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Commentary

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How pandemic modelling failed policy-makers, and how to do better

Harvey Schipper

As countries gradually emerge from this phase of the COVID-19 pandemic, we now face the equally uncharted territory of how to re-open our societies, in effect balancing risks – medical, social and economic – for the longer-term.

The quality of available data and modelling continues to be much-debated in Canada. Jane Philpott has been appointed by the Ontario government as an adviser charged with creating a new health data platform. The question is whether her mandate is broad enough to encompass the reality of such a large-scale disruption of society. And Theresa Tam, Canada's Chief Public Health Officer, recently warned of potential "explosive growth" in new cases based on the current models the federal government uses.

In fact, the time has come to rethink the concept we call a "pandemic." The COVID-19 pandemic, by virtue of its global scope and scale, has starkly revealed the limits of a time-tested medical epidemiologic model. It is too narrowly focused, contributing to missed opportunities at every step of the way. The global response has been framed from the perspective of a single disease, to the exclusion of all other medical causes of morbidity and mortality. Beyond that, the model does not take into account the broader consequences of the new disease and our response to it: economic, social and political.

The result is, as with the proverbial blind men and the elephant, we see the same lethal process with legitimately different eyes, and draw sharply different conclusions. Our responses are haphazard. It became apparent elsewhere, gratefully less so in Canada, that trust in leadership erodes. Difficult, necessary judgments became politicized, the captive results of dogma and ideology and blatant self-interest.

As a starting point we need to find some common language to reconcile competing perspectives on responses to the crisis. That will enable us to take the lessons of this pandemic to shape a new understanding, one that is anticipatory instead of being reactive.

This has substantial implications for Canada, both domestically and from a global perspective. There already was reconsideration of just-in-time production and global supply chains. COVID-19 has made it a front-page issue. There has always been an undercurrent of concern about the disadvantaged, the aged, and cultural and economic disparity. This Darwinian virus had made it explicit. We have endured muddled abstract discussions about what our economy will look like a few decades from now. Our public health response has made that an urgent consideration as it becomes clear that what might have been thought of as a transient wind-down is in many respects a profound disruption.

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COVID-19 also poses a serious challenge to the public perception of science. The constantly emerging data – some of quality, some less so, some contradictory until an understanding emerges from the fog of discovery. This inconsistency, inherent in scientific discovery, will play into the hands of ideologues and zealots who will say science is only opinion, no better than any other. We have to deal with that as well.

I would like to frame this discussion by stepping back to understand all of this from the perspective of how we acquire knowledge and how to use it in the face of rapidly shifting ground and inevitable uncertainties. My line of reasoning starts with a consideration of what models are, then examines where the current model is likely to lead, and posits the greater promise of an evolved more all-encompassing way to think about this kind of public health crisis.

Understanding models

"All our science, measured against reality, is primitive and childlike – and yet it is the most precious thing we have." – Albert Einstein

Much of the controversy surrounding the COVID-19 pandemic centres around the models we use to predict what is likely to happen.

Models are mental constructs that help us understand things. They are the necessary oversimplification of reality that enables us to act. Underlying all of that is a fundamental realization. We build those models based on a tiny subset of all the information coming our way. For one thing we are limited by our ability to detect information. As applied to science, models largely dismiss what cannot be seen and measured. As Thomas Kuhn explained, models typically start simple and become more complex over time, ultimately to be replaced by other models with different conceptualizations which predict better. One of the drivers of changes in models is new technology which allows us to see what previously could not be detected. The process isn't smooth; it is often fraught with disagreement and controversy.

Beyond what we can detect and measure, our models include what we consider to be relevant. The rest we ignore. As long as the model seems to describe what we are observing fairly accurately we are satisfied. However, the real test of a model is how well it predicts a future event. We attribute the extent it does not predict the future to something called "statistical error" which is a way of saying there were other factors we did not consider, which may be important. The larger the error, the less we understand; which is to say the poorer the model. At a certain point we replace one model with another that better explains and predicts what we observe.

There are many attributes of a model which can be misleading. Three are worth keeping in mind in the current crisis:

- The first is very different things can at first scrutiny appear the same. We see a phenomenon and try to fit it into something we know. Deciding something is an entirely new phenomenon, not explicable by our existing model, is not always straightforward. Science is rife with stories of the debate around the emergence of a new model, something Kuhn called "paradigm shift." In the early going with COVID-19, it was not clear that we were dealing with a new, highly contagious, SARS-like coronavirus.

- Second, the new thing has distinguishing characteristics which make it different. In medicine, usually we first identify a new clinical entity or disease by its most dramatic manifestations. With COVID it was the sudden onset of severe respiratory symptoms that just weren't quite typical of influenza or pneumonia. Gradually new elements are added to the model, further distinguishing it. In the present case the

distinction was made firm by the identification of a new causal agent. However, the detected presence of a disease is different from its clinical impact. Some diseases, like SARS or MERS, have a very narrow pyramid of severity. There are few mild cases. Others like influenza have a broad range of severity. In this context there should be little surprise about the emerging trend toward lower death rate estimates than were first expected. That is more the usual than the exceptional pattern of new disease recognition. However, a lower death rate affecting many persons is still a large problem.

- Third is that a real thing can look very differently in different contexts and when viewed with different eyes. A physician in the Arctic will not think of episodic fevers, chills, aches, deteriorating neurological state and falling haemoglobin as malaria, unless in a recently returned traveller. And then only if the doctor is very sharp. Quite different in tropical Africa. This manifests in important ways that can have a huge impact on our appreciation of the disease and our approach to treatment. Where the presence of or concern about a disease is great, false attribution is a reality. Currently, there is a natural tendency to presume it's COVID, especially if testing is either unavailable or unreliable. Moreover, we may attribute cause to COVID even if other co-morbidities may be more important contributors to morbidity and mortality.

The important idea to take from this discussion is that models are abstract extrapolations of reality that give us a structure for further understanding and response. They are not ultimate truth, and it is the very circumstances which demonstrate their limits that make possible new insights and correspondingly better models.

The pandemic model

Let's return to the basic mental model of a pandemic. Epidemic is a term used to describe the appearance of new cases of a disease that appear in a population, at a rate which, over a given time, substantially exceeds what is "expected," based on recent experience. We typically think of epidemics as infectious, although the term has come to be used more broadly, as in, for example, the "epidemic" of drug-related deaths in the US and elsewhere. Epidemics happen in every species. The difference between epidemics and pandemics is one of geography and scale. A pandemic is an epidemic that spreads around the world. Our concern about epidemics and pandemics is how many people get the infection, and how sick they become.

Epidemics are a consistent part of the intimately connected biology of the world. They have been reliably recorded going as far back as 430 BCE in Athens. They have decisively shaped human history. A new pattern of sickness

arises. Depending on how many people get it and how sick they become, it captures attention. The illness is characterized, and at the beginning there is a surge of cases. Then, over a period of time, the epidemic passes.

All epidemics fade away with time. Some recur, in two or three waves before finally disappearing. Others become endemic, meaning cases continually occur, perhaps seasonally, perhaps in small clusters, a slow dribble that never completely disappears.

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Mitigating an epidemic requires having a robust model of how it works so that we can intervene effectively. The more the model can predict what happens the better. That requires having a comprehensive understanding of all the factors at play, and how they relate. Importantly, not all epidemics result from new diseases, a nuance that often plays a determinative role in our response.

Let's unpack this. Over the past 200 years, we've built a relatively narrow model of an infectious epidemic. It has two parts, a causative infecting agent and a vulnerable human host.

What do we have to know about the vulnerable host?

1. Who gets it? Everyone or some subset? If some subset, how do we identify those at big risk, moderate risk or little risk?
2. What happens when they are exposed? What is the time course and natural history of the infection?
3. What are the mechanisms of sickness, the organs involved, and the biological processes engaged?
4. What are the biological tipping points that determine whether things get worse or better, and why?
5. What happens afterwards? Not every infection leads to immunity.

What do we have to know about the infecting agent?

1. What is it? Bacteria, fungi, parasites and virus, and other agents, cause infection in different ways.
2. What does it require to survive (or what kills it)? Botulism and anthrax can remain dormant in the soil for years. Viruses are much more fragile.

3. How does it spread? Body fluids as in Ebola or HIV? Large droplets like influenza, and apparently COVID-19? Microscopic droplets, called aerosols, like measles?

4. How many infectious particles does it take to make you sick? It takes far fewer particles to give you hepatitis than HIV.

5. How do factors two, three, and four come together to determine how infectious the virus is? This leads to the much bandied R_0, the higher the number the more infectious. Measles is at the top of the list at around 18. Influenza around three. Remember though, that it is a measure of who gets infected, not who gets sick.

Assuming you know the answers to all of these questions you can build a pretty accurate and predictive model of an infectious disease. This structure serves as the basis of epidemiology, which goes one step further. It studies disease outbreaks in their context. Epidemiology's hallmark first success was solving a cholera outbreak in London in 1854 by meticulously documenting the pattern of the spread of the illness, and ultimately tracing it to a contaminated water pump on Broad Street. The pump was shut down, and the epidemic ended. The disease was not "treated," nor was there immunization. Its context was understood and changed. It happened because John Snow, the hero of the story, expanded his vision beyond the clinical pattern of illness to the social and physical context of the outbreak. Epidemiologists explore the social and cultural drivers of illness in search of an often-preventive solution. That's how we got rid of smallpox, and are very close with polio. That's how we dealt with negligent water supply management at Walkerton, Ontario in 2003. That's how expert teams can parachute in and shut down outbreaks of Ebola.

> *With COVID we don't have good answers to many if not most of those questions that drive our model.*

More often than we think, however, we don't know the answers. If we're lucky the unknowns work in our favour. A recent example is Zika. It's an insect-borne viral disease that arose in Polynesia and later exploded in Brazil. It caused profound neurological damage and death to developing fetuses and spread like wildfire across the Caribbean and into the southern United States. Then, just as precipitously, it seems to have disappeared. We have hypotheses, but no clear answers. We accept this with persistent disciplined curiosity and humility.

How does this help us with COVID-19, and where do we hit the limits of the model? With COVID we don't have good answers to many if not most of

those questions that drive our model. Change any parameter and the model can swing from tens of thousands (we're already there) to millions of deaths, from a one-time surge to recurring endemicity. We do have a sense now that the natural history of this illness, from contact to death or recovery is less than six weeks. We know it spreads from person to person, it seems without an intermediate host or reservoir. So, we are forced to assume the worst, from an infectious disease perspective. That leads directly to an inescapable and unachievable truism. If it were possible to isolate every person on earth from one another for around two months COVID-19 would be gone. But, of course, we can't.

That impossible biological truth is the starting point within the current pandemic model. It's why we are doing what we are doing, keeping people apart while we come to understand all the parameters of this pandemic model. Given the limits of what models could tell us about the COVID-19 pandemic, it appeared we were left with few options, none ideal:

1. Exploit herd immunity. We learn who has had the disease and what is the nature of their immunity. The conventional wisdom is that when enough of the population is immune the disease will go away, or at most become an occasional or seasonal irritant. There are two ways to achieve that, both seriously considered. The first advocates allowing this to happen naturally, by exposing those unlikely to suffer greatly, like measles parties of a generation ago. We can do that right now, provided we are certain who should not be exposed. However, that's the part we don't know well enough. Yes, seniors. But there is a steady stream of younger, previously healthy people who succumb. We have to understand that, before we allow nature to take its course. The strategy of gradual, closely monitored re-opening is based on a robust understanding of acquired immunity. That's where antibody testing comes in. It has to be both sensitive and specific, meaning the test is an accurate measure of antibody levels. Moreover, we have to have confidence that those antibodies actually confer immunity. In addition, it may well be that some degree of genetic profiling will add accuracy to our predictions. If it turns out that the infrequent extreme and lethal expressions of COVID-19 in younger people relate to an immunological quirk, knowing that will also make a difference.

2. We discover an intervention that cuts down the likelihood that once infected, the explosive respiratory (and perhaps multi-organ) collapse takes place. This would be a medication that could be taken at home, had few adverse effects and was likely of short duration. It could be administered presumptively. If successful it would immediately lower death rates and relieve the pressure on the acute health care system.

3. We find better ways of treating those who are really sick. As we come to better understand the pathophysiology, I suspect we will evolve a range of interventions. Success with option two, the early intervention drug, relieves the pressure on intensive care units. For

those who deteriorate despite the first intervention we may have to accept greater treatment risks. Of course, it remains possible that a drug identified in option two could obviate the need for option three. However, our emerging understanding suggests that the acute decompensation phenomenon may have causes so different from a direct viral effect that this option may be unlikely.

4. We prevent, with a vaccine. That presumes coronavirus biology is amenable to that. If it were purely a matter of pandemic rampage because we have no immunity, then this disease would not be concentrated in the elderly. Like the 1918 Spanish Flu it would affect all ages, particularly the young. But that's not what's happening. This may be as much about aberrant immunity as lack of immunity. Which is to say the odds are we will come up with a vaccine, but it may take longer, be less effective, and carry more risk than we would prefer to entertain.

These options require considerable knowledge of the disease, and aside from option one, a very cautious and gradual approach to lifting lockdowns, an approach that Canadian policy-makers have been taking so far. But is that enough? Is it the full consideration the challenge deserves?

The current pandemic model works quite well when the epidemic is local, and the cause is understood. The less the cause is known, the more rapid the dissemination, and the larger the scale global, the more likely the model is bound to break down.

There are three reasons:

- First, the current epidemic model is medical, and narrowly so. It focusses on a particular pathogen. It is blind to the effects that a singular focus on one pathogen has on other medical morbidity and mortality. From that perspective alone, there is a real risk of major policy error. It is possible to do more harm than good. Delayed treatments for cancer and heart disease may cause deaths and worse outcomes. Despair from lockdown conditions and financial hardship may cause a spike in suicides. The next generation, more robust epidemic model will need to factor in all cause morbidity and mortality.

- Second, the current model recognizes the existence of cultural and other "external" factors, but does not allow them to influence the model's projections or guidance. They are not measured in a useable way. Specifically, as this pandemic is making clear, the current model does not take into account the broader economic and societal structures where the pandemic is taking place. The epidemic arises in a complex society, not a laboratory. As examples, what are the elements of economics, geography, living conditions, diet and nutrition, governance structure and culture which may be outcome determinants of more import than the strictly biological? The different responses and

experiences of Taiwan and the United States demonstrate the importance of these other determinants.

- Third, not all epidemics are infectious. They may result from toxic exposure, as in the lead poisoning of the water supply in Michigan, or behavioral, as with opioid dependency and death, or culture-driven as in the consequences of smoking. Broadening the epidemic model by bringing to bear its full multidisciplinary potential may help us mitigate more morbidity and mortality than that caused by infectious agents alone. It could be that such a comprehensive approach could even prevent as yet unknown infectious challenges.

As a mental exercise, consider the following. One might re-interpret the data that as many as 75 percent of COVID-associated deaths in Canada take place in retirement homes. Yet the virus is widespread elsewhere. Might one not therefore posit that the deaths were due to overcrowding, lack of attention to other co-morbidities, and poor general hygiene? That's much in keeping with the Broad Street cholera story of 150 years ago. The bugs were still around. They were separated from the hosts. It is likely that our narrow view of possible pandemic causation has limited our ability to respond.

It turns out that given a large enough event, classical epidemiological modelling does not, by itself, provide sufficient basis for policy.

Along similar lines, the model does not consider, let alone factor in even the direct health consequences of major economic disruption. If we use the World Health Organization definition of health as medical, social and societal well-being, it becomes apparent that in a pandemic of this newness and scale, the model fails badly. Because COVID-19 has become a global event, the knock-on effects of our interventions, based on the model, become too dire to ignore. They are too widespread, and there is no means to mitigate them by reallocating resources, or dispersion or other manoeuvres.

It turns out that given a large enough event, classical epidemiological modelling does not, by itself, provide sufficient basis for policy. The mounting tension between public health professionals who want to maintain social distancing for as long as possible, and politicians and the market sector who want a return to economic stability and growth is a direct reflection of those limits.

Hazards to the public perception of science

Science is not well understood by the general public. There is a misperception that the observations of science reveal, in a linear fashion, absolute truth, and that the slow, progressive emergence of knowledge with disagreements, corrections, and reversals means that science has failed. And if science has "failed," then the opinions which derive from it are no different than those of anyone else, however derived and with whatever overt or concealed motivation. For a worried public, or someone whose life is collapsing around them for economic, social or even medical reasons, the temptation to embrace the dogmatic certainty of hucksters is hard to resist.

Put another way, the true scientist, who has some humility about what is known and what is not, is at a rhetorical disadvantage. And a political one as well. We have already heard irresponsible leaders claim that the early data predicting much higher mortality than is becoming apparent proves science has no value, while in the same breath claiming credit that their actions made all the difference.

The narrow paradigm may contribute to this erosion of public confidence. Patients whose access to essential treatment is being delayed don't feel included in the consideration. Their quality of life, if not their lives are being traded against the fear of the day. Including all cause morbidity and mortality in the model would help to address that.

To a point the public will put up with wholesale changes to the way they educate their children, conduct their business, travel about and live their lives. If something bad happens to someone close to you, fear may reinforce behaviour. But what if the risk remains somewhat abstract? What happens when it turns out the death rate is a fraction of that initially feared? Will science take a serious blow in the public perception?

There are at least three cultures which see things in different ways. Scientists who live in a world of emerging knowledge, uncertainty and debate, and focus on the pathogen. Economists who focus on parameters of economic performance, income distribution and monetary policy as it affects people's lives. Politicians who see it quite differently, considering jobs, cultural agendas, political ideologies, and getting re-elected. Politicians rarely communicate in nuance. A more comprehensive and representative epidemic model will make the public communication more transparent and less polarizing, though perhaps no less difficult.

The benefits of a new pandemic model

I'm hopeful that for all its apparent shortcomings, the global initial response to this viral outbreak will be seen as largely successful. However, that's not to say a more comprehensive model would not have already opened different response options.

I'm making a plea for a next generation epidemic model that goes beyond our current model (as described on pages 5-6) to include:

1. Measures of all cause morbidity and mortality;
2. Measurable parameters of culture, geography and physical structure;
3. Measures of economic impact; and
4. A lexicon of common language.

If we are to establish a paradigm with global application it will have to be based on a common understanding of key measurable elements, such as diagnostic criteria, incidence, case and mortality attribution from the classical medical perspective, and similar consistent measures of other attributes such as social density, economic conditions, even cultural attributes.

An effective paradigm also requires transparency from the earliest consideration of an event. One is left to wonder, in the current circumstance, if an internationally accepted standard of reporting had been in place, and those measures broadcast sooner, would we have been in a better position, if not to abort COVID's dissemination, then to better target the non-medical intervention that took place?

This will not be easy. The language and measures of each discipline are different, even contradictory. Political and cultural impediments to transparency are difficult to navigate. But it can be done.

As an example, it was long considered that quality of life could not be considered in assessing cancer treatment because it could not be measured. It took a while, but this author was able to develop the metrics to the point where quality of life is an accepted and considered essential marker of the efficacy of cancer therapy. In fact, it is now considered "hard data," along with response rates and survival. Already the Bank of England has set up an expert group, led by Arthur Turrell with a specific remit to develop metrics which bring both economic and classical epidemic considerations to a common table.

Trigger criteria

The decision to initiate a global lockdown, local variants notwithstanding, was based on a medical model. Inherent in that model were its established strengths, including what we have learned from past very different epidemics, and knowledge about what we need to measure accurately and reliably.

Also inherent were its shortcomings, in particular its critical dependency on numbers whose accuracy and reliability were unavoidably very imprecise and unstable. A more comprehensive model will allow us to define "trigger criteria" to guide the difficult decisions about when, where and how to initiate consequential interventions such as travel bans, quarantines, or lockdowns with their huge social and economic consequences.

It will provide additional avenues for epidemic response. A broader concept will also allow the model to be effectively applied to other epidemics such as opioid-related deaths, or environmental and occupational hazards.

"These trigger criteria must be based on globally accepted measures, coupled with standardized, timely and transparent reporting.

Perhaps most pointed, it will make explicit what is the implicit underpinning of any epidemic response: the balancing of lives and cost. In this current pandemic, unless we come up with a medical intervention that eliminates the morbidity and mortality of COVID-19, any efforts to relieve the restrictions on physical distancing will be assessed on a ***real***, not theoretical lives lost basis. The narrow focus of the current model may seriously distort the broader reality. Nonetheless, the premise of opening the economy, absent interventions that medically mitigate the disease, is that we open, see if people start getting sick and dying, and if necessary, shut down again. Those have long been public policy realities. COVID-19 now makes them explicit, and sets the stage for a broader, more reality-based understanding.

These trigger criteria must be based on globally accepted measures, coupled with standardized, timely and transparent reporting. Globally accepted trigger criteria will, like advanced weather forecasting, allow more calibrated and situation specific interventions.

Canada, as a global middle power, is well positioned to lead such a critical and complex effort. We were able to establish the concept of modern international peacekeeping because we had a respected military history and

expertise, and we were seen as an even, steady hand without hegemonistic aspirations. In the challenge, we bring great scientific expertise, and a Canadian cross-cultural awareness that will make bridging those difference and finding common language possible.

More comprehensive response capability

The response to the current pandemic has been medical. We understood conceptually that the physical distancing would have a social and economic cost. We had only the vaguest estimates of how that would manifest. Assuming the worst, based on early medical data of inconsistent and perhaps not transparent quality, we adopted a maximum response. I believe that was the right thing to do given what we knew and the capabilities at hand.

Understanding the broader, non-medical contributors to a pandemic may help in the short-term. Even more important, the more holistic understanding suggests significant prevention opportunities. Again, using the current pandemic as an example, high population density, as distinct from economic and educational status, is associated with higher risk. The experiences of Wuhan, London, Northern Italy and elsewhere make that clear. How do we take that into account given the modern urban direction of encouraging increased density on environmental grounds? Do we reconsider zoning and building standards, such as air handling, water services, elevators and egress?

Increased resilience

Much of the reporting about this pandemic has been about lack of supply: not enough masks, ventilators, swabs and test kits. That misses the point. It is not possible to predict with certainty the characteristics of an epidemic. Face masks would not have helped in the Walkerton epidemic. For the next pandemic we may not need respirators, maybe not even hospital beds. Preparedness is about resilience, the ability to observe with an open mind and adapt. Will we have expert voices at the table whose range of experience extends beyond medicine, who can recognize vulnerabilities and posit solutions. Will we be able to shift our priorities and refocus our energies in new, unanticipated directions? Or are we to be shackled to always fighting the last war? The more incisive our frame for thinking, the more likely we will respond with alacrity.

The need for resilience also offers economic possibilities. For example, Canada could build on our great strength in medical basic science to better realize the global economic and soft power political potential of being a trusted responder and supplier of research expertise, essential medicines and devices, distance technologies and even direct medical care.

The long noted but ignored narrow and vulnerable supply chains for essential substrates for medicines has suddenly become an active consideration. Upwards of 90 percent of the essential base of penicillin class antibiotics, and even greater proportion of the foundation material for all steroid medication come from one source. Could we become a trusted supplier of essential drugs and pharmaceutical capacity. That is a national policy decision, because on narrowly corporate grounds it is likely not tenable. But then again, neither is a standing army.

There are other possibilities, particularly those that could build on current innate strengths of the Canadian economy. One immediately thinks of our ability to utilize distance technologies, large databases, and advanced information technologies. Recall that a small Toronto company, BlueDot gave first warning of the emerging COVID danger, well ahead of anybody else.

These are only examples. An incisive modern epidemic model will guide us to a better sense of the capabilities and resources we need to develop and stockpile. Common language and purpose will also make it easier to justify to our electorate the investments and interventions needed.

COVID-19 has more Darwinian characteristics than most other pandemics. It targets mostly those we already know to be vulnerable: the aged, the infirm and those who are economically and socially marginalized. Someone has observed that it is like a forest fire that clears out the dead wood and allows new trees to germinate. But we have spent decades building societies which are not built on survival of the fittest. Instead, the sanctity of the person has dominant societal value. We accept an element of competition to drive innovation and economic growth, but even there most civilized communities provide a safety net for the creatively destroyed. With remarkable acuity COVID-19 has shone a light on where our actions have fallen short of our words.

Conclusion

This is a medical public health crisis for which we have largely shut down large parts of the world economy. Yes, we can hope to learn things about how to use distance technologies, make redundant supply chains and find another balance point for international trade and fiscal efficiency. But at the end of the day it comes down to trading dollars for lives. Thinking about pandemics as principally biological phenomena outside their broader context may have made it all worse. That may be the most profound realization.

As we have also seen, the legitimacy of science is at stake in this pandemic. At a political moment when liberal globalist values are under attack for many reasons, the scientific basis of progress in much of the is under attack. If science can be discredited, then the most robust bulwark against reversion of human progress will be weakened.

The pandemic model and COVID-19 is the stalking horse for the attack. There is a nascent public perception that science is too narrow, too arrogant, too stuck in its perspective to be trusted to get us through. In my view, that is a profound and dangerous misapprehension, but the constant and unilateral focus on the classical pandemic model leaves us vulnerable.

Epidemics and pandemics are nature's way of exposing the gaps in our societal structure. There will be more, and they could be more lethal. What COVID-19 is telling us is that our excellent infectious disease medical model only takes us so far. Acknowledge that limitation. Build a better understanding that more fully encompasses human behaviour, economics and societal structure. Use the discipline of science to build and test the new models. Lest one think a single all-encompassing model will provide a formulaic solution to every pandemic, just recall the certainty with which we have embraced such models in the past. What will come of such an effort is a better approximation, and much more important a more comprehensive approach to pandemics from their earliest moments. That must be our answer.

Ole Peter Otterson, the distinguished physician neuroscientist and Rector of The Karolinska Institute in Stockholm, recently commented that it is the *humility* of science that offers the light at the end of the tunnel. Science provides us with moments of monumental rethinking, when we realize that as good as we've been, it is not good enough. That is the humbling continuous rigorous pursuit of knowledge. It is what will lead us out of our current difficulties.

About the author

Dr. Harvey Schipper is both an engineer and a physician who has combined disciplines to bring innovation to the health and life sciences sector. He brings prescient strategic subject matter expertise to bear on complex problems ranging from legal case management to corporate governance and public policy.

His career has bridged five continents as cancer specialist, innovator, health systems designer, businessman and advisor to government, academe and the corporate sector. As a physician he was Professor of Medicine and Director of the Regional Cancer Care system in Manitoba and has helped design cancer programs around the world. He established the WHO Collaborating Centre for Quality of Life Research in Cancer, which reframed outcome research from tumour focused to patient-centred on a global basis. Later he served as Corporate Vice-President of MDS, a health and life sciences multinational in a strategic portfolio. As Vice-Chair of the Institute of Corporate Directors in Ontario he led the creation of the Not for Profit programs which remain national standard setters. He is currently Professor of Medicine and Adjunct Professor of Law at the University of Toronto.

Over more than 35 years he has helped companies and organizations transition to the emerging health economy. As corporate director or expert advisor, his particular skill has been setting each initiative in the broad context of the health care environment. His work with governments and large health systems focuses on future orientation and transformation.

Out of a long-standing interest in the interface of medicine, law and public policy, he has played a substantive role in critical issues. These include the tainted blood crisis, where he was a Founding Director of Canadian Blood Services, and recently in the deliberations around 'assisted dying,' as a member of the Council of Canadian Academies Expert Panel on Medical Assistance in Dying.

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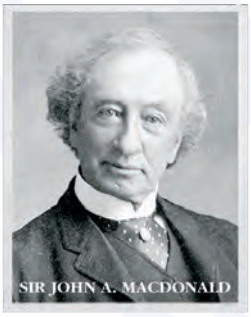
About the Macdonald-Laurier Institute

What Do We Do?

When you change how people think, you change what they want and how they act. That is why thought leadership is essential in every field. At MLI, we strip away the complexity that makes policy issues unintelligible and present them in a way that leads to action, to better quality policy decisions, to more effective government, and to a more focused pursuit of the national interest of all Canadians. MLI is the only non-partisan, independent national public policy think tank based in Ottawa that focuses on the full range of issues that fall under the jurisdiction of the federal government.

What Is in a Name?

The Macdonald-Laurier Institute exists not merely to burnish the splendid legacy of two towering figures in Canadian history – Sir John A. Macdonald and Sir Wilfrid Laurier – but to renew that legacy. A Tory and a Grit, an English speaker and a French speaker – these two men represent the very best of Canada's fine political tradition. As prime minister, each championed the values that led to Canada assuming her place as one of the world's leading democracies. We will continue to vigorously uphold these values, the cornerstones of our nation.


SIR JOHN A. MACDONALD


SIR WILFRID LAURIER

Working for a Better Canada

Good policy doesn't just happen; it requires good ideas, hard work, and being in the right place at the right time. In other words, it requires MLI. We pride ourselves on independence, and accept no funding from the government for our research. If you value our work and if you believe in the possibility of a better Canada, consider making a tax-deductible donation. The Macdonald-Laurier Institute is a registered charity.

Our Issues

The Institute undertakes an impressive program of thought leadership on public policy. Some of the issues we have tackled recently include:

- Aboriginal people and the management of our natural resources;
- Making Canada's justice system more fair and efficient;
- Defending Canada's innovators and creators;
- Controlling government debt at all levels;
- Advancing Canada's interests abroad;
- Ottawa's regulation of foreign investment; and
- How to fix Canadian health care.

CONTACT US: Macdonald-Laurier Institute
323 Chapel Street, Suite #300
Ottawa, Ontario, Canada
K1N 7Z2

TELEPHONE: (613) 482-8327

WEBSITE: www.MacdonaldLaurier.ca

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What people are saying about the Macdonald-Laurier Institute

In five short years, the institute has established itself as a steady source of high-quality research and thoughtful policy analysis here in our nation's capital. Inspired by Canada's deep-rooted intellectual tradition of ordered liberty – as exemplified by Macdonald and Laurier – the institute is making unique contributions to federal public policy and discourse. Please accept my best wishes for a memorable anniversary celebration and continued success.

THE RIGHT HONOURABLE STEPHEN HARPER

The Macdonald-Laurier Institute is an important source of fact and opinion for so many, including me. Everything they tackle is accomplished in great depth and furthers the public policy debate in Canada. Happy Anniversary, this is but the beginning.

THE RIGHT HONOURABLE PAUL MARTIN

In its mere five years of existence, the Macdonald-Laurier Institute, under the erudite Brian Lee Crowley's vibrant leadership, has, through its various publications and public events, forged a reputation for brilliance and originality in areas of vital concern to Canadians: from all aspects of the economy to health care reform, aboriginal affairs, justice, and national security.

BARBARA KAY, NATIONAL POST COLUMNIST

Intelligent and informed debate contributes to a stronger, healthier and more competitive Canadian society. In five short years the Macdonald-Laurier Institute has emerged as a significant and respected voice in the shaping of public policy. On a wide range of issues important to our country's future, Brian Lee Crowley and his team are making a difference.

JOHN MANLEY, CEO COUNCIL