helping these firms develop their technologies through the SR&ED program.

These firms and their talent are extremely vulnerable to the COVID-19 driven recession, as is Canada's investment in their talent and technologies. The CATAAlliance has called on the Federal Government for targeted funding to provide bridge support for these firms during this crisis. Canada cannot afford to lose these firms; they are critical to Canada's recovery and future growth. However, there's an albatross out there as governments ramp up urgently needed support for Canadian businesses. The Prime Minister has warned against scamming government efforts to save our businesses and their employees.

Unfortunately, I believe the Prime Minister has a very legitimate concern. I've repeatedly seen the major problems that can be created by government efforts to help business throughout my career, in both the public and private sectors, as the Senior Science Advisor for the SR&ED program during its inception, as Acting Director of Innovation Policy with a predecessor of ISTC, and as a senior consultant to companies on their SR&ED claims.

I find that, eventually, government catches onto aggressive behaviour and that the damage caused by the corrective actions they take can be hugely damaging to the very firms and their owners that the government was trying to help.

Frankly, there is nothing more frustrating than to sit with a well intentioned business owner who pushed the envelope and have to tell them that this is going to happen, knowing that the outcome is likely the shutting-down of the business.

I urge that all of us who are searching for assistance for the business community at this time of crisis be equally focused on getting the business community to do it right and recognize the consequences of failing to do so. Our businesses cannot afford the alternative.

In my experience, the SR&ED program is an example of what can happen.

The program has gone through a number of challenging periods over its 35 years where files piled up and CRA struggled to sort out the good from the bad. Many of these problematic periods were caused by the governments of the time trying to assist businesses and things getting out of control. The ultimate question for both parties at times like this is: Is it worth keeping this kind of support? In the case of the SR&ED program, we've just got back to the point where we are hearing of more positive experiences than negative.

Let's listen to the Prime Minister's call for restraint as we work with governments to assist our businesses.

I encourage the leaders of our business communities to promote this message as they work to obtain assistance.

Planning for an Uncertain Future

Roseann O'Reilly Runte
President and CEO, Canada Foundation for Innovation

Today, we are in mid-crisis mode across the country and around the world. While managing the daily issues that arise, we are all trying to imagine the best possible ways to support our country as we emerge (and emerge we will!) from this pandemic. We do not know exactly where we are in terms of the length of this affliction or if it is a single event or something that will repeat itself or mutate and recommence over time.

We cannot yet evaluate the effectiveness of our responses. The study of past plagues, while edifying, is not extremely helpful because the world has so completely changed with greater scientific knowledge, more technology, improved communications and transportation, resulting in the rapid movement of populations and products. People, however, have not changed. When the Great Plague ended centuries ago, for example, people shortly began to venture forth and congregate once more. Even in the recent past, during the SARS epidemic, we stopped shaking hands, but post-SARS we went right back to our old habits.

How can we plan effectively for the future? Moving forward, we will certainly include major unforeseen crises as part of our risk-assessment and management process. In the past, we typically turned our attention to the most likely risk to be confronted by our organization. I doubt that many of us, especially the non-epidemiologists, would have included a pandemic on the list. We would likely not have listed massive floods and raging wildfires either.

As researchers, we can list the possible woes that might afflict our human condition and affect our performance. Then we might hunker down and build defenses, a bit like the bunkers of the Cold War. However, we can also turn the question around and ask what knowledge will we need most to avoid and prevent disasters. Rather than plan to mitigate the effects of such crises, we can plan to create the conditions by which they will be rendered nearly impossible. For example, rather than build a bulkhead to reduce the damage of flooding, we might turn our attention to the causes of flooding. When there was an epidemic of polio, we built iron lungs but we quickly turned our attention to the importance of an effective vaccine.

The challenges humankind faces can perhaps be summarized in three words: health, the economy and the environment. The three are inextricably related. Without good health, work is not possible, the economy will suffer, and we will be unable to rise to the challenges of the environment. Without a strong economy, health and the environment will be negatively affected and without a good environment, health and the economy will lag. These three challenges encapsulate the Sustainable Development Goals of the United Nations.

They are local, national and global. They affect every individual on the planet.

If we focus on progress in these three areas, we will be able to bring together goals and plans, hopes and cautions. Every individual and every agency, every nation, could ideally direct efforts in the same direction and each small step we take ourselves, multiplied, would go a long way to helping Sisyphus push that metaphorical boulder up the mountain.

For the research community, in order to succeed in these goals, we need to have a strong foundation of education, expertise and the equipment that will support research in these areas. We also need to encourage business and industry and communities to work together. We also must adopt a global perspective and build the capacity to join international efforts to achieve these goals.

For the nation, once this crisis abates, there will be a need for economic stimulus. If this support focused on three themes: the environment, health and economic development, we would create a thoughtful guide for decision makers and it would encourage all efforts to align. Coming out of this pandemic, we could end up with clearer mandates and a stronger vision. We can ensure that we rethink our past and adopt a new frame for our vision so that we share determination to move forward as a research community, a global community and as a nation that provides thoughtful leadership.

"Rather than plan to mitigate the effects of such crises, we can plan to create the conditions by which they will be rendered nearly impossible."

Policy Development

Lessons Learned From Managing Global Health Challenges

Putting public health policies in a context: Lessons learned from Korea's response to COVID–19

Hani Kim, PhD, MPH
Program Officer, Bill and Melinda Gates Foundation

The first case of COVID-19 was confirmed in South Korea on Jan. 20, 2020. The epidemic reached a plateau by March 12th. WHO and others have praised Korea's COVID-19 control, and attribute Korea's success mostly to three factors: 1) early initiation of control efforts, 2) extensive and innovative testing strategies, 3) effective epidemiologic investigations using contact-tracing (1). These specific strategies undoubtedly contributed to Korea's COVID-19 control. However, the publicized "lessons learned" from Korea overlook the sociopolitical and health system context that gave rise to the specific strategies and policies. To generate insights that may have a broader public health value beyond Korea, it is necessary to contextualize the policies, and identify conditions conducive to an effective pandemic response such that those conditions can be considered in other contexts. We reflect on the policy context that enabled the successful COVID-19 control in Korea.

Outcomes, intended or unintended.
COVID-19 has been contained, though tenuously, with a total of 455,032 suspected cases tested, 10,156 confirmed cases and 177 deaths as of April 4 (2). Policies were implemented to enable a system-wide emergency response (Figure 1) (3). New diagnostic tests reduced the assay time from days to less than six hours. Mobile-phone data and apps supported epidemiologic investigations through contact-tracing, and risk communication to the public by the public health authorities (3). Innovative testing strategies enabled a rapid deployment of large-scale testing of suspected cases (e.g. drive-thru testing) (4). Efficient triage helped allocate resources (e.g. hospitals, health care workers) according to the risks of developing severe disease (e.g. public or private buildings converted to the Residential Treatment Centers for dedicated monitoring and treatment for mild cases, with on-site medical staff). Hospitals were designated to have separate wards for the suspected COVID-19 cases from non-respiratory illnesses in order to minimize hospital-transmission (3). Vulnerable social groups were exposed, including the undocumented foreign migrant workers, low-income households, and workers with poor working conditions.

Context
The corporatist Social Health Insurance system (multiple insurers) introduced in 1977 was transformed into the publicly funded single-payer National Health Insurance in 2000 (5) owing largely to decades of democratization movements. A popular uprising impeached and imprisoned two presidents from the conservative
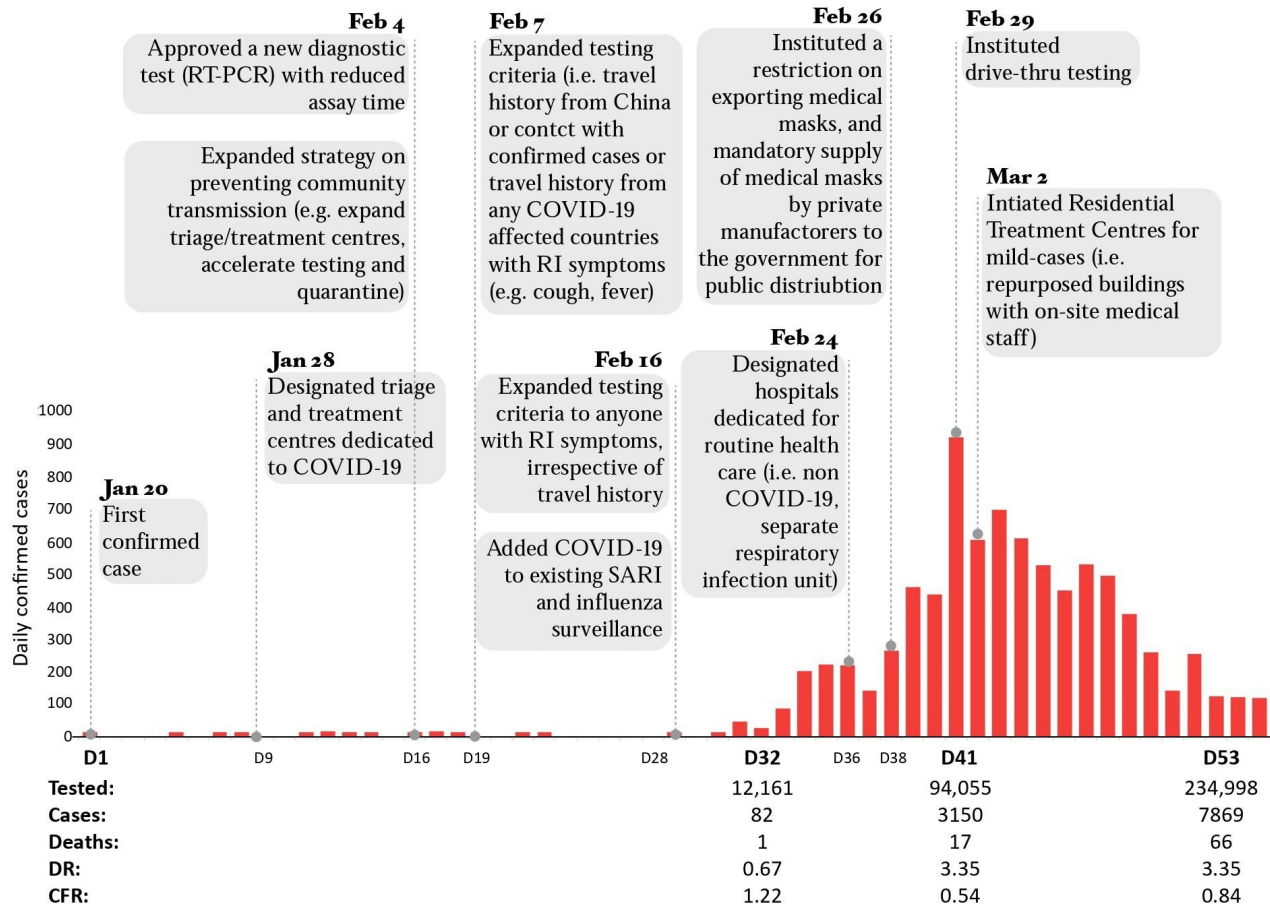
Figure 1. Government policies instituted. *Cases* = RT-PCR positive for SARS-CoV2 irrespective of clinical symptoms. *DR (Detection rate)* = cases/total tested. *CFR (Case fatality rate)* = deaths/confirmed case, RI=Respiratory Infection, SARI=Severe Acute Respiratory Infection. Data Source: Korean Ministry of Health and Welfare briefing reports

Party (Myong-Bak Lee, 2008-2013; Geun-Hye Park, 2013-2017), and elected the current government in 2017. The relatively high level of public trust in the current government must be interpreted in this context of Korea's recent political history. South Korea ranks 46th highest in the Gross Domestic Product per capita of $39,500 and spends $2431/year/capita on health (6,7).

Pandemic influenza A/H1N1 caused 750,000 cases and 252 estimated deaths in Korea between May 2009 and August 2010 (8). Between May and November of 2015, the Middle East respiratory syndrome coronavirus (MERS-CoV) caused 186 confirmed cases and 38 deaths (9). During the MERS-CoV outbreak, the conservative government was heavily criticized by the public for delayed testing, failure to identify and isolate 'super spreaders', and lack of transparency in risk communication to the public. The two outbreaks triggered a rigorous public debate on the conflicting needs between protecting personal data and ensuring collective well-being during epidemics. The public demand for a system-wide reform in epidemic preparedness led to strengthening the Korean Centers for Disease Control and Prevention (KCDC), and the establishment of the provincial-level Rapid Response Teams under KCDC's leadership. The Infectious Disease Prevention and Control Act was legislated to permit collection and sharing of personal data by the government for the sole purpose of prevention and control of infectious diseases (10). Epidemic preparedness was recognized as a core public health function after the two outbreaks, and mechanisms for the government-led response were put in place.
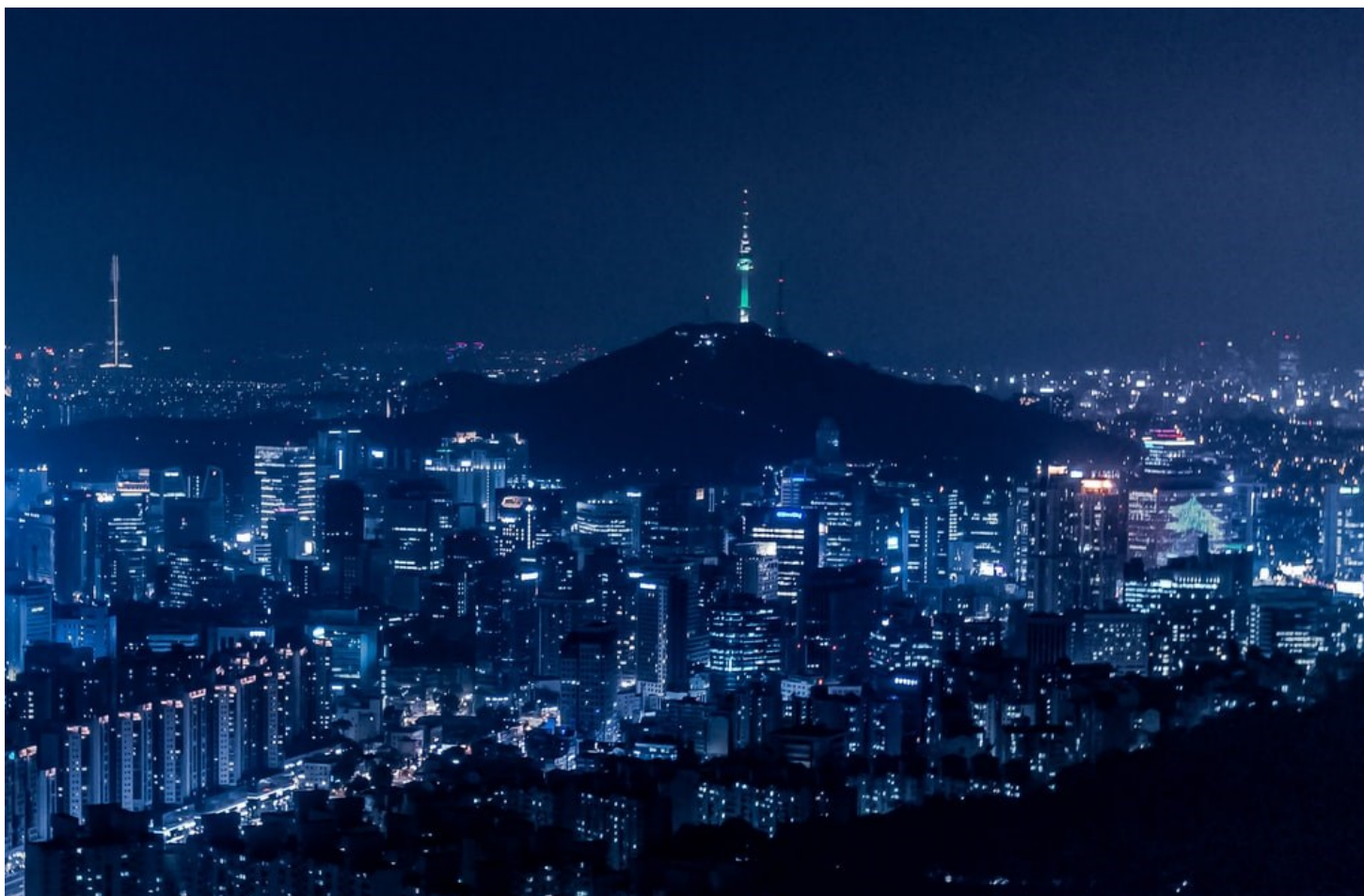
Reflections

Timely and coordinated response to COVID-19 in Korea was possible largely because of the system-wide strengthening of public health institutions within a strong publicly funded primary health care system. Intended and unintended outcomes highlight the need to emphasize democracy, equity and solidarity in the long-term strategies for pandemic preparedness.

First, strong leadership and transparency of the government, and active civic participation were critical in the COVID-19 control in Korea. The social contract between the citizens and the government is inherently tentative and dynamic; it must be continuously calibrated through democratic deliberation for specific policies (e.g. use of personal data for epidemic control). Second, epidemic blind spots put the entire population at risk; thus, making an equity-focus a necessity. Is a series of just-in-time emergency cash transfers sustainable or even effective in the long-run? Is there an argument for strengthening social protection floors that can proactively identify and protect the vulnerable social groups, and strengthen resilience at a systems level? Third, in times of heightened anxiety towards and scrutiny over others, can we imagine long-term strategies to avoid atomization of communities, and to strengthen social cohesion? Fractured communities with distrust towards one another are not conductive to an effective public health response to an epidemic. These questions have relevance beyond Korea.

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

Lessons Learned from Managing Global Health Challenges

The Promise of Science, Values and Pandemic Policy Decisions

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Unprecedented policy decisions, with risks and consequences that are largely unknown and unpredictable, are being made in response to the COVID-19 pandemic. Politicians, public health officials, and medical experts assure us that these decisions are being made based on evidence, and that measures to contain the pandemic are following the science. The promise of science—our expectation that science will solve our most critical and urgent challenges and guide us to a better future—has become a powerful force as we confront the uncertainties of the pandemic. We are expecting a lot from science in the global efforts to contain the SARS-CoV-2 virus and mitigate its impacts. Research efforts have been mobilized to generate scientific evidence about the virus, its behaviour in individuals and communities, the social interventions necessary to slow its spread and eventually stop it, and the technological innovations needed for testing, diagnosing, treating and vaccinating against it. And, we want the science FAST. But policy decisions are informed and shaped by more than scientific evidence. Values—the beliefs, priorities and ideals—that underpin our society and guide our behaviour are fundamental to effective public policy. The COVID-19 pandemic has shown us very clearly the entangled relationship between values and science in the policy process.

Scientific evidence is an essential element of a well-functioning, credible policy process. But it is normally a result of a systematic, rigorous, incremental process, widely known as the scientific method. SARS-CoV-2 is an emerging pathogen in its earliest phases. The science or scientific evidence on SARS-CoV-2 is only just beginning to emerge. It is advancing and being adopted, without the rigorous checks and balances of the scientific method, at a pace and scale that would normally be unthinkable. SARS-CoV-2 is showing itself to be a truly novel organism, challenging our existing knowledge and general understanding of pandemics. What we thought we knew is being called into question. What we know is in constant flux. There is still so much that we don't know.

The truth is, science rarely gives us complete and definitive answers, even when we have years of research and data. More often, scientific evidence is inconclusive. Science rarely gives up all its secrets, despite our hubris or hope in thinking otherwise. It is unlikely that science will ever reveal all of the mysteries of SARS-CoV-2 and COVID-19. Yet, despite this uncertainty, as our most credible and reliable source of knowledge about the natural world, science has been profoundly successful in serving society and guiding us to brighter futures. And so, our faith in the promise of science appears to be well-founded. Nevertheless, scientific uncertainty leaves decision-makers with difficult choices about which inconclusive, incomplete, and inconsistent evidence should be used to guide and inform decisions. We begin to see the limits of the promise of science in policy-making. How do experts give advice and how

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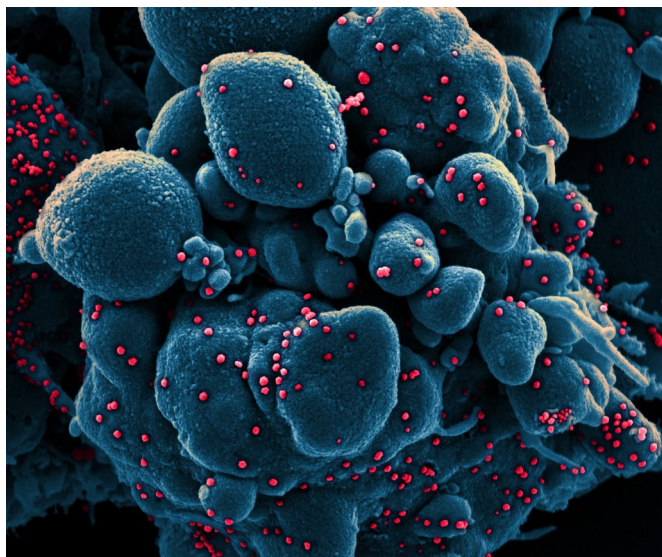
do leaders make decisions in the face of such profound scientific uncertainty—when the promise of science appears to be failing to live up to our expectations?

To understand how science fits into policy decisions, it is important to recognize the role that values play in the decision-making process. Fundamentally, public policy decisions are value judgements—expressions of what we value as a society. Policy decisions are shaped and influenced by our beliefs, interests, and priorities. Values even play a role in science. The processes that scientists use to accept or reject scientific evidence and knowledge claims are guided and informed by values. It is generally believed that policy disputes can be resolved by facts or evidence, when in reality, most policy debates arise from conflicting values. Agreeing on shared or common values is often the most challenging aspect of the policy-making process.

Our shared values have been the driving force in our response to the pandemic: preserving life, protecting health and safety, ensuring economic stability, and maintaining individual freedoms, liberty, and financial security. Based on those values, science has guided and informed decisions around the appropriate actions needed to respond to the pandemic. In the early stages of the pandemic, those values were given relatively equal weight in shaping policy decisions and interventions. With increasing and evolving evidence about the virus, its potential impacts, and the effectiveness of various interventions, decision-makers have been forced to give greater weight to

some values and less to others. Life and health and safety have taken on greater importance at the expense of our liberty, financial security, and economic stability in our struggle to contain the virus. In turn, the scientific evidence guiding and informing decisions has shifted to reflect the re-balancing of values. Throughout the pandemic, our fundamental values have remained constant. What we have seen is a shift in the importance of certain values and evidence. It is this co-evolving weighing of values and evidence that partially explains the initial response to the pandemic, which is facing some criticism for being too slow, as well as the differing pandemic strategies being implemented around the world.

Understanding the entangled and dynamic relationship between values, science, and policy may help us to make sense of what appear (in hindsight) to be decisions that were not based on evidence but, were in reality, responding to our shared values. The COVID-19 pandemic has shown us very clearly that unimaginable policy decisions are possible when we are unified by shared values. Imagine what other social crises we could resolve with the power of shared values and the promise of science.

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COVID-19: The End of the Beginning of Health Digitalization

While it is admittedly early to contemplate the far-reaching implications of the COVID-19 pandemic for Canada's health system, one thing is already unequivocally clear: we have at our disposal only a single resource capable of moving with the alacrity and agility of a lethal virus.

DATA

If we are to arrest transmission of infection, we need to accelerate transmission of data—and the COVID-19 pandemic has emerged as a crucible of invention and improvisation across the health data ecosystem. Our experience over the past few weeks is shedding light on the power of data and digital tools to enable real-time decision-making, drive innovation, empower patients and ultimately protect and improve health and wellbeing—and it is also exposing in stark relief the work that remains on the journey toward healthcare digitalization.

**COVID-19 has made it impossible to ignore the limitations of Canada's health data ecosystem for science, policy and public health.** There is compelling evidence that specific populations (e.g. the elderly, individuals with pre-existing health conditions) are at higher risk of complications from COVID-19, including death. We also know that some populations, including many Indigenous communities, may be particularly vulnerable to the COVID-19 outbreak due to chronic resource shortages, overcrowding and the lack of running water, further compounded by higher rates of pre-existing conditions. But the way in which we collect data impedes our ability to understand the impact of COVID-19 within these subpopulations. National data collection only focuses on age and sex; each province uses different data collection methodologies and tracks different metrics. Our disparate, disconnected and incomplete data limit our ability to extract insights that can drive research (e.g. what are the biological markers that will help us to assess risk?), clinical and policy decisions (e.g. which interventions work best in which populations and under what circumstances?) and public health (e.g. how can mitigation strategies meet the unique needs of individual communities?).

To mitigate the spread and impact of COVID-19, jurisdictions are rapidly filling gaps in healthcare digitalization by enacting policies to improve data collection, integration, sharing and privacy. British Columbia, which has some of the strictest regulations in the country regarding where personal data can be stored, is a case in point. Responding to a need to make a wider range of digital communication tools (e.g. Slack, WhatsApp) accessible to doctors, patients, teachers and students, British Columbia has temporarily modified its Access to Information and Privacy Act, lifting a requirement that personal data must be stored in Canada. While implemented as an emergency measure, this exception does not represent a temporary relaxation of privacy provisions; if anything, it is a reminder that the purpose of privacy legislation is not to make data inaccessible, but rather to provide clarity and certainty so that data can be accessed ethically, safely and compliantly. As Michael McEvoy, B.C.'s Information and Privacy Commissioner, observed: "Access and privacy laws are designed to allow for the sharing of information."

Data sharing across sectors and sovereign boundaries is driving the research community's agile response to COVID-19 and accelerating innovation. as a New York Times headline recently noted, "COVID-19 Changed How the World Does Science, Together." The unprecedented degree, pace and non-competitive nature of data-sharing has been central to this collaborative transformation. For example,

TransCelerate, a not-for-profit collaboration of 21 global biopharmaceutical companies, is leveraging its cloud-based platform to share de-identified, anonymized preclinical and clinical data, including control arm data from ongoing and planned COVID-19 clinical studies, as well as data from past studies in related diseases or patient populations, to make the testing of COVID-19 therapeutics and vaccines safer, more efficient and guided by better science.

Data sharing is central to Canadian researchers' substantial contribution to the global response to COVID-19. Across the health research and innovation continuum, Research Canada's members are harnessing the power of digital tools to advance our understanding of COVID-19, drive therapeutic, vaccine and diagnostic innovation, and generate evidence to support better healthcare decisions. The University of Calgary's two-year global prospective study involving children with suspected COVID-19 will enable real-time data sharing with national and international authorities, helping policymakers make rapid, evidence-based adaptations to case screening and management for earlier identification of children at high risk of COVID-19 infection and severe outcomes. Working closely with the WHO and other international partners, researchers at UHN are using human mobility and surveillance data to generate forecasts and guide public health policy during the COVID-19 pandemic, with a specific focus on low- and middle-income countries in Southeast Asia.
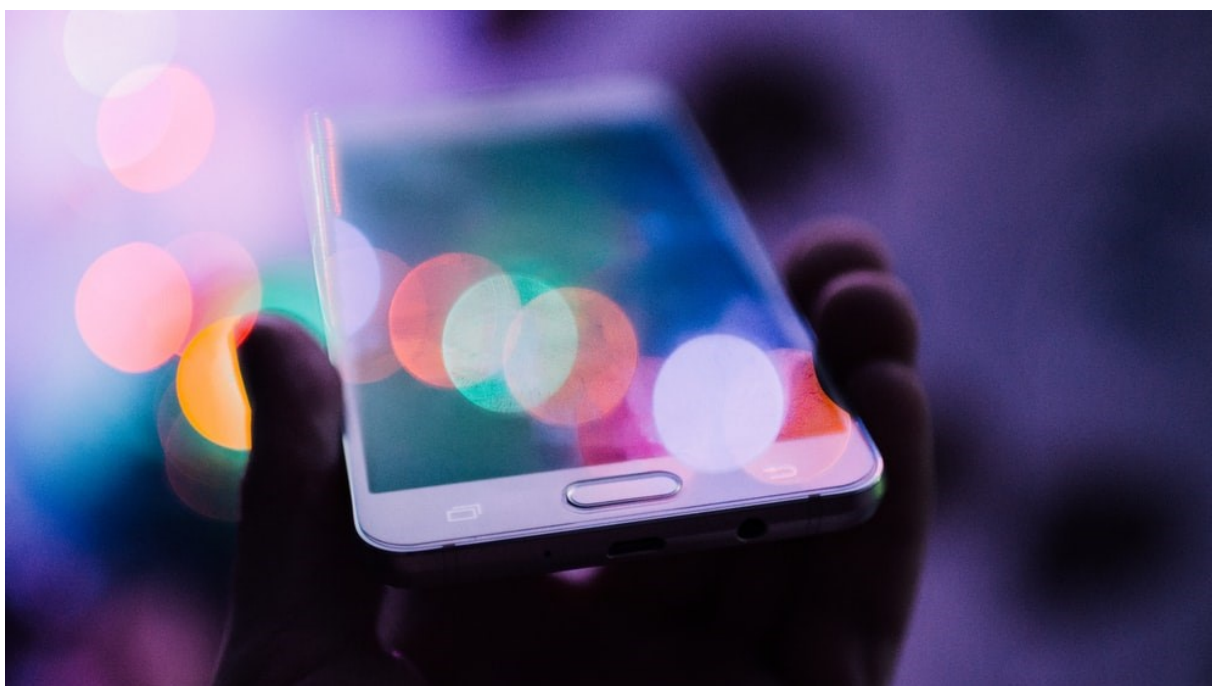
The digital tools employed in response to COVID-19 have reinforced the importance and possibility of digital health innovation beyond the pandemic. COVID-19 is forcing us to confront the reality that we need better digital tools and need to use digital tools better if we are to meet 21st century health challenges. Applying human and artificial intelligence, BlueDot is a Canadian firm specializing in automated infectious disease surveillance. By analyzing news reports from around the world, forum and blog posts, airline ticketing data, animal disease networks and more, BlueDot can detect early signals of disease outbreaks and was among the earliest to break news of COVID-19 in December 2019. If widely accepted and adopted, digital tools harnessing diverse, often unconventional, datasets offer the potential to identify patterns and guide action that can save lives.

The public—hungry for COVID-19 information, increasingly aware of the power of personal health data, and engaged with the choices they need to make to ensure they benefit from their data—is emerging as the driver of change. We can see the power and potential of this growing public movement in the creative grassroots efforts that are helping to close gaps in our official datasets. For example, as of 17 April 2020, there were over 418,000 voluntary submissions from Canadians reporting their personal COVID-19 symptoms to Flatten.ca, a not-for-profit website that uses self-reported data to identify COVID-19 hotspots. If anything, this initiative demonstrates that Canadians are willing to share personal information if they can envision the potential for personal and public benefit.

While the metaphor has become cliché, COVID-19 is a war. And it is true that in the theatre of war, you make exceptions—perhaps lowering the bar for approval and adoption of a new intervention because the risk of delayed introduction vastly exceeds the risk that it doesn't work as promised—that would be unnecessary, even unconscionable, in peacetime. We will eventually return to peacetime. But it would be a grievous mistake to return to "normal" and forfeit the opportunity to advance systemic changes in the regulation, management and structure of our health data ecosystem essential to advancing science, policy and public health in the future.

Realizing this future will mean being clear about the attributes we expect to see in a resilient, accountable and impactful health data ecosystem. It will mean evolving from rigid interpretations that hold privacy sacrosanct to an enlightened understanding of privacy as an enabler. It will mean recognizing that the benefits of sharing personal health data (and the risks of not doing so) far outweigh the risks of error, and that risks can be curtailed by taking full advantage of existing and emerging technologies to protect the security and privacy of health data. It will mean applying Canada's leadership in AI to analyze complex datasets and extract insights that will guide science and lead to better, more equitable care. It will mean increased focus on designing data systems that are interoperable and interconnected. It will mean re-engineering regulatory and reimbursement systems to accept and adapt to real-time, real-world evidence and digital innovations. Most importantly, it will mean empowering all stakeholders—and patients and the public, in particular—with the digital literacy and agency to contribute, use and benefit from health data responsibly, ethically and sustainably.

Until we optimize data collection, sharing and analytics and fully enable acceptance and adoption of innovative digital tools, we are missing opportunities to prepare for and respond to health emergencies, accelerate innovation and deliver effective, patient-centred care every day.

Health data are the bedrock of health research and a learning healthcare system. Health data are critical to our response to COVID-19 and give us hope that we might be turning a corner. At the same time, better access to high-quality health data earlier in the outbreak might have altered the trajectory of COVID-19 and prevented the human tragedy that it has become. We must learn from this experience and reimagine our approach to health data if we are to honour the lives COVID-19 has stolen.

CSPC
Call for Editorials

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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Thank you

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