HEALTH SCIENCE INQUIRY

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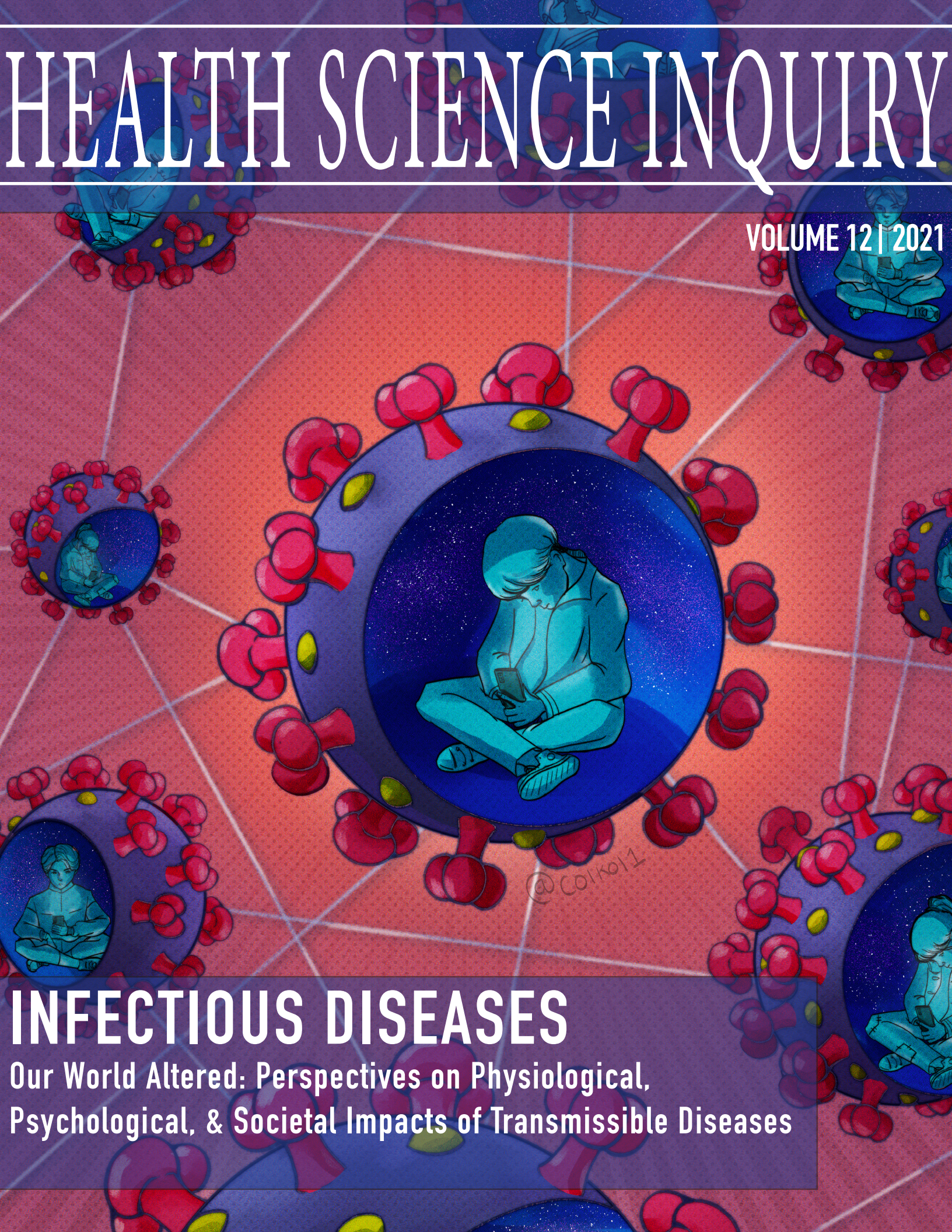

INFECTIOUS DISEASES

Our World Altered: Perspectives on Physiological, Psychological, & Societal Impacts of Transmissible Diseases

Health Science Inquiry is a student-run, annual online publication that seeks to publish the views and thoughts of Canadian graduate students and post-doctoral fellows on pertinent issues in the health sciences. The journal is managed by an editorial board of graduate students from universities and research institutions across Canada. The journal was first founded in 2010 at the University of Toron- to, but is now published through the University of Alberta Libraries.

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LETTER FROM THE EDITORS-IN-CHIEF

Caroline Wallace, PhD & Tamana Yousof, PhD(c)

Dear Readers,

As co-Editors-in-Chief, we are thrilled to share the product of many months of hard work on behalf of our exceptional team of 58 volunteer staff, contributing authors, and artists. This year, our staff comes from 13 universities across Canada all sharing a common passion for health science communication.

For our 12th annual issue of HSI, tackling infectious diseases was a pressing endeavor on a global scale. With content spanning the physiological, psychological, and societal impacts of transmissible diseases, we have produced an issue that comprehensively reports on the many facets that comprise a global pandemic.

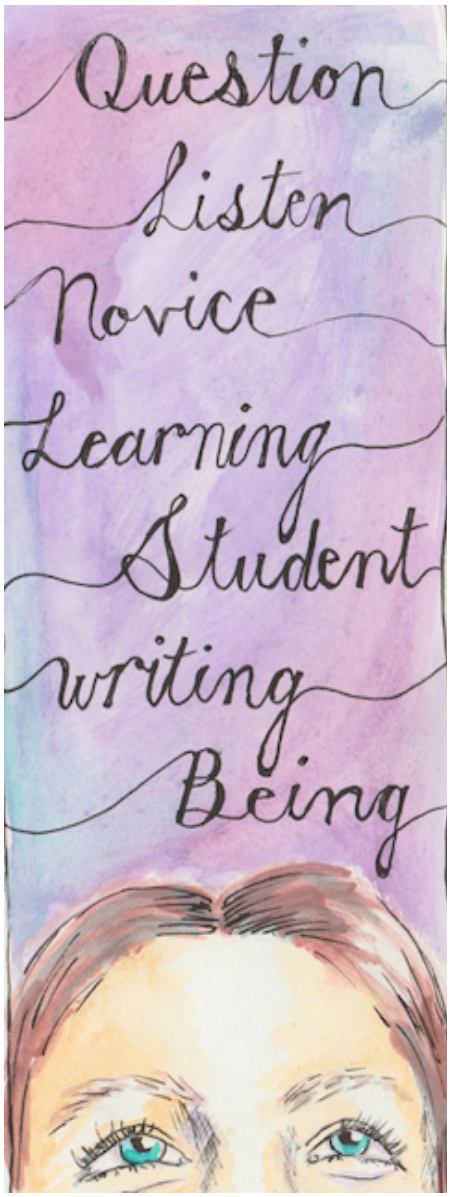
Taking on the role of Editors-in-Chief in the climate of a pandemic has been interesting to say the least, with lots of pivoting to ensure we carry on the legacy of HSI providing engaging and refreshing health sciences-based research. For both of us, leading HSI served as an anchor to stay connected with the graduate student community in these "unprecedented times".

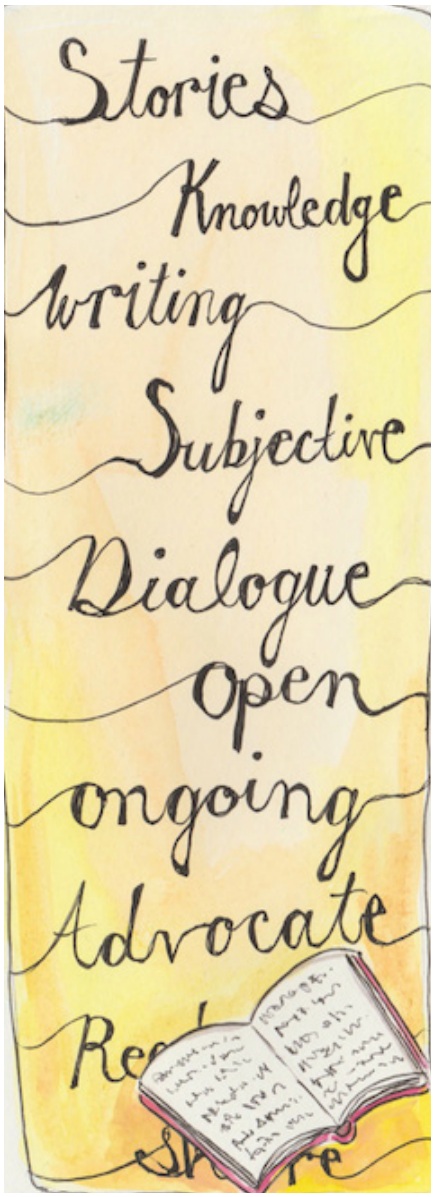
With the pandemic exacerbating this age of misinformation, we believe that evidence-based science communication is fundamental to the health and progression of society. With this year's issue, we have aimed to deliver content that reflects these values and to instill these principles in Canadian graduate students and emerging scientists. As HSI continues to grow and evolve, these goals will serve as a beacon to guide our mission to produce reliable research for everlasting impact.

Sincerely,
Caroline & Tamana
Co-Editors-in-Chief, 2020-2021

Caroline Wallace recently completed her PhD in the Centre for Neuroscience Studies at Queen's University, where she studies the relationship between diet and nutrition and psychiatric disease through activity of the gut-brain axis. Her research includes examining clinical dietary interventions as novel treatments for mood disorders and investigating potential biomarkers underlying this relationship.

Tamana Yousof is a PhD candidate at McMaster University, studying obesity, diabetes and fatty liver disease in Dr. Richard Austin's lab in affiliation with St.Joseph's Hospital (Hamilton, Ontario). Her research examines the role of T-cell Death Associated Gene 51 in regulating the AKT-autophagy axis in mouse models of obesity.





SCIENCE IS THE NOTION OF GATHERING INFORMATION THAT CAN OCCUR IN DIFFERENT FORMS TO BUILD UPON OUR CURRENT KNOWLEDGE AND TO AQUIRE NEW KNOWLEDGE.

Drawing by Micaela Hardy-Moffat

Micaela Hardy-Moffat is completing a Master of Public Health in Health Promotion at the University of Toronto. Working as a Registered Nurse, Micaela is particularly interested in health literacy and education. Having completed a Bachelor of Fine Arts in 2010, and then a Bachelor of Science in Nursing in 2014, Micaela hopes to combine the fields of art and science to help create health information that is accessible to the broader public. Micaela often asks for artistic feedback from her two-year old son, who gives very honest critiques!

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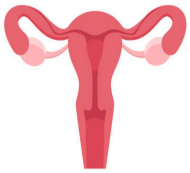

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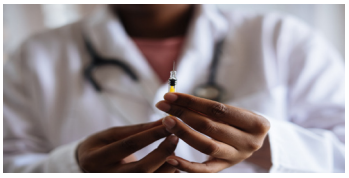

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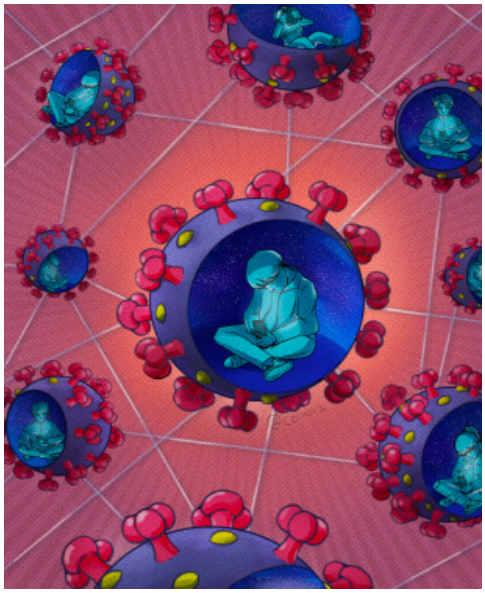
ON THE COVER

Alone Together | **Tristan Woo**

Alone Together reflects on the experience of isolation during the pandemic, as well as the irony behind this feeling of loneliness being shared by so many. It also highlights the role of technology, as the main way in which people stayed connected; while also reflecting on how this connection was, in many ways, a ghostly reflection of actually sharing a space with loved ones.

Tristan is currently completing a MSc in Medical Biophysics at the University of Toronto focusing on molecular mechanisms of pancreatic cancer. Out of the lab Tristan is a freelance digital illustrator, you can find her work @coikoi1 on Instagram and Tumblr.



COVID-19 in the North American Prison System and the Public Health Response to the Epidemic

Simran Bhullar[1*]

[1]University of Guelph, Guelph, ON, Canada
*Author for correspondence (bhullars@uoguelph.ca)

Abstract

With a sharp increase in the number of the 2019 coronavirus disease (COVID-19) cases worldwide, one of the hardest hit institutions are high-density prison systems. Incarcerated individuals are at a disproportionate disadvantage of contracting COVID-19 due to their previous medical history of underlying conditions, the densely packed quarters they reside in, as well as increased contact with correctional staff who frequently go in and out of prisons. This calls for public health efforts to ensure that there are guidelines in place in order to manage COVID-19 in the prison systems in a structured manner, and to reduce mortality related to the disease among prisoners. The current public health response has been to follow recommendations from the Centers for Disease Control and Prevention, as well as push towards decarceration of those individuals who are least likely to re-offend. Finally, with continued vaccination rollouts, researchers encourage priority vaccination of both prison staff and prisoners in order to control the COVID-19 outbreaks.

Introduction

Within the first 3 months of the World Health Organization (WHO) declaring the 2019 coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a pandemic, six Canadian prison facilities had experienced COVID-19 outbreaks(1). Epidemiological data obtained during this time puts the positive test rate of COVD-19 for the Canadian prison population at 29%, compared to 6% in the general population(1). Several other countries including the United States (US), France and Italy experienced similar outbreaks within their prison systems, causing a significant concern among the public health agencies. Although efforts to control its transmission have been implemented, multiple factors make the incarcerated population more vulnerable to COVID-19, which makes it necessary to have a public action plan that addresses ways to ensure their safety. The objective of this short review is to understand the factors that make the prison population vulnerable to infectious diseases like COVID-19, as well as address the response of public health sectors to mitigate the effects of the pandemic on this population.

Vulnerability of the prison population

Census data from early 2020 showed that the COVID-19 case rate for US prisoners at both state and federal prisons was 5.5 times higher than that of the US population(2). This steep escalation of cases can be attributed to the health disparities prevalent in the incarcerated population.

Compared to the general population, individuals within the criminal justice system are more susceptible to infectious diseases such as tuberculosis, hepatitis C virus and human immunodeficiency virus, with a greater risk of complications(3,4). This is compounded by the fact that the average age of the prison population increases every year due to longer sentences(5). Older incarcerated individuals are more susceptible to heart and lung diseases, with over 10% and 15% reporting heart conditions and asthma, respectively(5). Together, this leads to a highly conducive environment for the spread of COVID-19, since individuals with underlying respiratory and heart conditions are at a significantly higher risk of contracting the virus and suffering from life-threatening complications(5,6). In addition,

in an attempt to reduce infection rates in individuals who are already deprived of liberties, social distancing is implemented to isolate positive COVID-19 cases; this can lead to elevated cortisol levels which can increase the risk of COVID-19-related mortality(7).

In addition to increased susceptibility due to comorbidities, the prison setting itself contributes to the vulnerability of its population. Prisons are often overcrowded, and the lack of single cells makes it difficult to physically distance and adhere to the Centers for Disease Control and Prevention's (CDC) recommended guideline to isolate individuals following a COVID-19 diagnosis(8,9). Furthermore, SARS-CoV-2 has been shown to survive on countertops and stainless steel surfaces for over 72 hours(10). The presence of multiple hard surfaces in prisons along with a lack of cleaning supplies such as hand sanitizers, surface cleaners, soap and water allows the viral droplets to linger for longer periods of time(7). With up to 20% of the viral cases being asymptomatic and prison custodial staff interacting closely with the inmates and staff, the chances of rapid transmission of the virus increase dramatically(8). Incarcerated individuals are often filtered in and out of prison settings for prison transfers, court hearings and medical appointments, which can readily expose them to the virus(7). Finally, the prison staff frequently go in and out of prisons, leaving those inside at a higher risk of being exposed to the virus(5).

While these factors alone put significant strain on prison systems to contain the spread of COVID-19, inadequate supply of personal protective equipment for the staff and inmates and inconsistent screening for the virus further impairs its containment(11). The increased number of outbreaks puts additional demands on the healthcare facilities within the prisons, which often lack access to the proper health services that are usually readily available to the general public(3). An example of such healthcare disparity was seen within the Canadian federal prisons, where the number of incarcerated individuals tested for COVID-19 were consistently lower than the general population during the earlier months of the pandemic(1). Thus, it is apparent that limited testing and healthcare poses a significant challenge in controlling COVID-19 in prisons. Moreover, the access to quality medical care varies from one prison to another, making it difficult to provide standardized care to those diagnosed with COVID-19(5).

Public health response to the prison outbreaks

With outbreaks overwhelming the prison healthcare services, the need to mitigate the spread of COVID-19 becomes an important public health issue(3). The overarching response from the WHO has been to implement prison-specific guidelines that include prevention and risk management practices(3,12). These include reduction of non-essential personnel and limiting importation/exportation of incarcerated individuals within prisons(3,12). To control a potential outbreak, positive COVID-19 cases are isolated whenever possible, and emergency protocols are created to transfer patients to hospitals if they need specialized care(3). Other restrictions include visitation suspension as well as limiting the number of visits by legal representatives(4). To reduce the effects of such social isolation, some prisons have opted for personal and legal communication through teleconferencing(4).

Perhaps the biggest consideration has been the push towards decarceration(13). This involves the large-scale release of prisoners who are least likely to re-offend, vulnerable populations such as older individuals and individuals with chronic conditions, and those whose offences pose no threat to public safety(4,14). By providing decarceration priority to those incarcerated for non-violent crimes, those who are eligible for parole or have served majority of their sentence, prison facilities can reduce their population which can help flatten the COVID-19 curve(15). Decarceration of these individuals has been shown to pose a low risk to the public, reduces overcrowding in prisons and allows for increased testing and proper quarantining of the remaining prisoners, which helps decrease viral transmission(16). A recent study using the stochastic compartmental mathematical model found that prison depopulation efforts combined with asymptomatic testing and adherence to CDC guidelines reduced potential new COVID-19 cases by approximately 83% in 83 days in one US jail(17). Several countries around the world have implemented decarceration as a way to reduce the spread of COVID-19. In March 2020, Iran released over 85,000 prisoners, while France and Italy reduced their prison populations by releasing 10,000 and 6,000 pris-

oners, respectively(18). In contrast, however, the US has failed to depopulate their prisons at similar levels; in the states where such decarceration happened, the rate of decarceration of white people has been higher than that of African-Americans, which exacerbates the already-present racial inequalities within the justice system(16). Social improvements by providing decarcerated individuals with access to quality healthcare and food security can lead to permanent reductions in prison populations, which would allow for more resources to be allocated to those within the prisons(16).

The priority allocation of COVID-19 vaccines to the incarcerated individuals remains a controversial topic. In addition to the vulnerabilities experienced by the incarcerated individuals, a disproportionate number of them are minority and stigmatized groups(19). Advocates of priority COVID-19 vaccination allocation for such individuals argue in support of health equity(19). Delivering vaccination to the prison population can help reduce the inequalities often faced by the marginalized and the minority groups, who otherwise bear a greater burden of communicable diseases(19). Vaccination of the incarcerated population helps reduce municipal costs by taking the burden off the healthcare systems and hospitals in the area, who offer care to the infected individuals requiring hospitalization(19). Finally, providing appropriate healthcare to those in custody is a constitutional and a moral duty of the government, and receiving vaccination for a pandemic should not be dependent on an individual's criminal status(19).

Despite the above-mentioned considerations and CDC guidelines encouraging simultaneous vaccination of the prison staff and prisoners, actual plans differ based on each prison's jurisdiction, with several states omitting vaccination plans for incarcerated populations in the US(9,14). This goes against the recommendations by researchers and the American Medical Association who have pushed to consider prisoners in the initial vaccine allocation phase(20). Recognizing differences in jurisdictional plans and making efforts to fill in these gaps can stop some prisons from being excluded from receiving the vaccinations(21). Finally, as vaccine rollouts continue, many prisoners could have hesitations about the vaccine due to lack of educational materials as well as due to the distrust in governmental institutions(21). A survey conducted by the CDC found that over 75% of the participants within certain US prisons were hesitant to receive the COVID-19 vaccination(22). The common reasons for refusal of the vaccine were: distrust in the government due to past interactions with law enforcement (20%), general refusal of vaccines (14%), a belief that COVID-19 vaccination would cause them harm (6%); these statistics were higher in the incarcerated population compared to the general population(22). This calls for efforts to improve vaccine awareness using multiple formats and languages to highlight the benefits of vaccination and increase awareness of the risks associated with contracting COVID-19(22).

Conclusion

COVID-19 has made a lasting impact on multiple spheres of the society, including the criminal justice system. The challenges faced by the public health system in ensuring the safety of the incarcerated population are not only due to the vulnerabilities faced by these individuals, but also due to the environment of the prison system itself. Prisons make up an important part of government institutions, and officials have respondedby establishing guidelines which are better suited for prison settings to reduce COVID-19 outbreaks, allowing for decarceration of individuals least likely to re-enter the criminal justice system, and by calling for vaccination of the incarcerated individuals and prison staff. An overwhelming majority of incarcerated individuals are people belonging to minority groups; by providing a swift response to get such epidemics under control, we can strive for health equality between them and the general population.

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Hindsight is 2020: Lessons Learned from the COVID-19 Pandemic on Death, Dying, and Grief

Reanne Booker[1*]

[1]University of Victoria, Victoria, BC, Canada
*Author for correspondence (reanne.booker@albertahealthservices.ca)

*This article was the **highest rated** submission to our 2021 issue, ranked by our independent faculty judging panel. For this, the author has been awarded one of two annual HSI scholarship awards.*

Abstract

The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) pandemic has led to significant changes not only in the way we live, but also in the way we die. Visitor restrictions mean that patients are dying alone, and that families and loved ones are often unable to say goodbye or visit in the days and hours preceding death. Further, limitations on various cultural norms and rituals following death, such as the ability to hold funerals or wakes, are also influencing the experience of death and dying. The impact of these changes on bereavement and grief remains unknown, but it has been speculated that such changes may lead to adverse bereavement and grief experiences. There is an urgent need to establish a national grief strategy to ensure sufficient resources and supports for people experiencing the loss of a loved one, be it from coronavirus disease-19 (COVID-19) or another cause, during and beyond the pandemic.

It was January 1, 2021. The start of a new year that held more anticipation and promise than that of New Years past. This new year, to me, heralded the promise of hope and optimism, particularly as the COVID-19 vaccines were starting to roll out. I was sledding with my two girls, and we somehow found ourselves on a particular section of the hill with so many jumps that made it seem as if we were sledding down a mogul-covered ski hill. Every bump made me question my sanity, and my bone density.

As we sat at the top of the hill playing in the snow, the cold permeating my snow pants, I felt it. The silent vibration of my phone ringing. Not once, not twice, but repeatedly. I answered on what must have been the 3rd or 4th attempt, and I immediately sensed that something was wrong. It was a long-time family friend, M, who had metastatic breast cancer. She was speaking rapidly. I could hardly make out her words and I suspected she was moving between English and Farsi. She sounded scared and confused. She was in the Emergency Room (ER) at one of the acute care hospitals in the city, and she wanted me to come to her. She wanted to go home. A million thoughts raced through my head: would they let me see her, given the COVID-19 visitor restrictions? How could I help? Who was on-call for palliative care? We immediately left the hill and made our way home. On the walk back home, I was slightly out of breath as I was moving quickly and carrying all the sleds. I spoke first with her husband. Then, M's daughter called. In those few minutes on the way home, I had a conversation with her about goals of care and what her mom would want if time was short, which I was sure it was.

After several calls to the hospital, I was able to speak with M's nurse in the ER. At first, it sounded as if things were perhaps not as dire as I had envisioned. They were already talking about discharging her. Relief. I relayed what M's husband and daughter had told me about her uncontrolled symptoms and the reasons why she had been taken to the ER two days in a row. I asked the nurse if they would let me see her if I were to come to the hospital. The nurse was firm; it was an unequivocal 'no'. My worry was compounded by the fact that I thought M might be in a delirium, and the language barrier might be problematic. She needed someone there to advocate for her. She needed someone there

to be her voice. I spoke again with her husband and daughter. I also spoke with the physician who was on-call for palliative care at the hospital. I tried to call M again, but she didn't answer. That's good, I thought. She's probably sleeping. I went to bed worried but hopeful. I would check in first thing in the morning.

I woke up on Saturday to a quiet house. I had slept restlessly; my slumber had been interrupted by many dreams but none foreboding. I sent the text just after 9 am. The response came back swiftly: we lost her. Lost. Where? Why? How? I was just talking to her. How could it be that she was just here, and now, she is so gone? Again, a million thoughts raced through my mind. What happened? Was she in pain? Was she scared? And almost unbearable to think, did this incredibly generous, kind, loving, selfless human being die alone? My girls wanted me to ask. They wanted to know. But even now, more than a month later, I cannot bear to think about it. I don't want to know. I don't want to think for a second that she was alone. I want to imagine that she was calm and ready. I want to imagine that her family made it in time. Or if not, that a caring nurse was by her side until the very end, stroking her hand, even if through the impersonal, impervious layers of latex. I hope she wasn't scared. I hope she felt peace. I hope.

In the time since M died, I've been going through the usual stages of grief, but not in a linear fashion, and always with an undertone of anger. M deserved better. Her family deserved better. In replaying the events of January 1 in my mind, I have distilled down what I believe to be the core issues, along with opportunities for improvements in the healthcare system and how these opportunities might help us die better, whether from COVID-19 or anything else.

Grief

Grief is a natural and expected response to loss [1,2]. Previous research has revealed that people who experienced the loss of a loved one went through a period of acute grief that subsided as time passed, due to the adaptation to the loss [1,2]. However, the potential for grief to evolve into a grief-related disorder, even in pre-pandemic times, has been well recognized. Disordered grief, such as complicated grief (CG) and prolonged grief disorder (PGD), was estimated to affect approximately 10-15% of the bereaved prior to the COVID-19 pandemic [3,4]. Grief experts have reported that disordered grief may be on the rise, now and in the future, as a consequence of an array of factors related to the COVID-19 pandemic to be explored in further detail below [5,6]. Complicated grief has been described as grief that persists beyond what would be expected based upon cultural norms, and that interferes with daily functioning [7]. The ICD-11 describes this grief as a "persistent and pervasive grief response characterized by longing for the deceased or persistent preoccupation with the deceased accompanied by intense emotional pain" [2]. Complicated grief can impact one's physical and mental health, the ability to work, and the ability to maintain relationships. Moreover, CG has the potential to increase pressure on the healthcare system [8]. Complicated grief has been found to be associated with depression, suicidality, social isolation, and post-traumatic stress disorder. In addition, CG can manifest as panic attacks, excessive worry, and impaired function [9]. Disenfranchised grief encompasses psychological, sociological, and political aspects of loss and describes the experience of grieving losses that are unacknowledged or unsupported by social systems [10] such as the absence of funerals and the lack of social or cultural recognition of death [11, 12].
Grief in the context of a pandemic

As of May 6, 2021, more than 3.2 million people worldwide have died of COVID-19 [13]. Verdey et al. [14] created a COVID-19 bereavement multiplier to estimate the average number of people who will experience the death of a close relative for each death due to COVID-19. The authors estimated that for every person bereaved due to a COVID-19 death, there could be up to 9 people who grieve the loss [14]. Many countries, including Canada and the United States, have reported excess mortality in 2020 due to COVID-19 related deaths and other causes [15-17]. According to Statistics Canada, there were an estimated 309,912 deaths in 2020 [15], leaving more than 2.78 million people grieving the death of a loved one. It is unknown how many of these individuals will experience complicated grief, but the changes in how people have been dying since the pandemic began will undoubtedly impact the bereavement experience and grief response of many. Factors related to the COVID-19 pandemic that might influence grief and bereavement.

The experiences that occur as someone is dying have the potential to impact the subsequent grief experience of family and loved ones [11]. It can be expected that the grief experience of someone who loses a loved one during the pandemic may be adversely impacted by the restrictions and limitations imposed by the pandemic. In a review article on the impact of previous pandemics on grief and bereavement, Maryland et al. [18] reported that the COVID-19 pandemic is "likely to have a major impact on the individual and societal experience of death, dying, and bereavement". Grieving alone and in isolation has been described as a "uniquely different, unnatural feature of bereavement" during the pandemic, which is not limited to deaths from COVID-19 [19]. For those who lose a loved one to COVID-19, the nature and experience of such a death may contribute to the bereaved person's grief [20-22]. For example, death in an intensive care unit may impact the bereaved person's grief by factors such as rapid decline and subsequent lack of preparation for the loved one's death, and the inability to be with the dying person due to isolation requirements [6,22-25]. Further, while it has not been expressly discussed in the literature to date, there may be profound guilt if the bereaved person may have been the source of infection of the dying person. All of these factors may contribute to disordered grief for someone who loses a loved one to COVID-19. The bereavement experience of deaths that are not due to COVID-19 may also be influenced by pandemic-related factors [25,26]. Apart from COVID-19 related deaths, other deaths may occur during the pandemic where family and loved ones are unable to be with the dying person due to visitor restriction policies [3,6,25]. Therefore, family and loved ones may be unable to say goodbye to, pay their respects to, or make amends with the dying person [22,25,27,28]. Public health restrictions have also limited gatherings for funerals or precluded the ability to honour other practices and traditions held after someone dies, potentially impeding a sense of closure and importantly, decreasing the social support for the bereaved [6,22,24,25,28]. Furthermore, people may experience multiple concomitant losses during the COVID-19 pandemic, including the loss of human lives, property, financial security, social and physical connections, sense of safety and security, and the autonomy to move freely in the world [3,9,11,22,25,29].

Altered or absent customs and rituals

In addition to the impact of visitor restrictions, many usual customs and rituals surrounding death, including funerals and wakes, have been constrained or prohibited due to the pandemic [9,10,18,30]. Travel restrictions and limitations on social gatherings have reduced the social supports to bereaved people [9]. Practices surrounding death are shaped by culture and religion and may include body preparation, viewing of the body, funerals and wakes, cremation, and burials, to name a few [24]. Public health guidelines have limited or changed many of these rituals such as the shift to virtual funerals rather than in-person funerals [22,24,28,31]. The consequences of the altered or absent rituals on the bereaved person's mental well-being remain unknown, but some studies suggested that the inability to attend a funeral, or the reduction in numbers of people who can attend, may adversely influence bereavement outcomes [24,32]. In a review, Burrell and Selman [28] identified 17 articles, including both quantitative observational and qualitative studies, that addressed the impact of funeral practices on bereaved relatives' mental health, grief, and bereavement. Overall, the authors found that the evidence on the impact of funerals on bereaved relatives' mental health and bereavement outcomes was equivocal and that ultimately, the "benefit of after-death rituals, including funerals, depends on the ability of the bereaved to shape those rituals and say goodbye in a way which is meaningful to them, and on whether the funeral demonstrates social support for the bereaved" [28].

Lessons from previous mass bereavement events

Harrop et al. [22] conducted a systematic review to synthesize the evidence on system-level responses to mass bereavement events, including the terrorist attacks in the United States on September 11, 2001, the terrorist attacks in Norway in July 2011, the Norwegian Maritime disaster in 1999, Hurricane Katrina in August 2005 in the United States, and the tsunami in South East Asia in 2004. The review included twelve papers from six studies. The authors reported that while there were limitations in the quantity and quality of the evidence base, there had been commonalities among the studies in terms of key features of bereavement service delivery. In particular, the authors found that a proactive outreach approach, a centrally organized but locally delivered program, event-specific professional competen-

cies, and psycho-educational content were essential [22]. Additionally, the authors identified the need for crisis- or event-specific competencies, which included the factors discussed above related to the COVID-19 pandemic. Cultural sensitivity and multilingual support should be integral to any program or service that is offered [22].

Similarly, Killikelly et al. [4] recommended a three-tiered approach to addressing prolonged grief disorder during the COVID-19 pandemic. For low-risk individuals, the authors recommended general interventions, such as basic, self-help guidance. For at-risk groups, the authors suggest selective interventions such as non-mental health specialist support, community groups, trained volunteers, and engagement with clergy and chaplains. For individuals deemed to be at high risk of PGD, the authors advocate for indicated interventions, such as support provided by trained clinicians, psychologists, psychiatrists, and grief/bereavement counsellors [4]. These recommendations mirror those delineated by Palliative Care Australia [5], who categorized their recommendations for support as follows: informal support, community support (generalist or specialist), and specialised professional bereavement support.

There is a need to educate healthcare providers and the public alike on the possibility of prolonged and complicated grief during and following the pandemic [9]. Media campaigns and public education on grief during the pandemic may help to mitigate disenfranchised grief by providing acknowledgment and validation of grief. Evidence-based interventions to help manage prolonged and complicated grief are needed [33]. A national strategy on grief has been recommended by the Canadian Grief Alliance (CGA), a coalition of national leaders in grief and bereavement, and it has been supported by over 150 professional organizations and associations across the country [34]. The CGA is calling for the development of a National Grief Strategy to identify gaps, best practices, and priorities, an investment by the government of $100 million over 3 years to expand and sustain grief services, $10 million to fund grief research, and a public awareness campaign to increase Canadians' awareness and understanding of grief and coping strategies [34].

Likewise, other organizations have recognized the need for a concerted, systematic approach for dealing with grief in the context of the pandemic. In January 2021, the National Hospice and Palliative Care Organization and the Social Work Hospice and Palliative Care Network in the United States put out a joint call for a national bereavement response for COVID-19 related grief in the US [26]. In February 2021, Carroll et al. [3] sent a letter to United States President Joe Biden calling for a national grief strategy. Attention to underserved, racial, and marginalized populations will be critical, especially given that these populations have already been disproportionately affected by the pandemic [35,36]. The COVID-19 pandemic has emphasized how important it is for people to think about their goals and wishes for medical care, including their care at the end of life. There is recognition that all clinicians, not only those trained in palliative care, should possess the skills to discuss advance care planning and preferences for EOL care with patients and their loved ones [11]. Similarly, all clinicians should have the capacity to provide exemplary symptom management and be proficient in holding difficult conversations. Bereavement care, a key component of palliative care, should be incorporated into EOL care and provision of support to families should occur prior to and following the death of a loved one [37].

Finally, just as there has been worldwide collaboration on many aspects of the pandemic response thus far, I would like to see international collaboration on developing strategies and sharing knowledge and resources to address grief and bereavement during and after the COVID-19 pandemic.

Conclusion

The COVID-19 pandemic has impacted the way that people are dying, and the way that people are experiencing bereavement and grief. While it may not be possible to prevent the inevitable grief that comes with losing a loved one, there are ways to help diminish the associated distress and help ensure that people experience uncomplicated grief. A national grief strategy is urgently needed to prevent unimaginable and protracted suffering. Such a strategy should outline interventions, including educational initiatives for the general public to help improve grief literacy and to increase awareness of available supports, as well as for healthcare providers to ensure that they are prepared to recognize and respond

to disordered grief. In addition, the strategy should include interventions, such as general interventions, targeted interventions, and specialized interventions. Interventions should also be tailored to the local context and reflect of the unique issues of the COVID-19 pandemic. Research to assess the impact of the pandemic on grief and bereavement as well as on interventions that may help address grief and bereavement should also be included in the strategy. Of note, this paper did not address grief in healthcare providers, a topic that warrants a separate paper altogether. Unequivocally, the moral injury and distress that many healthcare providers have experienced since the beginning of the pandemic has the potential to influence the mental health of healthcare providers, which is worthy of considerable attention [38].

I think of M and her family often. I wish things would have been different for her. I wish she would have been surrounded by a room full of people. I wonder how that would have changed her experience, her family's experience, and even my experience. I know that the pain of losing her wouldn't be allayed, though I can't help but wonder if this gnawing sense of regret would be replaced by a sense of peace. Death may be inevitable but dying and grieving alone shouldn't be.

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The Long Haul: The Impact of COVID-19 on the Surgical Backlog Problem

Hana A. Dibe[1*], Jared C. Wooten[1]

[1] Western University, London, ON, Canada
*Author for correspondence (hdibe@uwo.ca)

Abstract

Wait times for elective and non-elective surgeries were an existing concern, pre-COVID-19. The effects of the pandemic year have prolonged these wait times, causing further harm to surgical candidates. These delays pose a significant challenge for governments and require higher prioritization of healthcare spending to prevent worsening outcomes from delayed surgeries.

March 11th, 2021 marks one year since the COVID-19 outbreak was declared by the World Health Organization [1]. Since then, the world has watched as the world's economy, social interactions, employment, and day-to-day lives changed inextricably. Most importantly, the healthcare system remains a highly stressed sector throughout the pandemic. From the beginning, healthcare professionals warned of the impact an even moderately deadly virus would have on healthcare systems [2].

Intensive care units (ICUs) in hospitals worldwide experienced an influx of patients requiring intensive care for complications of infection with COVID-19. Ontario was projected to see 1904 hospitalizations from COVID-19 over 60 days [3]. In efforts to preserve hospital capacity and resources in early April of 2020, the Ontario government cancelled all elective surgeries, increasing the availability of acute care and critical care beds by 7,849 and 585, respectively [4]. Elective surgeries are planned, non-emergency surgeries, which are often the first to face cancellations in situations of hospital stress, such as knee replacements and gallbladder removals. Compared to 2019, Canada saw a 20% reduction in elective cancer and cardiac surgeries in 2020, as well as even larger reductions in vasectomies, hernia repairs, and pelvic floor repairs (Figure 1) [5].

Although these efforts have provided extra hospital space in a time of need, they are not without consequence. The cancelling and delay of elective surgeries has resulted in a backlog, further increasing wait times and potential harm to recipients [6,7]. In Canada, cancellations for elective surgeries began as early as mid-March of 2020, which have continued rising. One model forecasted the cancellation of 32,881 surgeries per week in Canada, extrapolating to a total of 394,576 cancelled surgeries if this continued for 12 weeks, which would take an estimated 40 weeks to overcome [8].

In Ontario, the lockdown in spring of 2020 created a surgical backlog of 148,364 (11,413/week), which were estimated to take 84 weeks to clear, but it could be anywhere from 11 months to 2.8 years [7]. In British Columbia, 30,000 surgeries were delayed over a 2-month period, resulting in a waitlist of 93,000 by the time surgeries resumed [9]. It was estimated that British Columbia would take roughly 2 years to clear their waitlist [9].

The delays have significant implications for patient outcomes. A study analyzed the impact of surgical delays for cancer patients by using observational data of cancer survival in England. They found that even moderate surgical delays of three and six months would result in 4,755 and 10,760 excess deaths, respectively, of the 94,912 surgical resections performed in England each year [6]. Regarding colorectal cancer, surgical delays of one and three months are associated with respective 13% and 57% increased mortality risks [10]. For hip replacement surgeries, each month on a waiting list is associated with decreased post-operative function [11].

Additionally, surgical delays introduce a significant financial burden within the healthcare system. Increased risk of infection and post-operative mortality due to surgical delays results in significant increases in cost for individual surgeries [12]. As a result of elective surgery delays during COVID-19, the cost has increased from $36 to 47 thousand for coronary artery bypass grafts and from $20 to 29 thousand for colon resections [12]. Furthermore, these delays were more likely to occur for patients who were female, Black/Hispanic, and those with other comorbidities [12]. These cost increases accumulate, increasing the financial burden beyond that already imposed by COVID-19 [13].

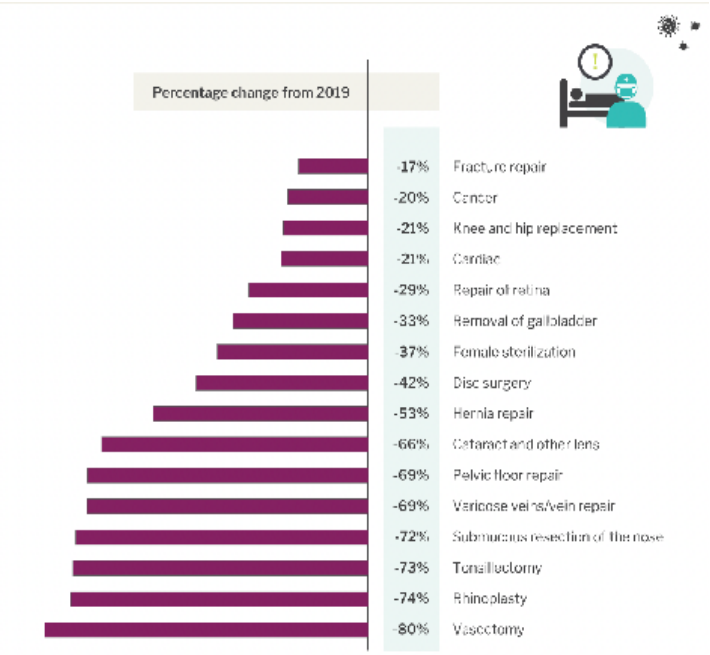
Clearance of these backlogs would require operating room time, ward beds, ICU beds, not to mention the availability of the staff [7]. Providing these resources in the near future could be difficult, as ICU patient counts in Ontario are at an all-time high in the midst of a third wave, providing little ICU capacity to spare [14].

Conservative opponents to universal healthcare in Alberta have used the pandemic as an opportunity to constrain the public system by outsourcing operations to private clinics [15]. Alberta Health Minister Tyler Shandro announced a partnership with private health clinics, funneling a significant portion of the federal government's COVID-19 funding into these clinics, with the goal of clearing the backlog by the end of 2021 [15].

The province of British Columbia has set a promising example with their response to their surgical backlog, demonstrating the importance of prioritizing healthcare funding [9]. British Columbia was able to reduce their estimated 2-year long waitlist largely due to a funding addition of $250 million a year; this money was allocated to hiring more staff, purchasing more MRI machines and increasing operation times of diagnostic imaging machinery [9]. By December of 2020, the province's Health Minister Adrian Dix reported that 90% of patients with surgeries postponed during the first wave of COVID-19 have had their procedures completed. They were hopeful that their projected 2-year long backlog would be gone in under 15 months [9].

Although the current situation regarding surgical delays is dire, provinces are working to implement solutions to address the backlogs. There is hope that in the future, increased healthcare spending will be prioritized to reduce the need in canceling elective surgeries during crises such as the COVID-19 pandemic.

Figure 1. Changes in selected surgeries, March to June 2020



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The Benefits and Challenges of Staying Physically Active during the COVID-19 Pandemic

Joyla Furlano[1*], Anisa Morava[1]

[1] Western University, London, ON, Canada
*Author for correspondence (jfurlano@uwo.ca)

Abstract

Engagement in physical activity improves one's physical and mental health. Moreover, regular physical activity can also boost immune function, which has become of great importance during COVID-19. Yet, physical activity levels have decreased globally during the COVID-19 pandemic while sedentary behaviour has increased. Despite the challenges of remaining physically active during the pandemic, the changes to our daily routines have led to more online physical activity resources becoming available. The increase in online fitness resources seems promising for continued engagement post COVID-19. Here, we outline the importance of regular movement, in any form, during COVID-19 and make recommendations for how to achieve this through digital fitness initiatives.

This commentary explores the health benefits of physical activity (PA), current PA levels, available digital PA resources, and barriers to PA engagement during the 2019 coronavirus disease (COVID-19) pandemic. Engagement in regular PA, defined as any bodily movement that is produced by skeletal muscles resulting in energy expenditure,[1] has been well-documented to impart a myriad of benefits to one's physical and psychological health.[2] Notable benefits include improved cardiovascular function, increased muscle strength, and decreased depression and anxiety levels.[2] There is also evidence to suggest that exercise can strengthen one's immune system by increasing blood flow, reducing stress and cellular inflammation, and strengthening antibodies (i.e., blood proteins that fight foreign substances in the body).[3] This is particularly important during COVID-19, especially for populations that are more vulnerable to the disease including older adults and immunocompromised individuals.3 Moreover, regular PA has been shown to reduce the risk of at least 25 chronic medical diseases (e.g., obesity, chronic obstructive pulmonary disease),2 many of which are associated with greater health complications if infected by the COVID-19 virus.[4] On the contrary, a lack of PA has been shown to lead to bodily dysfunction, including muscle protein degradation (i.e., cell dysregulation) and atrophy, which can be evident after only a few days of no PA.[5] Furthermore, physical inactivity is a major risk factor for cardiovascular disease and other chronic illnesses associated with premature death. Recently, the Canadian Society for Exercise Physiology (CSEP) published 24-hour movement guidelines which emphasize the importance of daily movement behaviours for all ages. According to their recommendations, adults aged 18+ should engage in 150 minutes of moderate-to-vigorous (i.e., aerobic) PA per week, as well as muscle strengthening exercises targeting major muscle groups at least twice per week to optimize health benefits.[7]Moderate PA is defined as activity that uses 3-6 metabolic equivalents (METs; an objective measure of the rate at which a person expends energy relative to their mass) and includes activities such as jogging or cycling; vigorous PA uses greater than 6 METs and includes activities such as sprinting and stair climbing; light PA uses between 1.6 and 2.9 METs and includes walking slowly at a regular pace.8 Importantly, the CSEP guidelines have been updated to include recommendations surrounding daily sedentary behaviour (SB), defined as any waking behaviour characterized by an energy expenditure less than or equal to 1.5 METs in a sitting, lying or reclining posture.[7,9] Examples of common sedentary behaviours include sitting while watching television, driving a car and working at a computer desk. Studies have shown that sedentary behaviour is

associated with a variety of adverse health outcomes, including all-cause mortality, that are independent of PA level.10 As such, CSEP's movement guidelines suggest that, in addition to engaging in regular aerobic and muscle strengthening exercises, adults should limit SB time to 8 hours or less per day as well as break up long periods of sitting as often as possible (e.g., every 30 minutes).[7]

The COVID-19 pandemic has resulted in numerous changes to daily life, including community-wide lockdowns and "stay-at-home orders" that have affected PA levels.11 In most cases, these restrictions have led to a decrease in daily movement and an increase in SB12 as a result of closing gyms, restricting sports activities and increasing time spent indoors. In turn, this has resulted in downstream reductions to incidental movement behaviours typically accrued when going to school, work and other social activities.[13] Fitbit data scientists found that countries around the world were experiencing a 7% to 38% decline in step counts at the onset of the pandemic in March 2020, when comparing data from the previous year (i.e., pre-pandemic).[14] Similarly, one study found an 18.2% decrease in general PA levels (measured in MET minutes per week) in adults as a result of the COVID-19 lockdown.[15] In fact, the majority of studies that have compared PA levels before and during COVID-19 have found reduced PA levels and increased SB during the pandemic, and this appears to hold true across all populations.[12]

Given the strong evidence of the health benefits of PA, coupled with a reduction in PA levels during COVID-19, one of the largest health priorities during the pandemic has been to make PA resources accessible. Despite the obvious barriers to engaging in PA at this time, one silver lining of the pandemic has been the introduction of more digitally available PA resources including PA apps and online fitness classes or training.[16] Yang &Koenigstorfer15 found that the use of digital-based initiates (PA apps) during COVID-19 was associated with greater PA levels during lockdown, after controlling for pre-lockdown fitness levels and intention to be physically active. In this study, the use of gamification-related features (i.e., game design elements including points and levels) was particularly beneficial to attracting users and increasing PA levels.[15] Evidently, mobile health technology may help buffer the decline in PA that has occurred during the pandemic.[15]

One of the largest benefits of digital PA resources during COVID-19 is their accessibility. For example, online classes and apps are frequently being offered free of charge during the pandemic and can be tailored to one's needs. Nationally-known gyms and organizations are now offering instructor-led online fitness classes (that were not previously offered pre-pandemic) at no cost, many of which require no at-home equipment or suggest ways in which equipment can be substituted with everyday household supplies (e.g., using water jugs instead of light dumbbells to add resistance to bodily movements). Nike Training Club has waived their monthly fee for premium service indefinitely, which offers yoga, cardio and targeted running training programs, as well as nutrition and wellness advice.[17] An additional benefit to online PA resources is the opportunity to connect with others, far and wide, digitally. For example, Strava, an internet service for tracking PA, is an excellent tool for sharing activities with others and joining public PA challenges. Research has shown that social support, delivered through online PA resources, increases one's feelings of confidence and competence in their ability to be physically active, which in turn increases PA engagement.[18] However, it is important to note that these digital resources may not be available to all citizens (e.g., those with lower socioeconomic status (SES) who may not have internet or smartphone access). Future research should assess how SES correlates to PA levels during COVID-19, and how PA resources may be improved to meet the specific needs of those with lower SES.

In conclusion, there are numerous benefits to engaging in regular PA during the pandemic, including strengthening the immune system and preventing comorbidities that may worsen COVID-19 outcomes. As we continue to face the challenges of being physically active during COVID-19, it is important to emphasize that any amount and type of movement can have significant health benefits. For example, light occupational and recreational movement, as well as movement acquired through performing household and everyday tasks, can help increase blood flow and improve joint and muscle function.[19] Moreover, targeted strategies for reducing sedentary behaviour are needed now more than ever, and are often overlooked. Public health

strategies should focus on educating the public on the various PA resources available to them during the pandemic, including new and extended digital-based initiatives. Importantly, increased access to digital resources will continue to be helpful after COVID-19 is eradicated, particularly for those who may face barriers to accessing fitness facilities. Acknowledging that our future PA 'normalcy' may look different than it has previously, it is important that we as a society continue to support one another as we continue to find creative ways to be physically active during these ever-changing times. Finally, future research should examine COVID-19 outcomes based on PA levels, as well as assess the utility and effectiveness of currently offered PA resources to determine how we may be able to improve them for similar future circumstances.

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Taking the Pulse on Pedagogy: Anesthesiology Training in Virtual and Augmented Reality

John Christy Johnson[1*], Peter Anto Johnson[1]

[1] University of Alberta, Edmonton, AB, Canada
*Author for correspondence (jcj2@ualberta.ca)

Abstract

Anesthesiology represents a field where clinical precision cannot be compromised when it comes to procedural task performance. As such, better pedagogical approaches can be critical in ensuring a trainee is able to acquire mastery and refine technique for anesthesiologic interventions. Virtual reality (VR) and augmented reality (AR) technologies are one option that is growing in popularity due to its ability to enhance hands-on learning (albeit virtually), especially during disease outbreaks, such as the current COVID-19 pandemic. A large advantage to these forms of remote learning technology is the reduction of human resources required to run a training session. This commentary explores the current state of VR/AR in anesthesiology medical education.

Introduction

Simulation training in anesthesiology has evolved to mimic human responses with an astonishingly high fidelity and realism with mannequins that can replicate life-like functions from breathing to heartbeats to electrocardiograms (ECGs), it is possible to recreate a vast array of patient presentations (1). It would be ideal if every student could be provided an opportunity to practice on a dummy, but bandwidths on time, supply, and effort are rate limiting steps. This is where the unique opportunity of practicing anesthesia in virtual reality (VR) and augmented reality (AR) have the potential to revolutionize medical training, becoming especially relevant applications in this new reality presented by infectious disease. During times of social distancing and remote education delivery, a virtual modality that can engage students from the comfort of their homes can be an advantage for teachers and trainees alike. Here, our objective is to highlight the advancements and value of experiential, simulation-based learning offered through VR/AR in the field of anesthesiology. (2) For the purposes of this article, VR will refer to an experience that removes the user from the real-world experience with a simulated digital one while AR will refer to an experience that retains the user experience in the real world that has been digitally enhanced, and anesthesiology is defined as the medical discipline concerned with relieving pain before, during, or after surgical intervention.

Advances in VR

In VR, students are given an opportunity to recreate anesthesia procedures in an engaging and cost-effective way. Provided that educators invest in VR Headsets ($360.13 CAD per set for Oculus Rift headsets used in clinics),(3) trainees can practice and perfect their skills in a virtual environment in a manner that saves time, effort, and money. Educators can reduce the logistical burdens of setup and takedown while saving money on expensive simulation apparatus. Additionally, they are able to shift their focus exclusively to the development of trainees' procedural skills. Furthermore, the prevalence of VR can significantly increase the accessibility of education as students have to deal with pandemic restrictions that prevent them from in-person training. VR simulations also provide high-definition 3D graphics that allow for interactive user manipulation and construal.(4) With the integration of haptic feedback, perhaps the role of VR can even be enhanced to a greater degree.(5,6) Increased realism can foster positive effects on student confidence and in the larger context, patient safety.(7)

One great advancement in VR surgery and anesthesiology training comes from higher resolution x-ray

imaging.(8) For example, 3D anatomy models of the bile duct can be constructed in AR with high degrees of detail and used in VR for diagnostic training and exploration pre-operatively in common surgical anesthesia procedures such as cholecystectomy. (9,10) Anesthesiology residents will have to foster a good understanding of anatomy to manipulate software and work alongside technicians in interdisciplinary work environments to optimize models and carry out anesthesia in a seamless way during surgery.

I had the opportunity to work on a dental anesthesia VR simulation at the University of Alberta. To set the context, prior to the VR simulations, dental trainees would typically practice injections on chicken legs prior to practicing on their colleagues.(7) Perhaps conceivably, this was quite concerning for the safety of trainees and their peers. VR can represent a feasible intermediate step during this transition for healthcare students. Our lab, the University of Alberta Rehabilitation Robotics Lab, produced a learning object that can be used in VR and provide feedback to allow students to become better equipped to perform dexterous injections(11). If these types of pedagogical programming can be implemented in the classroom, it could change the landscape of learning. The VR experience still has several deficits when compared to patient mannequins. For example, essential nontechnical skills such as teamwork become much more difficult to assess in VR when completing a module in isolation. However, provided the current context of the COVID-19 pandemic, reducing one's contacts with peers, teachers, and others can actually be useful.

Advances in AR

Beyond VR, AR applications can be pursued to superimpose models onto cadavers. With markers and overlays, it is possible to practice intubations and insertions with greater precision. In having these 'handrails' on anatomical landmarks, students would be given a chance to explore specific techniques involved in surgical anesthesia(12). AR also can play a role in surgical planning as students and educators can discuss possible courses of anesthesia administration as a team or class(13). For example, one of the innovations being developed are AR guidance systems for combining tracked needles with non-invasive ultrasound and patient-specific geometric models to create phantom paths that anesthesia residents can use to practice nerve block(14). Understanding the technical skill to place needles within submillimetre targets takes practice, failure, and repetition for residents to acquire this expertise. An equally pertinent application has been developed in our lab. As spinal needle injection procedures such as lumbar epidurals are becoming more and more prevalent, needle placements are of utmost importance as trainees could unintentionally damage sensitive spinal cord tissue. An educational intervention study showed that manual palpation can correctly identify spinal levels 30% of the time, but additional training, with ultrasound guidance, greatly improved this success rate to 78.7% (15). Our lab has a vertebral AR model that can be used in applications like this to identify lumbar spinal levels(11). Beyond the clinical value of these technologies, it also has a vital pedagogical value as students can recognize their mistakes and allow for correction.

AR is currently being used in real-life robotic surgical interventions and as we evolve our technologies, it might start becoming more commonplace in routine surgeries as well(16). If this is the case, anesthesiology trainees may need to start acquiring skills that enable them to use AR while performing anesthesia.

Future Directions

The future of VR/AR is ripe with possibilities. If current trends for VR and AR equipment costs continue, it is conceivable that there will be a time when households no longer have any financial barriers to afford VR/AR systems that permit interactive student learning from home. In this future, remote education can look completely different with learning objects or modules specialized towards different procedures and skills that could be assessed and monitored remotely by an evaluator.

Alternatively, it may even be possible to tap into machine learning algorithms that can increase the challenge required for practicing maneuvers and injections. (17) Combining VR/AR 3D models with artificial intelligence can transform clinical decision making. For example, a machine learning model can predict difficult intubations from using appearance or alternatively, control anesthesia depth based off electroencephalograms of the brain. (17) With added functionality like this, students would be given an opportunity to make even more

realistic decisions to prepare them for real patients.

Limitations and Caveats with VR/AR

Translation of VR/AR technologies into healthcare pedagogy is teeming with potential and data, but there are still pitfalls and limitations that prevent it from being fully embraced by institutions. Currently, although VR/AR headsets are something that lab grants and medical training institutes devote their resources towards, they are not readily available in homes. Limitations in bandwidth also exist as computational paradigms can only model anatomical intricacies so well.(18) It is also integral to consider the legal, ethical, and social implications that can arise from errors and misrepresentations of experience.

Significance in the Current Context

In these times of social distancing, companies have greater incentives to develop VR/AR educational tools for medical specialties like anesthesiology to better support trainees. However, engineers and developers believe there may be long-lasting implications to adoption of these tools even after the pandemic is over.(19) Perhaps, the landscape of anesthesiology pedagogy will be altered permanently with these novel developments.

The COVID-19 pandemic has also presented a brand-new period of challenges for medical educators. With the growing expansion of telehealth applications, there is more pressure on medical curricula to match these changes. As remote patient monitoring technologies have gained momentum, remote trainee monitoring technologies could be the next step. I believe this is the question we should ask ourselves. Can we outsource education via AR and VR just as we do with telemedicine applications? If so, how can we best support infrastructure for remote learning and what types of learning objects can be implemented while retaining accessibility?

Conclusion

In conclusion, advances in VR/AR are valuable advances that can reimagine the way we provide education to anesthesiology students. As a constantly growing and rapidly evolving field, there is a need for educators and students alike to stay up-to-date and provide these opportunities for learning, if feasible. Providing opportunities for experiential learning in VR/AR can help reduce medical student error in clinical situations and enhance the delivery of anesthesiology care provided.

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Online Physicians: The New Norm?

Peter Anto Johnson[1*], John Christy Johnson[1]

[1] University of Alberta, Edmonton, AB, Canada
*Author for correspondence (paj1@ualberta.ca)

Introduction

The rise of and transition to virtual care is a trend, which has permeated both primary care and specialist healthcare settings amidst the new reality of the pandemic. For many patients and physicians who are used to conventional care, tele-healthcare has created a rift in the way consults, referrals, and treatments are approached. However, by now both patients and care providers recognize virtual care has become the new norm to which we must all adapt. This commentary aims to explore advances and limitations of virtual care amidst the pandemic in light of conventional standards established by our current healthcare delivery model.

Advances in Remote Healthcare

Virtual care employs novel technologies that prevent the spread of more variants, strains, and infectious diseases, while enabling patient care and follow-up by reducing the need for contact and travel [1]. Moreover, advances in remote monitoring, videoconferencing technology, and patient safety screening reduce the risk of viral transmission and offer increased convenience, cutting travel and wait times – one of the biggest critiques of modern primary care. Virtual care technologies might also allow physicians and other care providers to have more time in their schedules to see more patients, eliminating the need to physically visit office locations. Studies have also suggested that virtual connectivity and communication provides an environment that is less restrictive and lowers stress levels [2,3].

Limitations of Virtual Care

Virtual care has inherent limitations associated with the absence of in-person consults. Patients do not receive the same level of attention or human contact fundamental to an in-person interaction [4]. Face-to-face communication is hampered when doctors and patients are sitting in front of their computers rather than each other. The presence of another human being in the environment ultimately influences sensitivity of counsel especially where care has psychological components [5].

A variety of complications can also be anticipated when considering the many modalities of virtual care including telephone appointments, videoconferencing calls, or even online chat consults, including limitations in network connectivity, decision-making based on visual clinical findings, and ease of communication between practitioner and patient [6–8]. Furthermore, though many novel innovations in telemedicine and remote monitoring technology are evolving, physical exams and investigations have nonetheless become more difficult in a virtual care environment [9–11]. Self-reports and other subjective measures can be biased without the physical presence of a white coat figure whose clinical expertise is what guides a diagnosis, investigations, and medical interventions [5]. Additionally, the dependence on these technologies could threaten patient confidentiality, which is difficult to protect online [12].

Barriers to Accessibility

In spite of an ease of access to care, this new norm of virtual care may not be able to address barriers that create disparity among patients. Several studies have demonstrated parallels to in-person healthcare access, finding systemic racial factors, socioeconomic inequities, and limitations in rural access to care that persist in virtual care [13–15]. Studies have also determined that the generational gap in digital literacy is a poor predictor of access to virtual care, suggesting that the modality of healthcare delivery may not have an effect on older adults' use of virtual care services [13,14]. Other research studies suggest that geographical proximity to primary care clinics and referring hospitals is

more closely associated with access to care, despite the increased access enabled by virtual care [16,17]. A body of literature, which has focused on economic status reports that patients with a lower median household income had decreased access to tele-health compared to middle- and high-income patients [15,18,19]. Of the studies describing demographic factors, increasing age and male sex are associated with lower odds of accessing virtual care [15,19]. Additionally, Indigenous, Asian, non-English speaking, and other ethnic minority groups are less likely to use virtual services as observed by trends in in-person healthcare [1,13,14].

Future Avenues

These factors are undeniably complex and reflect structural systems, societal frameworks, and personal circumstances that virtual care approaches have not yet addressed. As such, although the use of telemedicine and virtual care during the pandemic has increased the accessibility of health services to the larger population, studies have highlighted a sustained disparity among already vulnerable groups, perhaps reflecting inherent systemic flaws already present in healthcare. As such, it is critical for healthcare providers, policymakers, and innovators to work collaboratively in addressing these barriers. One promising avenue is a focus on patient engagement through user-friendly digital systems such as healthcare apps and group education through virtual care support groups in chronic disease management [20]. Another unexplored direction is stakeholder advocacy at the community level to lower the barriers to virtual care, as well as referral by healthcare professionals to ultimately promote awareness and the use of virtual care services.

Conclusion

Already recognized as here to stay, virtual care presents new opportunities along with novel challenges and familiar limitations in terms of barriers to access to conventional care. Regardless, this is the new norm and a new reality to which we must adapt and develop strategies for a more equitable virtual care.

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To Resist or Not to Resist? That is the Dangerous Situation: A Look at Antimicrobial Stewardship in Pediatric Care in North America

Rana Khafagy[1*]

[1]Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada
*Author for correspondence (rana.khafagy@sickkids.ca)

Abstract

This article will explore the impact of antibiotic resistance on pediatric care in North America, specifically focusing on how it negatively affects patient health outcomes. The mitigation of this issue in everyday health practice will be outlined. Antibiotics are one of the most commonly prescribed medications in children, with a significant number of them being used inappropriately. Considering the growing global threat of antibiotic resistant superbugs, it is vital to develop strategies and programs for decreasing antibiotic misuse and combating antibiotic resistance. Antimicrobial stewardship is one such method of reducing antibiotic resistance and has already shown evidence of improving patient outcomes, such as decreasing risk of future invasive infections, decreasing hospitalization and decreasing mortality. With more awareness to this dangerous issue, we are beginning to see the development and implementation of a variety of practices aimed at using antibiotics judiciously in pediatric patients across North America. This article will address the severity of the issue of antibiotic resistance in pediatric care in North America and highlight how this can be managed using antimicrobial stewardship principles that are practical, evidence-based and easily implementable in healthcare practices. Although there is still much work to be done, small improvements in resistance rates show that we are moving in the right direction.

Introduction

While the COVID-19 pandemic is on the forefront of most minds, there is another dangerous public health threat lurking in the shadows – the rising resistance of bacteria to available antibacterial agents. Although antibiotics are life-saving medications, their escalating inappropriate use is leading to increased resistance among bacteria.[1,2] Among children in North America, antibiotics are the most common class of medications that are prescribed.1 Amoxicillin continues to be the most prescribed medication in children aged 0 to 11 years.1 Although its usage has decreased by roughly 14% since 2002, there still continues to be over 18 million prescriptions filled each year for amoxicillin.1 It is estimated that almost a third of these prescriptions are unnecessary, with some prescribed for viral infections (instead of bacterial) and others prescribed for more days than needed to adequately treat the infection.[1,2] As a result of using antibiotics such as amoxicillin inappropriately, we are seeing an increasing number of bacteria developing resistance to these agents.[1,2] In hospitals, there has been a trend of using broad spectrum antibiotics when a patient becomes unstable and the causative organism is unknown.[1,2] This is giving rise to a new breed of superbugs that cannot be treated with "big gun" agents, leaving us with limited options for treating these organisms.2 This problem may be solved with mindful prescribing. Antimicrobial stewardship is the practice of ensuring appropriate use of antimicrobial agents so that they continue to be effective at treating infections and is one way to decrease the alarming rates of infection resistance and superbug development.[9]

The Problem

In hospitalized Canadians, we are seeing a 6.25% risk of developing a bacterial superbug.3 Since 2012, there has

carbapenems, a class of wide spectrum antibiotics often used in hard to treat infections.[3] These statistics include pediatric patients, who are specifically noted to have increasing cases of hard to treat Staphylococcus aureus and Enterococus sp over the last decade.[15] In a 2014 study from the U.S. Military Health System, MRSA resistance to clindamycin increased from 9.3% to 16.7% in the span of nine years in a pediatric population.6 What does this translate to? An increased death toll.[15] Without effective antibiotics, infections can become fatal. For example, MRSA bacteremia in Canada led to 20% of infected patients dying within 30 days between 2014 and 2018.4 Mortality rate within 30 days increased to 31% for vancomycin-resistant Enterococcus (VRE) bacteremia.[4] These numbers are a reflection of both adult and pediatric patients, with the rate of increase in deaths from hard to treat infections steeper in pediatrics compared to adults over the last decade.[4] Pediatric-specific data from the US has demonstrated an increase in VRE infections leading to ICU admissions, with 120 cases per million leading to ICU admissions in 2012 but only 53 cases per million in 1997.[15,17] In children, we are seeing an alarming rate of antibiotic resistant organisms (AROs) among oncology and transplant patients who would otherwise die without effective antibiotics.[15] Currently, carbapenems are one of the strongest antibiotic groups in North America due to their broad spectrum and relatively low resistance. In a recent study looking at over 87,000 Pseudomonas aeruginosa isolates from U.S. children, carbapenem resistance increased from 9.4% to 20% between 1999 and 2012.[15,18] This is very concerning due to the lack of alternative antibiotics available if resistance becomes common with these "big gun" agents. Overall, we are seeing an increase in MRSA and VRE infections in children and rapidly increasing rates of resistance of bacteria to beta-lactams, fluoroquinolones and macrolides.[15]

In 2020, the World Health Organization declared antimicrobial resistance one of the top ten global threats to humanity.[5,6] If we do not take serious steps to decrease inappropriate use of antibiotics, there may come a time when even the most simple of infections will have significant morbidity and mortality risks.[6,7,8]

Antimicrobial Stewardship

Antimicrobial stewardship is the practice of using antimicrobials only when necessary and, if used, ensuring their appropriate use.[9] It goes beyond simply telling prescribers not to use antibiotics and focuses more on principles for how to use them judiciously. Literature has shown that antimicrobial stewardship programs (ASP) are effective at reducing antibiotic overuse and improving patient outcomes.[9] These outcomes include decreased hospitalizations, decreased ICU admissions, decreased risk of invasive fungal disease, improved quality of life and decreased mortality from hard-to-treat infections.[9,15,16] As such, several committees have created guidelines on how to implement ASP into daily practice with a focus on pediatric populations.[9,10,11]

Some important ASP principles are as follows (adapted from the Canadian Pediatric Society and American Academy of Pediatrics' position papers):[9,10,11]

1. Avoid the use of antibiotics when a virus is suspected.
2. Consider not treating mild and self-limiting infections.
3. Access to appropriate and timely tests for diagnosis and monitoring should be available.
4. Narrow antibiotics once a causative organism is identified.
5. Avoid treating contaminations, especially with urine and wound samples. Instead, treat if signs and symptoms of an infection are present.
6. Confirm allergies to antibiotics. Sometimes, the "allergy" may be a side effect or intolerance.
7. Optimize dosing and administration of antibiotics. In pediatrics, there is typically a dosing range and prescribers are encouraged to dose at the higher end of the range. Ensure the use of the child's most recent weight when calculating the dose.
8. Use the shortest recommended duration to treat. Parents should be encouraged to complete the full course, and neither stop early nor continue longer than instructed.
9. Do not switch antibiotics early in the course. It usually takes infections several days to subside.
10. Vaccinations are important! They prevent infections and decrease antimicrobial use overall

Barriers and Areas for Improvements

The principles of antimicrobial stewardship are simple enough and look to be relatively attainable on paper. However, when dealing with people issues are never black and white. In order to have successful programs to decrease the misuse of antibiotics, we need to understand three stakeholder groups: healthcare workers, pharmaceutical companies and patients.

Antibiotics in North America are typically available to patients by prescription, which means a healthcare intervention is needed to access them. As such, healthcare workers require education and support in order to prescribe antibiotics appropriately. If medical professionals lack updated information (for example, access to a regularly updated local antibiogram) and tools to identify the type of infection and/or offending organism, inappropriate prescribing may be the outcome.[6] Medical professionals may also be under pressure from patients' families to prescribe antibiotics when not needed.[6] Additionally, lack of infection prevention and control measures in clinics and hospitals may increase the spread of infections.[6] These factors should be addressed in order to decrease the ever growing number of antibiotic prescriptions being written across North America. Some successful solutions include providing healthcare professionals with a local antibiogram updated at least yearly, improving lab turnaround times for reporting cultures and sensitivities so antimicrobials can be narrowed appropriately, as well as imparting regular reminders of the appropriate use of Personal Protective Equipment (PPE) in healthcare settings.[6,9,10,11] Since 1987, there have been no major discoveries in the antibiotics drug category and this does not appear to be changing.6 With other, more captivating, markets, pharmaceutical companies are not incentivized to pour money into the research and development of novel antibiotics.[6,7] Most antibiotics that exist today have been isolated from a small sample of ecological niches and taxonomic groups, mostly from Actinomyces soil.8 Some approaches to combat this may be exploring other niches such as the marine environment, exploring synthetic mechanisms or engineering medications with more than one active agent in order to possess dual target activities.8 Groups such as the International Coalition of Medicines Regulatory Authorities (ICMRA) are focused on helping pharmaceutical companies prioritize the development of new antibiotics.[7] This is a start, although more funds and supports may be required to provide pharmaceutical companies with the incentives needed to innovate the antibiotic market.

Patients and their families should understand the dangers of inappropriate use of antimicrobials.[6] Too often do parents pressure prescribers for an antibiotic to treat their child's viral infection or instruct children to stop taking their antibiotics after a few days as they feel better. Just as prescribers should be educated in principles of antimicrobial stewardship, so should the public. The media should be leveraged to showcase the growing threat that looms due to these superbugs.[7]

Hope for the Future

ASP requires a multidisciplinary approach. We cannot rely on just one group to change the course of this dangerous dilemma. Prescribers, nurses, pharmacists, government agencies, pharmaceutical companies and patients need to work together to first, understand the dangers of antibiotic resistance and second, their role in slowing it down. With new promising evidence, ASP programs may significantly decrease the development of AROs and reduce clinical failures when treating various infections.[9,10] Although some of these principles may sound elementary, they are vital to combat this issue. Various groups require support in order to easily implement these principles in an already stretched healthcare system. Continuous evaluations of ASP programs are also crucial to ensure they continue to benefit their target populations.

People are beginning to be exposed to the severity and depth of this issue with a number of news and media outlets recently reporting on antibiotic resistance. This is an opportunity for public health and science communicators to use these platforms to reach a wide audience.[12] Social media is another tool that may be used to educate the younger generations. If you go on TwitterTM, you will not find a shortage of public health and medical influencers educating society. This should be continued, and encouraged, among our public health, science and healthcare colleagues. And we should move beyond this into other social media platforms in order to keep up with

the communication methods and styles of this new age.[12]

Preliminary data from the past 3 years has already started to show a decrease in bacterial resistance to fluoroquinolones and an increase in Staphylococcus aureus being susceptible to penicillin.[13] IDWeek 2020 also highlighted a variety of accomplishments, showing that we are starting to move in the right direction.[14]

Conclusion

In North America, resistance of organisms to available antimicrobials is increasing at an alarming rate. In children, this trend has become even more pronounced in the last decade. With the ongoing high use of antibiotics in pediatric patients, it is important to use them appropriately and judiciously so they continue to be effective. ASP is one solution to this dangerous problem. Through a set of guidelines and principles, this program aims to minimize inappropriate use of antibiotics. Evidence has shown that ASP implementation leads to decreased rates of hard to treat bacteria and improved patient outcomes.

Although ASP is one important method of tackling this problem, it doesn't come without its limitations. First, implementing a good ASP requires a lot of time and resources. The program must be comprehensive, involve various clinicians and stakeholders, be region-specific and must be regularly evaluated and updated. Due to its resource-heavy nature, smaller community hospitals may not be able to implement ASP. If not implemented correctly, ASP can be restrictive and limit healthcare professionals' ability to use clinical judgement when treating infections. Rather, these programs should serve as guidelines and assist prescribers when treating infections. They should not prohibit certain antimicrobials from being used if the prescriber feels they are needed or delay a patient from receiving effective treatment while the prescriber gets "permission" to use an agent. Some programs become over-ambitious and have a long list of guidelines and policies. This is resource-heavy and unnecessary. Moreover, this also makes it hard to analyze which part of the program is working well and which requires refinement. Effective ASP are typically narrow in their focus, with less than 15 interventions to promote appropriate antimicrobial use. Although there is emerging evidence of the benefits of ASP in reducing antimicrobial resistance, this evidence is early, not robust and may be anecdotal (as the studies may not be sufficiently powered to detect these benefits). Further, evidence has not proven any significant decreases in antimicrobial side effects or length of hospital stay, which is a common quality marker in hospitals.20 More high-quality evidence is required to continue to validate APS in our healthcare system and to turn the skeptics into believers. Other strategies targeting healthcare workers, patients and pharmaceutical companies are also essential to this fight against antimicrobial resistance.

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The Economic Impact of Pandemics on Individuals, Families and Communities

Umair Majid[1*], Aghna Wasim[2], Simran Bakshi[3], Judy Truong[4]

[1]McMaster University, Hamilton, ON, Canada; [2] University of Toronto, Toronto, ON, Canada; [3] University of Western, London, ON, Canada; [4] MaRS Discovery District, Toronto, ON, Canada
*Author for correspondence (majidua@mcmaster.ca)

Abstract
The Coronavirus disease 2019 (COVID-19) pandemic has dramatically changed systems, routines, practices, and beliefs. This pandemic will have a number of adverse outcomes which will continue to be felt for years to come. Understanding the economic impact on individuals, families, businesses, and communities is essential for developing strategies that reduce long-term negative outcomes. However, we are unaware of any evidence synthesis describing the range of economic or financial impacts associated with pandemics. In this paper, we analyze data from a large scoping review of previous pandemics to identify the various economic and financial impacts of global disease outbreaks on families, businesses, and economic systems. We found that individuals and families around the world experienced a reduction or loss of income associated with losing their job or having to work fewer hours, which increased their psychological stress. At the same time, the pandemic has negatively affected the financial outcomes of small and medium-sized businesses due to reduced economy activity, disruptions in the supply chain, and weakened infrastructure. We examine these findings in the light of two topics. First, we discuss how vulnerable and minority communities experience the various financial and economic impacts of global outbreaks to a greater degree compared to the general public. We also discuss the concepts of flexibility and resilience in order to understand how businesses respond to the changes brought forth by the pandemic.

Background
COVID-19 has dramatically changed systems, routines, practices, and beliefs. This pandemic has affected almost every facet of life with long-term implications for social and economic activity lasting years to come. People with mental illness have experienced exacerbation of symptoms, businesses have closed permanently due to reduced economic activity, and families and individuals have lost their jobs, causing ripple effects on their lives and future. Understanding the economic impact on individuals, families, businesses, and communities is an essential component of developing strategics for responding to the pandemic. Appropriate responses to the pandemic may reduce the potential negative and long-lasting outcomes associated with pandemics and global outbreaks. However, there has been no attempt to our knowledge to truly understand the range of economic or financial impacts that pandemics can have on individuals, families, businesses, and communities. In this review, we analyzed data from a large scoping review of previous pandemics to identify their economic and financial impacts on families, businesses, and economic systems. We conclude our paper by discussing the relevance of our findings within the context of COVID-19, and more specifically how countries will pivot in order to recover and restart their economies.

Overview of Article Scope
We conducted a narrative review of studies on how individuals, groups, and communities have reacted to pandemics. Since responses to pandemics have changed dramatically over time, we focused our attention on studies pertaining to pandemics since the start

of the 21st century, which include the following: Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), Influenza A/H1N1, Ebola Virus Disease (EVD), and COVID-19. We based this review from unpublished data generated from a previously published scoping review that attempted to identify the relationship between knowledge, misconceptions, risk perceptions, and behavior change during pandemics[1]. In this review, we focused our work on data that specifically outlined the various economic or financial outcomes of families, workers, businesses, and the economy. We reviewed all articles from the scoping review and extracted findings relevant to the economic or financial impact of pandemics on families, workers, businesses, and the economy. We opted to include studies from multiple countries to increase the quality and quantity of data and allow us to make useful comparisons across demographics and cultures. Therefore, the insight we offer in this paper is a representation of multiple countries and contexts. As a team, we analyzed these findings using thematic analysis[2] .Two researchers developed narrative summaries for each theme, which were then all integrated into a single findings section.

Findings

Economic Impact on Families and Workers

Six studies described how the pandemic increased stress, tension and emotional distress in families associated with real or perceived economic losses as a result of pandemics or global outbreaks [3-8]. These reactions to the pandemic or global outbreak arose for a number of reasons, such as fear of losing previously held occupations, having to shift to part-time work because of their inability to secure childcare, using more expensive transportation for commuting to reduce their exposure to infection, and paying for health services associated with infection at private hospitals. Families that primarily depended on income generated from a family-owned business were the most affected by the pandemic or global outbreak. In one study conducted in India, "tension" levels were reported as more severe than during the H1N1 pandemic [7].

Individual family members who held jobs experienced a significant loss of their income, which had ripple effects on their health, safety, and ability to seek health care [3-5,7,9-12]. Losing income came from having fewer clients access their services which resulted in lower commission, dedicating less time to the occupation, not being paid for time in quarantine, taking early maternity leave without pay, lack of paid sick days that were used to get tested or when they had the disease, and losing the job [9-12]. Other concerns that participants expressed within included studies were not being able to work from home and health care workers lacking food assistance for their family since they were mandated to provide health services for extended periods of time [9-12]. Furthermore, participants expressed how the pandemic or global outbreak increased the daily cost of living while reducing their income, which caused significant disruption in how they budgeted daily life expenses [7]. Participants resorted to using their savings in order to meet their most basic needs during pandemics or global outbreaks [7]. Finally, participants who recovered from an infection also lost their job due to a disease-associated stigma [9]. For participants who did not lose their job, they experienced daily work-related discrimination which reduced their work performance and income in the long-term [11]. Finally, feelings of stigma and discrimination towards certain ethnicities contributed to unemployment or even a complete closure of restaurants[13].

Economic Impact on Businesses and Societies

Research has shown that past pandemics and global outbreaks bring about economic decline, causing a devasting impact on businesses. During the SARS epidemic, the drastic decrease in both business revenue and service demand led to a collective loss of about $60 billion in Southeast Asian and East Asian economies [14]. One study also demonstrated that the spread of Ebola was associated with a sharp decline in business in affected communities [15]. Business losses incurred during pandemics or global outbreaks have been associated with significant delays in resuming normal economic activity and reduced customer traffic leading to profit declines [9]. The lack of clientele noted at community centres, workshops, and restaurants was at least in part attributed to a fear of infection [9,13]. Tourism also suffered substantially as a consequence of SARS; people were afraid of getting infected and refrained from travelling abroad in order to stay safe [13,16]. In fact, financial losses and business closures, particularly those in the travel and tourism industry were associated with avoidance strategies and policy interventions introduced by governments to limit cross-border travel to reduce disease spread [17,18].

Global outbreaks and pandemics have negatively impacted the supply chain in businesses; for example, the outbreak of Ebola in Liberia contributed to the weakening of infrastructure and loss of economic resources [19]. The spread of disease was frequently associated with a decline in both economic and social activities, placing countries at a risk of economic recession [20]. The economic activities affected in West Africa during the outbreak of Ebola included the production of cocoa [21]. Similarly, a small proportion of pig producers from Australia experienced drastically lower sales during the H1N1 epidemic [22]. Furthermore, global outbreaks were accompanied by a significant reduction in the value of housing [23].

Table 1. Key Findings

Impact	Findings
Families and Workers	• Increased stress, tension, and emotional distress, primarily associated with real or perceived economic losses from the pandemic or global outbreak • Fear of losing previously held occupations, having to shift to part-time work because of inability to secure childcare, using more expensive transportation for commuting to reduce exposure risk, and paying for health services associated with infection • Losing income from fewer clients, less time to the occupation, not being paid for time in quarantine, taking early maternity leave without pay, lack of paid sick days, losing their job, not being able to work from home, and lacking food assistance for their families
Businesses and Societies	• Sharp decline in business due to reduced customer traffic and delays in resuming normal economic activity • The tourism industry was negatively impacted due to physical distancing mask-wearing policies, border closures, and movement restrictions on the public • Supply chains that supported businesses were negatively impacted that caused further weakened country infrastructure and lead to the loss of economic resources

Discussion

Review of Findings

In this paper, we reviewed studies from previous pandemics and global outbreaks to identify the economic and financial impacts on individuals, families, businesses, and economic systems. In the following sections, we reflect on the aforementioned findings in relation to emerging evidence on the COVID-19 pandemic. We first discuss the immense impact the pandemic has had on minority and vulnerable communities and what this means for informing policy decisions. We will then discuss flexibility and resilience as potential solutions for identifying how businesses will respond to the pandemic to reduce its adverse outcomes on revenue.

The Impact of the Pandemic on Minority and Vulnerable Communities

Through history, the impact of pandemics or global outbreaks has had inordinate negative consequences on minority and racialized communities. While our list of included studies captured the situations of a variety of countries, we found continuous mention of minority and racialized communities in each country. We recognize, however, that minority groups in each country – especially between high- and low-resource countries – may differ considerably in the challenges they face. For the purposes of this discussion, we focus on "low-income communities" across all countries to attempt to draw out common challenges they have faced around the world since the start of the COVID-19 pandemic. We adopted this focus since included studies primarily mentioned general minority groups without a clear delineate of the demographic or other characteristics of participants.

Similar to previous outbreaks, COVID-19 has adversely affected economies worldwide and triggered financial instability among ethnic minorities, marginalized communities, and vulnerable populations. For example, 42% of Filipinos and 47% of West Asians in Canada lost their jobs due to the pandemic or were forced to work fewer hours; however, only about one-third of the Caucasian participants reported facing similar difficulties [24]. Moreover, a greater proportion of minority groups compared to Caucasian participants expressed that the outbreak of COVID-19 had rendered them unable to pay for their basic necessities, including groceries and rent [24]. Similarly, another study conducted in the US demonstrated that Latino families have been subjected to drastic economic challenges during the pandemic, such as unemployment, closure of their businesses, inability to pay for housing arrangements, and an inability to afford healthcare [25]. In Bangladesh, a single day of lockdown was estimated to have led to a collective loss of $64.2 million in earnings

among individuals working blue collar occupations [26].

Social distancing policies introduced by the government have adversely affected the following sectors through complete shutdowns of physical operations or substantial reductions in their activity: entertainment, retail, transportation and travel, manufacturing, and bars and restaurants [27]. These sectors typically employ increasingly large proportions of recent immigrants, ethnic minorities, and other vulnerable communities. Consequently, these groups have been subjected to higher economic losses as compared to the rest of the population in the COVID-19 pandemic. Since these individuals also typically have lower levels of education, lower paying jobs prior to the pandemic, and a considerably small amount of assets, the outbreak of COVID-19 may have exacerbated the inequities that were already prevalent within society. As a result, these individuals are disadvantaged because they come from a marginalized background and thus have fewer opportunities to find alternative work. These inequities will likely continue to negatively impact vulnerable communities several years after the pandemic unless specifically tailored policies are developed and implemented at the local, provincial, and federal level to offset the economic downturn caused by COVID-19 for vulnerable populations.

We found that people facing financial difficulties in earlier pandemics experienced psychological and emotional distress. Similarly, research has shown that individuals that were either permanently terminated from their employment or temporarily laid off as a consequence of the COVID-19 outbreak experienced higher levels of psychological distress [28]. Thus, the psychological toll due to economic challenges associated with the spread of COVID-19 is likely to impact vulnerable communities more intensely than any other group because they form a disproportionately large number of individuals displaced from work by the outbreak [29]. Moreover, their financial situation may impede them from being able to seek the appropriate counselling or resources they need to overcome their difficulties. This may potentially be one of the many factors explaining the observation of worse mental health outcomes among racial minorities and LGBTQ communities in the COVID-19 pandemic reported in a study by Pedrosa et al. [29]. Minorities and vulnerable populations not only bear the psychological burden that accompanies fear and panic during pandemics or global outbreaks, but also endure the additional stress that comes from losing their jobs. Previously published literature has demonstrated that previous outbreaks were often followed by discrimination towards racial minorities [11,13,16]. There is evidence that suggests an increase in stigmatization of vulnerable groups during the COVID-19 pandemic [30]. This type of discriminatory attitude might deter employers from hiring individuals in such groups in the future, perpetuating an ongoing cycle of financial problems and the consequential psychological burden.

Business Flexibility and Resilience During Pandemics
Citizens are more likely during pandemics or global outbreaks to have reduced mobility due to lockdown and stay-at-home orders, and as a result, spend less of their income on amenities, services, and entertainment. Thus, small-, medium- and large-sized businesses have been dramatically impacted by the COVID-19 pandemic due to minimal economic activity. The air transport association predicted loss to air carrier organizations at $118 billion in 2020 [31]; and the international film market was predicted to lose over $5 billion in sales [32]. Intensifying this dire situation for businesses, disruptions to supply chains have a cumulative effect on many industries, especially due to an interconnected global market [33]. The rapid slowdown of economic activity will have rippling effects on economies for years to come. Compared to previous pandemics and global outbreaks, however, we believe that the overall impact on revenues will be less during the COVID-19 pandemic because a greater number of businesses have larger portions of their revenues coming from online sales. Furthermore, the diversity and quantity of online businesses will continue to increase [34]. While physical economic activity may be at an all-time low, virtual economic activity may increase to compensate some of the revenue losses during the COVID-19 pandemic. However, we recognize that there are certain businesses that do not have the facilities to accommodate increased virtual economic activity and hence compensate for their revenue losses.

Businesses, particularly small- and medium-sized businesses, who are unwilling or unable to pivot their existing revenue generating streams to leverage the increase in virtual demand for goods and services will experience an immense challenge moving forward. It is a reality of today's economic landscape that busi-

nesses must adapt their services and goods with the shift from physical to virtual economic activity. Businesses that do not adapt will continue to face inadvertent and adverse consequences – such as the same revenue being siphoned to competing businesses that have successfully adapted – which may ultimately lead to the long-term decline of the business and eventual business failure [35]. One study estimated a 10% failure rate of businesses in accommodation and food services, arts, entertainment and recreation, and education in the United States [36]. The business literature on failure advises us on what businesses can do when they encounter a rapidly shifting market landscape.

The first approach is to predict these possible shifts in market landscapes through viewing the future, making "big bets" (i.e., determine which shifts are most likely to occur), and then changing business processes and activities to match those shifts before they occur [37]. If a business' big bets turn out to be true, then the business will be ahead of competitors and as a result may experience the adverse effects of the pandemic or global outbreak to a lesser degree. Viewing the future and making big bets is a characteristic of highly flexible and resilient organizations that sustain their superiority in a particular industry for decades. One case study of six hospitality firms in Austria found that some firms engaged in a considerable amount of business innovation that successfully adapted their business models to the new pandemic or global outbreak conditions by creating new revenue schemes [38]. However, few businesses dedicate sufficient time and resources predicting the future, and many have a culture that conforms to the status quo.

The second, more reactive approach, is referred to as organizational isomorphism. In this approach, businesses switch their gears from business processes and service delivery to the acquisition of external knowledge on how other businesses have adapted to the changing market landscape [39]. Businesses may imitate the structures, strategies, and practices of successful organizations in their marketing landscape [40]. This learning process entails the rapid development of business adaption solutions, rapid testing of these solutions, and finally implementing and scaling these solutions to optimize the revenue generated from new business processes and activities [40]. Isomorphism for small- and medium-sized businesses might involve the provision of goods and services that people need because of the pandemic or global outbreak (i.e., goods they did not need before), providing the same goods and services in ways that reach a greater quantity and diversity of people during mass quarantine and stay-at-home orders, and/or letting go of certain goods and services that are in low demand because of pandemic-related considerations [39].

Unfortunately, we see a rising number of business closures because of their inability to adapt to the changing market landscape [40]. At the same time, however, new businesses are opening that have already acknowledged that almost all their revenue may be generated from virtual economic activity [41]. These businesses have already invested in online platforms that place them in a superior position to generate profit during a pandemic or global outbreak with reduced mobility [42]. This shows that businesses can adapt, but few may lack the resources, expertise, or direction to adapt effectively. Sood [43] recommended the following three suggestions based on their analysis of the impact of COVID-19 on consumer behavior in India: be true to your brand and to your intent, communicate to your clients, and find new ways to communicate with your customers.

Limitations

There are two notable limitations for this narrative review. First, we opted to include literature from a variety of countries and cultural contexts. While we recognize the importance of analyzing information on specific communities or populations, we emphasize the need to draw common economic challenges that communities, businesses, and economic systems have faced from pandemics and global outbreaks. Second, while this review focused on previous pandemics and global outbreaks, there is emerging research specific to the COVID-19 pandemic, some of which have been cited in this narrative review. We reflect on the continued need to document the economic impact of the COVID-19 pandemic on communities, businesses, and economic systems worldwide, particularly as some countries head into post-pandemic recovery and vaccination; it may be pertinent to analyze the persistent and long-term outcomes the pandemic will have on certain communities and businesses.

Conclusion

In this paper, we discussed the economic impact of previous pandemics and global disease outbreaks on workers, families, businesses, and economic systems. Overall, we found that families and workers experienced a reduction or loss of income, exacerbating psychological stress. We then discussed how vulnerable and minority communities experience the various financial and economic impacts of pandemics and global outbreaks to a greater degree than the general public. In the context of the COVID-19 pandemic, these groups may also face increasing levels of disease-related discrimination as we transition to post-pandemic recovery that may further stigmatize them and their communities. The pandemic has also had a negative impact on businesses due to reduced economic activity, disruptions in supply chain, and weakened infrastructure. We used the concepts of flexibility and resilience in order to understand how businesses respond to the changes brought forth by the pandemic. We identified viewing the future (proactive response) and organizational isomorphism (reactive response) as two responses that enable businesses to reduce the adverse economic outcomes of the pandemic on their activities and financial performance.

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Isolation and Mental Health: A Brief Discussion of Resilience as a Potential Response to COVID-19 Pandemic Stressors

Kassandra McFarlane[1*]

[1]Queen's Univeristy, Kingston, ON, Canada
*Author for correspondence (kmcfarlane@qmed.ca)

Abstract

The isolation and quarantine policies implemented to limit the spread of the COVID-19 pandemic are a new and challenging experience for many people and may negatively impact mental health. By promoting resilience in the population, some of the impact of these vital public policies may be mitigated. The purpose of this article is to discus s the role of isolation measures implemented during the COVID-19 pandemic as stressors, which mediate impacts on the mental health of the general population and how strategies to increase resilience may serve to mitigate these effects.

Stress and Mental Health

Stressors are stimuli in the external or internal environment that provoke a stress response and challenge the ability of an individual to respond in an adaptive, rather than maladaptive, manner [1]. Stressors challenge the capacity of an individual to respond to risks by placing pressure on homeostasis, forcing the system to correct itself [2]. An example of an external environmental stressor is extreme heat, which challenges the thermoregulatory capacity of the body, and if not successfully ameliorated, results in heat illness. Stressors may be physical, physiological, or psychological [1]. Physical stressors include things like weight loads or injury. An example of a physiological stressor is dehydration or hypoglycemia, where the body requires water or sugar to maintain homeostatic balance. A psychological stressor could be emotional abuse, for example. Stressors may fall into one or more of the above categories. For example, a natural disaster can be both a psychological stressor and a physical stressor due to the possibility of exposure to the elements and disruption of the social structure [3].

The response to stress is a complex process and involves activation of both autonomic nervous system and neuroendocrine systems [4]. The behavioural reaction to stress is commonly referred to as the "fight-flight-freeze" response [5]. The sympathetic nervous system, one branch of the autonomic nervous system, is responsible for some of the physiological mechanisms of this response, including the release of epinephrine and norepinephrine from the adrenal medulla, dilation of the pupils, and increased heart rate [6]. The behaviours often associated with the response include aggression (fight), running away (flee), or becoming still and quiet (freeze) [7]. The purpose of the stress response is to prime the body and permit an individual to respond in such a way so as to resolve the challenge [8]. Common symptoms as part of an acute stress reaction include sweating and the sensation of a pounding heart or palpitations, as well as the subjective experience of heightened anxiety and restlessness [5].

The stress response is most effective in the short-term, after which a return to baseline homeostasis is expected [8]. However, if the stressor remains present, the level of stress progresses to a chronic state [8]. In addition to the activation of the sympathetic branch of the autonomic nervous system, the hypothalamic-pituitary-adrenal (HPA) axis is also activated during a stress response and its main effector is the steroid hormone cortisol, released from the adrenal cortex [6]. In the context of chronic stress exposure, the long-term release of stress mediators and the prolonged exposure on the tissues of the body can result in damage and dysfunction [9]. The resulting imbalance between the parasympathetic nervous system, responsible for the

vegetative roles, and the sympathetic nervous system due to chronic activation results in excessive wear on physiological systems [6]. This autonomic imbalance has been associated with mental disorders [10]. Psychological changes associated with this dysregulation include a multitude of negative mental health outcomes such as depression, anxiety, and other illnesses [1].

COVID-19 Isolation as a Stressor

The novel coronavirus responsible for the COVID-19 pandemic has necessitated a variety of public health measures to slow the spread of the disease. Since the World Health Organization (WHO) announced the pandemic on March 11, 2020 [11], countries around the world have instituted policies and protocols involving an array of restrictions. Some of these restrictions include limiting or prohibiting social gatherings, implementing lockdowns and curfews, and enforcing isolation and quarantine [12]. These policies have resulted in the exposure of some people to social isolation for a prolonged duration. [13]

Both isolation and loneliness can be considered stressors as they challenge the social and emotional well-being of an individual [14]. Ongoing social isolation stress (SIS) has been associated with psychological morbidity, such as depression and anxiety [15]. Though its underlying physiological basis has yet to be fully elucidated, there is some evidence suggesting the neuroendocrine systems, specifically the hypothalamic-pituitary-adrenal (HPA) axis, are indicated in this process [16]. Chronic social isolation has been associated with increased HPA axis activity [16]. The HPA axis role in the stress response includes the coordinated release of the steroid hormone cortisol from the adrenal cortex, which helps prime the body to respond to stress [16]. Both increased and decreased levels of cortisol have been associated with negative health outcomes, including mental illness [6].

As schools and businesses have closed, many people are experiencing a disruption of their daily routines and socialization [17]. Additionally, with shelter-in-place orders and isolation requirements, seeing friends and extended family is also not permitted. Inadequate opportunities to connect with others face-to-face and a perceived lack of social support are associated with mental illness, such as depression, anxiety, or cognitive decline [14,18].

Moreover, a combination of the continuation of the restrictions and an uncertain end-point for the pandemic presents a unique challenge for a stress response evolved to function optimally with short-term adversity [8]. The extended duration of isolation and the subsequent chronic activation of the stress response can contribute to the development of mental illness [1].

While measures implemented to control the spread of COVID-19 are crucial to our collective recovery from this pandemic, the associated isolation due to disease containment methods can have negative psychological impacts [12]. Since these restrictions must remain in place until such time that the pandemic poses no threat, we must focus on steps to address and mitigate mental health morbidities.

Resilience as a Solution

Resilience has many definitions and its understanding has changed as research has progressed over the years. Resilience can be understood as a positive and adaptive response to an adverse circumstance that allows an individual to maintain or re-obtain mental wellness, despite the experience of adversity [19]. Additionally, it can be understood as an outcome or process [20]. Though many may consider resilience as a trait inherent to an individual, there is evidence arguing against this [21,22]. A specific example of resilience can be illustrated by the actions of Jerry White who lost a leg to a landmine but went on to co-lead the International Campaign to Ban Landmines coalition that received the 1997 Nobel Peace Prize [23].

Resilience is one of the factors that allows an individual to cope with unanticipated life situations [24] and is a key factor in preventing mental illness by providing a buffer against stress [14]. Fostering resilience is a possible strategy to confront the stress of social isolation due to the COVID-19 pandemic [24]. Assessing the resilience of a population can be partly accomplished by screening for mental illness or negative signs of stress (proxies for reduced resilience) to detect variation in levels compared to non-crisis periods [25]. Three factors have been proposed as the basis of a model to account for the resilience observed

during other natural disasters and can be adapted to the current pandemic: control, coherence, and connectedness [26]. Engaging each of these components may contribute to overall improved resilience [26]. A sense of control over our lives is critical to our psychological well-being [26]. The elements of our lives we focus on can influence our moods and affect our mental health [27]. By redirecting attention away from the uncontrollable aspects of the pandemic towards the factors in our lives we do have control over, we can empower individuals and reduce the potential for anxiety and depression [26]. Uncontrollable factors in this pandemic could include the behaviour of others, the rate of infections, and the regulations enforced to control the pandemic. Controllable factors are those we have some influence over and could be how much social media we consume, who we spend our leisure time with, and how much exercise we get. By opting to shift our attention to the things within our influence, we can exert our intention on those factors and feel more in control. What people focus on will differ between individuals as everyone's goals and life circumstances are unique. Practice is required in order to maintain new habits of thought and attention and in order to maintain focus on controllable elements in our lives [28].

In addition to focusing on controllable aspects of our lives during this pandemic, promoting an understanding of the circumstances in which we find ourselves is important to enable individuals to withstand the disruption to familiar activities and pursuits [26]. This ability to instil a coherent sense of our surroundings and find meaning is protective for mental health [26]. One way in which this aspect of the model may be applied is by providing accurate, timely, and accessible information to members of the population. Regular dissemination of knowledge about the pandemic from governments and health authorities through all available channels of communication is an option [29]. The kinds of information that are important to disseminate include the probability of contracting the illness and how the government has prepared for uncertain risk [30]. A delayed communication and minimization of the impact of a pandemic can result in a breakdown of trust of the government on behalf of the public, as was seen during the SARS outbreak against the Hong Kong government [31]. Though the initial steps of the Canadian Government during the COVID-19 pandemic have been criticized, overall, the perception of the government's actions during the pandemic has been positive [32]. As well, effective and timely communication from the relevant authorities can dispel any misinformation arising from unofficial online resources that might cause undue fear [33]. Along with control and coherence, connectedness within the community is also critical to support resilience within the population [26]. Connection and social support has been identified as one of the most powerful contributors to resilience in the context of natural disasters [34]. One particular tool of interest is the "loving-kindness meditation (LKM)" which focuses on directing positive emotions like happiness and compassion towards oneself and others [34]. Practicing LKM has been associated with psychological benefits like improved well-being and increased social connection [34]. Additionally, LKM encourages social interactions and, through increased positive emotions and connection, fosters resilience [34]. While isolation policies prevent gathering in person, there remain plenty of ways to keep in contact with the important people in our lives including regular phone/video calls, socially-distanced outdoor meet-ups, and online social networks. It should be noted here that there is a subset of the population who experience ongoing loneliness and isolation even during non-pandemic times. These include older adults without family, refugees, and some individuals with mental health problems [35]. Particular attention should be paid to these groups because many social programs are currently unavailable due to government restrictions. For those with limited to no social network, social programs that focus on the provision of networking services could be considered, such as the Age-Friendly Student Senior Connection (AFSSC) initiated by the University of Southern California Keck School of Medicine in the early stages of the pandemic [36]. The focus of this program was to connect older adults with volunteer graduate students to have regular phone conversations, thereby increasing the amount of social contact available [36]. Benefits of this program include reduced social isolation of older adults during quarantine restrictions [36]. This or similar programs could continue to operate beyond the pandemic in order to alleviate some of the isolation faced by these people on a regular basis.

Future research in areas focusing on those individuals who are most vulnerable to isolation (e.g., older adults, those living in remote communities) and how to increase their access to social outlets during a pandemic could inform best practices for these populations.

Conclusion

The threat to psychological well-being due to isolation-focused disease containment methods has created an unprecedented psychological crisis [37]. With almost half of the world's population currently living in social isolation due to the pandemic [18], there is an unmet need for actions to address the associated negative mental health impacts. Programs addressing this need can focus on fostering resilience by supporting individuals to gain control in their lives, facilitating easy comprehension through effective and authoritative communication, and encouraging safe social connections so as to build robust protection against psychological challenges [26]. Resilience has been known to provide some protection against depression and PTSD, for example, after the Fukushima disaster [38]. By adopting social programs to support resilience in the general population, these efforts can contribute to improved mental health outcomes even while facing great challenges [38].

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STI-gma: Stigma and Sexually Transmitted Infections

Arthi Chinna Meyyappan[1*]

[1]Queen's University, Kingston, ON, Canada
*Author for correspondence (arthicm@outlook.com)

Abstract

Despite the sizeable prevalence of sexually transmitted infections (STIs), the stigma experienced by individuals with STIs is enormous. These individuals can face both societal and self-stigma that are often not based on any scientific or evidence-based research, but rather cultural and social customs. This stigma has a considerable effect not only the mental and physical health of affected individuals but also creates barriers in communicating to partners and loved ones, getting tested, and receiving adequate treatment. In addition to increasing efforts in researching ways to eliminate this stigma and its associated burdens, structured psychoeducation and anti-stigma frameworks must be implemented to educate individuals on safe sexual practices and the ongoing and seriously taxing impact of stigma.

Introduction

Individuals with sexually transmitted infections (STIs) are doubly challenged in our current society. In addition to managing the symptoms of an STI, these individuals also face judgement and shame as a result of misconceptions. There is deep-rooted stigma, both societal and self, associated with STIs that are not scientific or evidence-based; and instead, are largely propagated through social and cultural customs (1). This not only functions as a considerable barrier when educating people on safe sexual practices, it also makes it especially difficult for those who have STIs to get tested, seek treatment, and receive the necessary care they require (2). Despite the numerous testing and treatment barriers that STI-associated stigma creates, there has been a limited effort researching approaches to eliminate these barriers or reduce their burden. Education and awareness of safe sexual practices are integral to not only prevent the spread of these infections but limit societal and self-stigma that impedes the physical and mental health of affected individuals and their loved ones. Thus, a review of these topics is essential to facilitate translation of this knowledge.

In Canada, the reported rates of STIs have been significantly increasing since 2001 and these infections are known to disproportionately affect those under the age of 30 (3). Excluding colds and flus, STIs are among the most common infections in the world (4). There are at least 20 STIs, either viral or bacterial, with some of the most common being chlamydia, gonorrhea, hepatitis B, trichomoniasis, human immunodeficiency virus (HIV), syphilis, human papillomavirus (HPV) and herpes simplex virus (HSV)(4). Bacterial STIs can often be cured, while viral ones cannot and all STIs can have short- and long-term physical and mental health consequences (5). Though there are antiviral therapies to manage symptoms of viral outbreaks, such as those associated with HSV and HIV, having to take regular therapies can be an expensive lifetime task.

The H-word

Among the very common, but incurable, are HSV, HPV, HIV, and Hepatitis B, and these infections are likely riddled with much worse stigma and subject to severe stereotyping (6). Globally, approximately two out of three people under the age of 50 have HSV-1, more commonly known as oral herpes, and more colloquially, as cold sores. One in ten people between 15-49 have HSV-2, most known as genital herpes. Both HSV-1 and HSV-2 can be transmitted to and through oral and genital regions (7). Research suggests many genital herpes infections are increasingly a result of HSV-1, however the exact prevalence is unknown (8,9). Not to mention, those with HSV are about three times more likely to de-

velop HIV, if exposed, and vice versa (10,11). Despite these staggering statistics, STIs other than HIV/AIDS, are a neglected public health priority – which we could even speculate is due to their associated stigma (12).

Many individuals are asymptomatic to HSV, as well as other common STIs, suggesting the aforementioned statistics may be underestimated. Among those that do experience outbreaks or symptoms, research suggests an association between psychological stress and the frequency of outbreaks (13). This is especially challenging given that living with an STI and its associated stigma is difficult and stressful in and of itself. While there are robust articles on the adverse effects and transmission of STIs, there remains a gap on the spread of information to educate individuals on the impact of stigma on day-to-day lives.

Impact of stigma

In what is supposed to be "an era of sexual liberation", we tend to forget that the stigma of these infections still exists just as much. There are ample pop-culture references that ridicule affected individuals, even with something as simple as scaring easily at the use of the word, "herpes", for instance. This can make it difficult for affected individuals to feel comfortable with their diagnosis and be able to openly communicate to loved ones and potential new partners without worry of being ostracised. This lack of communication, often combined with reduced testing and treatment, inevitably leads to a worsening of societal and self-stigma and may also exacerbate the spread of the infection (2).

Disclosure could facilitate a decrease in STI transmission with engagements in safer sexual practices, support from loved ones in seeking suppressant therapies, and reducing stress that may lead to viral outbreaks(14,15). However, in an environment where the infection and the affected individual are misunderstood and judged, fear of open communication and disclosure leading to potential ostracization, romantic rejection, etc. is understandable as this can be overwhelming and thus discourage disclosure with future partners. Many individuals isolate themselves and are reluctant to initiate sexual relationships due to lowered self-esteem as a result of their diagnosis; some even tend to experience depression with viral outbreaks and suffer from diminished performance in other aspects of their life, like their career (16). Predictably, research has also shown that concealment can mediate the relationship between stigma and depression (1).

Stigma can reduce the individual to the diagnosis, which may propagate difficulties speaking up about their condition and asking for help. This perpetuates self-stigma and impedes acceptance – further breeding negative cycles of shame (2). Not being able to accept it can create negative and unwanted side-effects of the stigma itself – such as difficulties maintaining meaningful relationships; this inevitably hinders disclosure and thereby prevents safe sex and healthy relationship practices(17). While a paucity of research exists examining the effects of education to reduce stigma related to STIs, we can relate this to the stigma associated with mental illness and the impact of psychoeducation. Research has shown structured psychoeducation efforts, looking to end self-stigma in individuals with serious mental illness, have been useful in reduction of internalized stigma. Particularly, psychoeducation programs encourage questioning and challenging stereotypes, relating to others, and utilizing personalized experience to prevent and ameliorate alienation (18). This can potentially be extrapolated to also reducing external stigma by raising awareness of sexually transmitted infections, questioning resistance and judgements unknowingly imposed by loved ones, and normalizing conversation around the infection and its effects.

Future Directions

There is evident impact of stigma on mental and physical health of individuals with STIs. Both self and societal stigma, while likely difficult to rapidly eradicate after years of existence, could certainly improve with open communication, structured psychoeducation of self and loved ones, and raised societal awareness of the infections and the negative impacts of associated stigma, particularly at the initial diagnosis. Perhaps, as a preventive measure, implementing anti-stigma frameworks to mandatory health education classes as early as in adolescence to early post-secondary education would be beneficial, given these are classified as the impressionable years (19). As for interventions for populations that are past the stage of prevention, structured psychoeducation targeted towards loved ones and affected indi-

viduals would likely help prevent ongoing self and societal stigma. Further research on the prevalence and implications of stigma related to STIs is also necessary to instigate appropriate and structured psychoeducation efforts.

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COVID-19 Pandemic in Africa: The Need for Investment in Research

Ifeanyi Kennedy Nmecha[1*]

[1] McMaster University, Hamilton, ON, Canada
*Author for correspondence (nmechai@mcmaster.ca)

Abstract

Despite the discovery of a vaccine, there are still growing concerns about the COVID-19 virus. While many western countries have made resource investments into health research, this is a challenging aspect for a lot of African countries. For a region with a lot of experience in epidemics, there has not been efficient investment in health research. Rather, there is a lot of over reliance on the west for vaccine production and development of protocols that are challenging to implement in African countries such as storage conditions for vaccines and access to clean water. A takeaway from the COVID-19 pandemic is that even in a global economic disruption, most countries will seek to aid their citizens and improve their well-being before outsourcing resources to third-world countries. So, it is imperative that Africa as a continent invest heavily in health research, education, medical infrastructure, and development to better prepare for future pandemics.

Introduction

Miguel Porta defines an epidemic, as the increase in the occurrence of an illness or disease in a population or region over the normal expected range (1). He further sheds light on an pandemic as the occurrence of an epidemic over a large area which spans international boundaries and affects an enormous amount of people (1). Over the years, recent data has suggested that there is a potential for an increase in the probability of a pandemic occurring (2), and this as a result of increase in migration, use of land, and increased exploitation of nature (2-3). Important and strategic policies will showcase the need to pinpoint avenues whereby potential outbreaks may occur in the future. Identification of these potential threats will help build preparedness and sustained health.

In December of 2013, the West African Ebola epidemic was first reported in a young boy in the town of Guéckédou, located in Guinea (4). The town is well known for having a large presence in traders across West African countries, thereby, making it a good hub for the spread of the Ebola virus. The Ebola outbreak which spread widely from 2014-2016 was the largest and the first outbreak which involved a few West African countries. The epicenters of the Ebola epidemic were primarily in Guinea, Liberia, and Sierra Leone, with other countries including Nigeria, Senegal and Mali experiencing minor outbreaks (4). A total of 28, 600 laboratory confirmed cases and over 11, 000 deaths were reported in the worst affected countries (4). Unfortunately, this Ebola epidemic exposed the world to a potential pandemic that could spread like wildfire if not properly managed. This epidemic showed the world how ill equipped we are in the face of a potential pandemic in relation to contact tracing, quarantine and isolation protocols, effective health care, and global communication (4). Only West African countries bore the brunt of the Ebola virus in 2014, with Sierra Leone having the most cases. Lack of good health infrastructure, failure of appropriate response by those in authority, and lack of health research are a few factors that led to what is known as the largest outbreak of Ebola in Western Africa (5). Over the years, Africa has overly relied on the West for foreign assistance in terms of vaccines, financial aid, and military aid. And this reliance was exhibited during the Ebola outbreak as the United States military led a $750 million dollar fight to eradicate Ebola by deployment of personnel and the creation of bed spaces, and various medical aid (6). Interestingly, Egypt and Ethio-

pia were the only African countries that sent substantial resources to help fight against the Ebola outbreak (7).

Fast forward to 2020, the COVID-19 pandemic has shown that resources from countries are being realigned to help aid their citizens because of the rising infection rate and the rising death. From creation of employment relief funds for those that lost access to their jobs, investment in research to help find a vaccine, increase in resources for contact tracing, increased aid directed towards mental health services. These are ways that the Western world has focused on their individual countries to help aid the burden created by COVID-19. However, from the African perspective, protocols are still being adopted based on what is done in the West without knowledge of what works for their citizens.

Insights from COVID-19 Pandemic in African communities

The effect of COVID-19 pandemic across the globe, which has caused massive death and disruption of life in the West, has seemingly not affected Africa as severely. Currently, Africa has about 4.1 million confirmed cases, as compared to 30 million and 16 million in North America and Asia respectively (8). The reduced numbers do not indicate a time of complacency, especially with the increase in the deadly and contagious variants emerging (9), rather it is imperative to unite to control the spread of this disease. A lot of African countries still lack sufficient intensive care beds and ventilators (10), with tons of overcrowding in the health care facilities. These challenges are not limited to improvement in healthcare alone. However, improvement of the quality of life which will enable less compact living and a chance to practise social distancing among neighbors. Handwashing and sanitizing are practises put in place to improve or help eradicate the spread of COVID-19, however, how can this be practised when people do not have access to clean running water (11). As mentioned earlier, Africa has been primed for a pandemic with the recent Ebola that broke out in 2014. However, they have not heeded to the writing on the wall. Africa has more experience dealing with epidemics than the West, however, insufficient investment into health research and infrastructure have limited their ability to respond to COVID-19 or develop a suitable vaccine (11). Thankfully, the Africa Centers for Disease Control has hastened its work to improve the diagnostic and monitoring capacity of the continent. This improvement has brought about a health care system that is quite durable compared to previously. However, more work needs to be done in terms of investment in a world class research and epidemiology center. Africa has developed highly educated researchers; however, majority keep leaving because of lack of funding or adequate research opportunities. Sadly, African governments contribution to research and development is very limited. In 2007, there was a signed agreement by the African Union member countries where they all committed to invest at least 1% of their GDP in research and development (12); however, this goal has remained unrealized. As of 2019, Africa's investment in research and development funding was a very low.42% of the GDP, with the global average resting at 1.7%. Presently, the ongoing COVID-19 pandemic has elucidated the dangers of minimal funding in research and development. Interestingly, Africa has 14% of the world population, but produces only 0.1% of the world's vaccines (13). This highlights the need for an increased funding from the government and, thereby will reduce the dependency on the West. Presently, 25% of people in Western countries have received a dose of the vaccine (14), compared to 0.2% in African countries (14). This showcases how Africa is at the back of the queue for receiving adequate resources during a pandemic.

One advantage that Africa has is time. Leaders in the health sector and community should see this as a perfect opportunity to act. Invest in the education of the universities by opening a state-of-the-art research institute with the aim to keep these educated individuals to lead discovery and reduce the overreliance on the West. One way this can be done is to maximize and invest in existing initiatives such as The African Centres of Excellence and African Research Universities Alliance to mention a few. Also, African universities should strategize and develop innovative ways to incorporate scientific teaching into their curriculum to reflect current world problems. This will serve as a good medium to develop research capacity and possibly standalone into self-sufficiency. Finally, governments should set a priority for science which runs beyond health ministry budgets. This will ensure adequate and sustained investment in research and development as the foundation of national security.

The recent pandemic has been an important reminder that most countries will default to protecting their nations policies during a crisis. This can thereby enhance global inequities when nations are faced with threats. Africa therefore needs to invest in her future and strengthen national research programmes and partnerships. Which side of history will you stand, invest in research, invest in education, and collaborate with the West. No one likes an over reliant partner.

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The Psychological Impact of the COVID-19 Pandemic and Rumination as an Overlooked Psychopathological Mechanism

Scott Squires[1*], Mianzhi Hu[1]

[1] Queen's University, Kingston, ON, Canada
*Author for correspondence (9sds@queensu.ca)

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Abstract

For over a year, the global coronavirus disease 2019 (COVID-19) pandemic has been humanity's greatest public health issue. During this time, clinicians and researchers worldwide have reported on the negative psychological impact due to safety measures that were implemented to curb the spread of this deadly disease (i.e., closing businesses, working from home, social distancing, quarantine, etc.). However, most of the published research about this topic has focused on complications to instrumental functioning (e.g., job loss, reduced income, shortages of supplies, increased child-care burdens, etc.), and how they lead to increased distress and reduced well-being. In contrast, little research has investigated how pandemic life has changed how we think about ourselves, our circumstances, and our futures, or how these cognitive factors have led to worsened mental health. In this article, we reviewed the literature on the psychological impact of the COVID-19 pandemic, with a major focus on the overlooked cognitive process of rumination (i.e., repetitive thinking about oneself and one's problems). We explained how rumination translated pandemic-related stress into psychopathological outcomes such as increased depression, anxiety, post-traumatic stress, and substance misuse. We also recommended strategies for mitigating the negative effects of pandemic-related rumination and provided recommendations for future directions regarding pandemic-related mental health research.

Introduction

In response to the sudden, global spread of coronavirus disease 2019 (COVID-19), governments worldwide enacted social and public health safety measures that nearly halted whole economies and drastically changed our lives. These measures included closing non-essential businesses, restricting travel, social/physical distancing, stay-at-home orders, quarantine, etc. These measures were crucial to "flatten the curve", mitigate the spread of disease, and avoid overburdening our healthcare systems. Since COVID-19 arose at the end of 2019, ~120 million confirmed cases and ~2.7 million deaths have been recorded; in Canada, these numbers are ~913k and ~22.5k, respectively [1]. Despite the tragic toll caused by COVID-19, the spread of the diseases has been largely controlled by these public safety measures. Some estimates even suggest that infection rates could have been dozens to hundreds of times higher within the first few months, had these safety measures not been implemented [2,3]. These protocols have saved many lives and protected many people from infection, but what have they done to our mental health? In this paper, we reviewed how the COVID-19 pandemic increased stress and negatively impacted mental health worldwide, paying special attention to the role of rumination (i.e., repetitive thinking about oneself and one's problems) in mediating the link between stress and psychopathology. Further, we explained how rumination can be used adaptively. Finally, we concluded with recommendations for future research about pandemic-related stress and psychopathology.

The Psychological Impact of the COVID-19 Pandemic

Around the globe, depression, anxiety, post-traumatic stress, insomnia, substance misuse, obsessive-compulsive symptoms and many other psychological problems have drastically risen during the pandemic. These problems were not only due to the stress from COVID-19 infections [4,5] or the fear of being infected [6,7], but also due to government-sanctioned stay-at-home and social restriction protocols [8-11]. Similar trends have been observed in Canada [12-14]. This is because public safety measures have led to financial insecurity and social isolation, resulting in profound socioeconomic and interpersonal consequences in the process [9,12,13]. Within the first several months of the pandemic, the number of severely depressed and anxious Canadians approximately doubled and quadrupled, respectively [12]. Additionally, ~80% of Canadian psychiatric patients reported a worsening of their symptoms, especially those with low levels of social interaction and sense of control [15]. Reports by Statistics Canada have shown that the number of Canadians who rated their perceived mental health as below "very good", on a 5-point Likert scale ranging from "poor" to "excellent", increased from 31% in 2018 to 46% and 52% in April and May 2020, respectively [16,17]. A survey from March 2021 reported that 1 in 5 Canadians were screened positive for either major depressive disorder, generalized anxiety disorder, or post-traumatic stress disorder, 68% of whom reported their mental health being worse since the start of the pandemic [18]. In other words, the public's safety has come directly at the cost of their mental well-being, not only due to increased life stress (e.g., business closures, supply shortages, etc.), but the restricted social interaction that could have helped buffer the consequences of that stress. Importantly, the psychological consequences of the pandemic have not just been observed in people required to quarantine themselves [13]; most of the same problems have been observed in people following less restrictive safety protocols as well [8-10,13,14].

There are many reasons that COVID-19 stress has led to increased psychopathology, which have received much attention in the literature (e.g., fear of infection, lack of social support, uncertainty about the future, socioeconomic changes, etc.). However, there is one overlooked mediator that might be critical for linking pandemic-related stress to psychopathology across diverse populations: rumination. After all, besides the common pandemic-related problems mentioned above, what is one thing in common across much of the population during a pandemic? It is the experience of repetitive, recurrent, cognitively demanding thoughts about these problems, which happens alongside the chronic physiological stress response to these problems. This process results in an increase in ruminative thoughts about the problems, such as how they relate to oneself and one's future. These thoughts can occupy the mind incessantly when people are alone or inactive during times of stress, which amplifies negative mood states, maintains the stress response, and increases the risk and severity of psychopathology [19-28].

It is important to highlight this distinction between the level of stress exposure and the tendency to ruminate about those stressors. This is because the level of pandemic-related stress is often outside of one's control; what may not be, however, is how often one ruminates about these stressors and in what way. The capability for individuals to learn how to control ruminative thinking means that rumination may be a good target for intervention in a way that individuals' pandemic-related problems, and indeed, their psychopathology, cannot be. Therefore, a call to emphasize rumination as an area for future pandemic-related stress research is warranted.

COVID-19 Pandemic Stress and Rumination

Rumination has many definitions across different areas of basic and clinical research (reviewed in Watkins [19] and Smith & Alloy [20]). This is because it can take on different forms (e.g., deliberate, intrusive, anger, positive, etc.) depending on many factors such as trigger (e.g., feelings, chronic stress, unattained goals, provocations, etc.), valence (positive or negative), temporal orientation (past, present, or future), and more [19-28]. While several theories of adaptive rumination exist, which are described further below, it is the maladaptive forms that are most likely to explain the link between COVID-19 stress and psychopathology.

The H-Ex-A-Go-N (Habit, Executive functioning, Abstract processing style, Goal discrepancy, Negative biases) model of depressive rumination is useful to

illustrate how maladaptive forms of rumination occur [21]. According to this model, a perceived discrepancy between one's current state and a desired goal triggers state rumination. These triggers are often negative feelings or unattained goals, but many theories posit other triggers as well, including stressful, disappointing, or anger-inducing events, intrusive memories, and more [19-28]. People typically ruminate to resolve internal discrepancies, understand their feelings, themselves, others, and the world, as well as prepare for the future. However, due to memory and executive functioning limitations, rumination often does not take on its intended form. In people with an abstract processing style especially, rumination can involve asking oneself abstract questions about ill-defined problems that have no clear answer or solution [21]. Such questions may include: "why is everyone so much more capable than I am?", "why can't I handle the stress of the pandemic better?", and so on. This process tends to produce unsatisfactory answers, amplifying negative thoughts and feelings that triggered rumination in the first place. Thinking becomes more negatively biased because of this, which can lead to negative interpretations of ambiguous information and preferential recall of negative memories. Negative mood is prolonged further as a result. This feedback loop between negative thought and mood perpetuates rumination in a vicious cycle until a satisfactory answer or solution is found – or more likely, the person learns to abandon the goal, engage in deliberate analysis, and/or structured problem solving instead of ruminating. They may also use constructive distraction strategies (e.g., behavioural activation, social engagement, etc.) to break themselves out of the cycle. Otherwise, continued rehearsal of state rumination under similar circumstances forms a habit of responding known as trait rumination [21], which is a major risk factor for many forms of psychopathology [19-28].

Few studies have directly examined how rumination mediates the effects that COVID-19 stress has on psychopathology. This is surprising given that rumination is known to be a critical transdiagnostic risk factor for many psychiatric disorders (e.g., mood, anxiety, eating, substance use disorders, etc.) [29] that have been shown to be worsened by the pandemic. Also, rumination is known to run amok in people who are less able to adaptively distract themselves from negative thoughts and feelings, especially during periods of social withdrawal/isolation and silence [24,28,30], which would be expected to occur to a large degree during the pandemic. Ye and colleagues [31] conducted a study that explicitly examines rumination as a mediator between COVID-19 stressors and their psychological consequences. Not only did they find that depressive rumination significantly mediated this association, but that this effect was stronger in individuals who received insufficient psychological support from their environment and social network. No other studies were found so far that measured pandemic-related stressors, unfortunately, but some other valuable insights are worth mentioning. In a follow-up to their previous study, Ye and colleagues [32] found that pandemic-related rumination predicted depression severity, and this effect was partially mediated by fatigue. Additionally, Arslan, Yildrim, & Aytac [33] found that anxiety about the pandemic predicted depressive rumination scores, and that this association was significantly mediated by loneliness, highlighting the negative toll that social isolation has had on psychopathological mechanisms (e.g. rumination). In another study focusing on the indirect effects of rumination, Satici and colleagues [34] found that the negative effect that participants' intolerance of uncertainty had on mental well-being was serially mediated, first by rumination, and then by COVID-19 fear. This was likely because intolerance of uncertainty about the pandemic leads to rumination and fear about those concerns, which negatively impacts mental well-being. The studies summarized above have been a good start to better understand the links between COVID-19 stress, cognitive risk factors, and psychopathology, but more work is sorely needed to understand the interplay between these factors, as well as how they arise and are mitigated by public health policies.

Improving Mental Health During the Pandemic

Several methods can mitigate the negative effect of pandemic-related rumination on mental health, in part by reducing maladaptive rumination and/or increasing adaptive rumination. First, behavioural deactivation has been frequently implicated in depressive rumination [29,35]. In general, being deprived of the opportunity to behaviourally distract oneself increases the probability of ruminating about one's current situation. To combat this, people are suggested to participate often in online and offline activities that they

enjoy, as allowed by governmental social restrictions. However, it is important to point out that psychosocial problems due to excessive rewarding behaviours (e.g., gambling, substance use, gaming, media and pornography consumption, etc.) have also been observed during the pandemic [12,36,37]. Therefore, people should be cautious about the way they choose to distract themselves from their ruminative thoughts. Behavioural activation is a big component of rumination-focused cognitive behavioural therapy (RFCBT), a new form of CBT that targets the process of thinking rather than its contents, as in traditional CBT [38].

Second, mindfulness-based therapy (MBT) and mindfulness-based stress reduction (MBSR) are effective treatments for depressive rumination [39,40]. Mindfulness-based interventions aim to develop a nonjudgmental perspective towards oneself and one's current situation by utilizing techniques such as body scan, Hatha yoga, walking meditation, and more [40]. These traditional meditation techniques can be used to reduce maladaptive rumination, but more importantly, people are encouraged to try learning acceptance of their current situation and form a nonjudgmental view towards the pandemic when not meditating as well. Third, actively seeking information from a limited number of official sources is helpful to reduce the uncertainty about the pandemic [41,42]. This is because unofficial channels, such as social media, are filled with conflicting information during public crises like COVID-19. When people are not able to distinguish useful information from rumors, the ambiguity adds to their stress [42] and potentially their tendency to ruminate.

Finally, it may be possible to learn adaptive rumination strategies instead of maladaptive ones for handling stress. When revising the widely used Ruminative Response Scale (RRS), Treynor and colleagues [43] discovered that depressive rumination was made up of reflective pondering and brooding; reflection was thought to be a constructive process in which people introspect about their experience and productively look for solutions. Watkins [44] also conceptualized rumination as having some adaptive outcomes. Experiential self-focused rumination, which focuses on one's negative self-experience and problems in a detail-oriented way, was thought to promote recovery from stress [45]. Repetitive thought research has also revealed that rumination can lead to adaptive preparation and planning, recovery, and increased health-promoting behaviours in some circumstances [19].

The question then becomes how to make rumination adaptive. According to Watkins [19,44], maladaptive forms of rumination are characterized by abstract, over-general processing, whereas adaptive ones aremore concrete and specific, thus allowing thinking to be constructive. In the context of COVID-19, people are encouraged to spend more time thinking about solutions to specific problems (e.g., academic disruption, supply shortage, social restrictions, etc.) instead of asking vague questions such as "why is this happening to me?". Taking control of rumination in this way is another major component of RFCBT [38]. Other suggestions to resist negative psychological impacts of COVID-19 include maintaining satisfactory interpersonal relationships, particularly family relationships, cognitively focusing on the positive side of the pandemic, and recognizing the transience of the crisis [40,45,46].

Future Directions and Conclusion

Before closing, it is worth highlighting some important limitations of the current research about the psychological impact of COVID-19, along with future directions in this research area. First, current knowledge about the psychological impact of COVID-19 is difficult to generalize across studies. Rather than comparing the psychological impact of COVID-19 across diverse groups, most research has been either based on samples selected from limited geographic areas (e.g. China and Canada), or focused on one group from a particular area (e.g., college students, nurses, workers, etc.). So vulnerable groups may be properly treated during the pandemic and afterward [47], it is imperative that future studies compare the cognitive processes and outcomes underlying the psychological impact of COVID-19 among a variety of demographic populations. Moreover, research so far has focused predominantly on a small number of mental health outcomes, such as depression, anxiety, and PTS, with little priority given to the understanding of maladaptive cognitive processes (e.g. rumination) that may lead to the psychological distress and subsequent psychopathology. Indeed, it has been suggested that a thorough investigation of a diverse set

of brain functions and cognitions is needed for us to understand the short- and long-term psychological impacts of this pandemic [47]. We echo that sentiment here with specific focus on cognitive risk factors like rumination. Second, research about the psychological impact of COVID-19 has also been too broad. It has often investigated high-order constructs (e.g., mental wellbeing, mental health, distress, etc.) without differentiating their subtypes. For instance, researchers have failed to account for the heterogeneity of rumination (e.g., depressive rumination, angry rumination, positive rumination, etc.), often treating it as a unidimensional construct instead. However, different kinds of rumination have different effects on mental well-being, and thus treating it as unidimensional is inappropriate. Indeed, we recently observed this in a study we are preparing for publication, in which we found that rumination only mediated the associations of COVID-19 stress with depression and anxiety if the thoughts about the pandemic were intrusive, involuntary, and ongoing, occurring regardless of one's effort to suppress them (i.e., intrusive rumination). Deliberate rumination was reported more highly in people with greater COVID-19 stress as well, but unlike intrusive rumination, this did not mediate the associations that stress had with depression and anxiety. This differentiation highlights rumination's heterogeneous structure and the imperative to study its subtypes separately. A detailed understanding of specific cognitive risk and resilience factors is critical, such as maladaptive and adaptive forms of rumination, respectively. As described above, these processes can be targeted through psychological intervention more directly than broadly defined constructs such as "well-being", "distress" and even "depression" (e.g., rumination-focused cognitive behavioural therapy, behavioural activation, etc.) [30,38,48]. Understanding the core distinctions between different types of rumination is required to understand how they should be treated.

Third, more research should be directed toward understanding practical public and mental health concerns, including how to mitigate the negative mental health consequences of the pandemic, improve psychological and social interventions, and counteract the negative effects of social media on psychopathology (e.g., by reducing exposure to fear-inducing pandemic-related stimuli) [47]. Some scholars have proposed that social and behavioral science can be incorporated to help with our understanding [49]. Evaluating factors such as cultural influence, moral decision-making, and political polarization may inform us about which strategies work in different social contexts and with different groups [49].

Finally, most studies have been using cross-sectional self-report data. The correlational nature of these data limits our understanding of directionality between stress, cognitive process, and psychological distress. Given the unpredictability of the outbreak of COVID-19 and social lockdown practices during the pandemic, it has been difficult for researchers to accurately obtain retrospective data from before the pandemic or use longitudinal procedures to infer the directionality or time course of effects. If we can overcome these difficulties and compare participants' responses over time and relate them to the severity of the safety measures put in place at different times, we can characterize and improve our social reintegration and mental health trajectories during the post-pandemic recovery period.

In conclusion, the social restrictions and safety procedures implemented by governments worldwide to control the COVID-19 pandemic have saved many lives, but they have also severely impacted the mental health of a significant portion of the population. A significant but overlooked cognitive mediator of psychopathology due to pandemic-related stress is the tendency to maladaptively ruminate about that stress. The dearth in the literature about this mechanism is inopportune, given that rumination is a transdiagnostic factor that likely explains much of the pandemic-related increase in psychopathology. Moreover, rumination is readily targetable by a variety of psychosocial treatments and self-help strategies that could be implemented as complementary public health policy. More research is required to establish which kinds of rumination mediate and mitigate the effects that different pandemic-related stressors have on psychopathology. Information about these mechanisms is crucial for our mental health recovery during the rest of the pandemic and beyond; without it, we will not be prepared for the psychological impact caused by the next pandemic or large-scale emergency.

Resources

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Stigma: The Overlooked Side of COVID-19

Tishani Sritharan[1*]

[1]Queen's University, Kingston, ON, Canada
*Author for correspondence (17ts11@queensu.ca)

Abstract

Coronavirus disease 2019 (COVID-19), a new viral illness that is part of the same family as the severe acute respiratory syndrome (SARS) coronavirus, has globally infected millions of people. The COVID-19 pandemic has created fear and anxiety within society and resulted in detrimental impacts such as social stigma toward certain groups. These groups include individuals who have contracted the virus, individuals of certain backgrounds, those associated with COVID-19 patients and healthcare providers. It is important to understand the process of stigma to develop more effective interventions; this can include utilizing a psychoeducational and behavioural modification approach to ease disease transmission and patient suffering. Globally, a collective effort needs to be made to increase education, improve the knowledge and attitudes related to COVID-19 and aid in the reduction of social stigma. Local and national teamwork and communication is important to work efficiently; transparency is key to alleviate fears and reduce stigma and discrimination by addressing general and specific concerns about COVID-19. Understanding stigma in the context of COVID-19 is essential to increase awareness of its negative consequences and to recognize that education can improve health care and outcomes for this disease.

Coronavirus Disease 2019 (COVID-19) and Stigma

Coronavirus disease 2019 (COVID-19), a new viral illness caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, has globally affected millions of people [1]. The virus can be transmitted through airborne particles via coughing and sneezing, touching surfaces with viral contamination or close contact with an infected individual [4]. Research is being conducted on the origins of the virus; some believe that the virus originated in Wuhan, China, as a result of the first known case being reported in Wuhan [5]. To this date, the search for concrete evidence on COVID-19 and its origin is ongoing. Determinants such as access to healthcare, economic security, neighbourhood and housing conditions, and availability of resources can make certain individuals more vulnerable to the virus. COVID-19 has created fear and anxiety within society and has resulted in negative consequences such as social stigma toward certain groups, including infected individuals, individuals of specific nationalities, those in contact with COVID-19 patients and healthcare providers. When an association is developed with COVID-19 and a nationality, group or person, stigma can occur. Stigmatized individuals can then show signs of social avoidance and avoidance to health care. For example, many individuals living with mental illness recognize the associated stigma and discrimination, and thus develop this fear of being labelled negatively, leading to distrust in the healthcare system. It is important to understand the process of stigma for its reduction, to develop more effective interventions and improved health care, and thus reduce disease transmission and patient suffering [2]. To understand how education can improve health care and outcomes for COVID-19 and to increase awareness of the negative consequences of stigma, it is crucial to understand stigma in the context of COVID-19.

History of Stigma

The term "stigmatization" specifies negative connotations. Stigma originates from the Greek word stigmata, which is defined as a mark of shame [6]. In Ancient Greece, stigma originally represented a brand to mark slaves or criminals [7]. Goffman defines stigma as a discrediting trait that reduces someone from society's definition of "a whole and usual person" to a "tainted, discounted one" [21]. Essentially, negative views are attributed to a person with characteristics perceived

as being different from societal norms [8]. The process of stigma involves labelling, separation, stereotype awareness, stereotype endorsement, prejudice, and discrimination [6]. A definition of stigma has not been agreed upon, and so Link and Phelan put forward their classification of the stigma process, where stigma exists when certain elements that are connected unite [9]. First, human differences are recognized and labelled. Secondly, the labelled individuals are associated to negative stereotypes by dominant cultural beliefs. Thirdly, a separation of 'us' versus 'them' is created by placing the labelled individuals into distinctive groups. Fourthly, status loss and discrimination experienced by the labelled individuals lead to unfair consequences [9]. This process then results in societal disapproval, rejection, exclusion and discrimination, and can be harmful to an individual's overall welfare and recovery, as they may face many barriers that directly stem from stigma [10]. This can have varying impacts on the person's well-being, causing challenges to their support system, employment, mental health treatment etc. [6]. Researchers Pryor and Reeder built on previous theories and formulated a conceptual model illustrating four connected indicators of stigma: social stigma, self-stigma, stigma by association and structural stigma [11].

Social (Public) Stigma

Social stigma is defined as negative or excluding behaviours exhibited by the public towards a person or group of people who share certain characteristics, creating barriers for these individuals. These discriminatory attitudes are driven by false views set in place by the public [12]. Such stigma within the social framework results in inequality in access to basic and essential services. Social psychologists identify three models of public/social stigmatization: socio-cultural, motivational, and social cognitive models. The socio-cultural model suggests that stigma is developed to justify social stereotypes, prejudices, and discrimination, which give way for the public to identify and label people with illnesses as being unequal. On the other hand, the motivational model focuses on the basic psychological needs of people. For example, research suggests individuals living with mental illnesses are generally in lower socioeconomic groups, and this can lead to being labelled aslower in standard. Lastly, the social cognitive model stems off a cognitive framework for the society, so that an individual with an illness would be labelled in a category different from those that are not ill [13]. Research has found that increased apparent social stigma prevents individuals from recognizing the importance of seeking assistance or being committed to their current treatment plans [14]. Moreover, increased apparent social stigma has been linked with an increase in individuals who attempt to self-treat an illness. This prevents the individual from having a secure social support system, thus hindering recovery [15]. COVID-19 can cause individuals to feel socially stigmatized due to fear of judgement from the public, leading to avoidance of virus test centers. It is crucial to reduce the levels of public discrimination as it can ease the perceived stigma, thereby allowing stigmatized individuals to come into acceptance of their diagnosis and seek medical treatment [16].

Self-Stigma

Crocker established that stigma is not only present in society, but it can also be internalized by the stigmatized individual [13]. Self-stigma occurs when individuals are aware that stigma is present within the society, and thereby associate these discriminatory stereotypes to themselves, even if the individual has not been directly stigmatized [8]. This results in detrimental effects on a person's self-esteem and self-efficacy, possibly resulting in them giving up on various aspects of life [17]. This phenomenon was termed the "why try" effect that states that as one accepts the self-sigma, it directly translates into feelings of helplessness, hopelessness and lower quality of life [18]. The idea of self-stigma was further explored in modified labelling theory, stating that the expectation of becoming stigmatized and being stigmatized are factors that influence the psychosocial well-being of an individual [19]. Specifically, it is the fear of being labelled that causes an individual to feel stigmatized, provoking an emotional response (e.g., embarrassment, anger or isolation). When self-stigma is present, people tend to feel ashamed and guilty, their confidence and motivation are lost, avoidance tactics are used, and individuals start to withdraw from themselves. Self-stigma is usually developed through three stages, with the first stage being the awareness stage in which individuals become aware of the discriminatory behaviour towards them. Next is the agreement stage, where individuals begin to accept that the negative stereotypes directed at them are true.

The last stage is the application stage, in which individuals begin to apply the negative beliefs on themselves, leading to behavioural change [18]. Individuals infected with COVID-19 can be hesitant in disclosing screening results out of fear of blame from recognizing the stigma and discrimination seen through media and other platforms; this may result in self-stigma and diminished self-worth. According to Corrigan et al., it is vital to challenge self-stigma at the agreement stage, prior to the adoption of unhealthy behaviours and a change in personal identity [19,20]. When an individual does not internalize the negative stereotypes surrounding them, neither their self-worth nor their quality of life will diminish. This will allow stigmatized individuals to feel empowered to fight against stigma.

Stigma by Association

Research suggests that individuals associated with stigmatized individuals can be stigmatized simply because they are connected or related to that individual [23]. This process of stigma is coined as "courtesy stigma" or "associated stigma" [21,22]. Due to stigma by association, family members of the stigmatized individual may experience many everyday struggles, including financial problems, time-consuming activities, missed career opportunities and family quarrels, creating family burden. Family burden and stigma by association together can be key causes of psychological distress and reduced quality of life of family members. Stigma by association also affects how those associated with a stigmatized individual view them, thereby negatively impacting their relationships [23]. Individuals living with and taking care of family members who have tested positive for the virus can feel discriminated against due to avoidance and fear from others. Stigma by association and family burden not only affects the quality of life of family members but also loops back and affects the well-being of those stigmatized individuals.

Structural Stigma

The stigma construct was only recently expanded beyond the individual (self-stigma) and interpersonal (social stigma) levels, to include larger macro-social forms of stigma [24]. Link and Phelan were among the first to distinguish between individual or self-stigma and structural stigma [9]. Structural stigma is formed through policies of larger entities or institutions (e.g., companies, schools, healthcare systems), which place restrictions on the opportunities of stigmatized individuals [19]. During the COVID-19 pandemic, travel restrictions to and from certain countries have been imposed, which has led to increased panic and stigma towards the residents of those places.

Cases of Stigma During COVID-19

Stigmatized individuals may not partake in strategies to mitigate the disease due to the fear of further being stigmatized: these strategies include COVID-19 testing, following mask mandates and social distancing recommendations [4]. In Africa, preventative measures such as being tested and wearing a mask have led to individuals being ostracized and bullied [25]. Healthcare workers in Africa are also experiencing stigma due to being associated with treating COVID-19 cases [26]. For individuals with Asian descent, there has been an increase in hate crimes. Media has shown evidence of COVID-19-related threats, attacks, bullying, derogatory language and hate speech [27]. Preventative strategies, such as wearing a mask or covering of face, have caused fear of racial profiling and harassment of Black American men by law enforcement [25]. Since there is still ambiguity surrounding COVID-19, there has been fear in communities and stigma that has caused discrimination and attacks against defenceless individuals. Infected individuals as well as those in close contact have been criticized and even likened to criminals. Media reports have shown evidence of health care workers being assaulted and shunned due to fear that they can contract the virus [28]. Due to this stigma, not only can the spread of the virus increase when individuals refuse to be tested in fear that they may contract the virus from healthcare workers, but there can also be an increase in mortality rate from both the assaults against healthcare workers as well as untreated COVID-19 patients. When individuals infected with COVID-19 feel alone and afraid to seek help and/or get tested, they can suffer with both the physical illness itself as well as internalized negative thoughts, which can ultimately be fatal. There can be a delay in the detection of infectious individuals when stigmatized individuals fear testing positive for the virus and instead isolate themselves to avoid blame, discrimination and being ostracized. This can delay diagnosis in which time the infection can turn severe [29].

Conquering Stigma

In the mid-1950s, even with significant theoretical literature, anti-stigma interventions did not receive much attention in the research field; this did not change until almost half a century later [30]. Altering the deeply rooted, stigmatizing attitudes and behaviours of society continues to be a long-term and challenging task. To our knowledge, most anti-stigma programs that exist to this day focus on the public aspect of stigma, but what is critical in the recovery of stigmatized individuals is the overcoming of self-stigma. Individuals should not only be educated on how to conquer social stigma but should be given the tools to overcome the self-stigma that has been bestowed upon themselves. Psychoeducation involves providing diagnosed illness information to patients and can help promote a union where the patient becomes an active collaborator in treatment. The goal is to improve a patient's illness management skills through mutual disclosure of relevant information [31]. Psychoeducational programs can offer coping strategies, symptom management, suicide prevention, improvement in social function, work opportunities and improvement of quality of life [32]. These strategies are important for those with an illness in reducing stigma while in a group setting, where individuals can develop rapport to practice new skills through new knowledge and self/public disclosure. Individuals who have been associated to COVID-19, whether that be through family members or being infected themselves, should take part in treatment to feel empowered by knowledge surrounding the virus and help others with this information. Behavioural modification therapy involves changing undesirable behaviours into desirable ones by providing the necessary tools. Overtime, self-stigma can be eradicated with these tools being put into practice, opening a path to recovery that may have been invisible before. COVID-19 patients, with these tools, will feel empowered to recover and learn to cope with and overcome the stigma surrounding them. An opportunity for those suffering from stigma to develop coping strategies and move towards recovery can be provided through a stigma course that adopts a group psychoeducational and behavioural modification approach to stigma management. The general population will also need to be educated to improve the knowledge and attitudes related to COVID-19 and aid in the reduction of social stigma. Media has played an enormous role in the COVID-19 stigma towards certain groups of individuals, and so local and national teamwork and communication is important to work efficiently. Transparency is key to alleviate fears and reduce stigma and discrimination by addressing general and specific concerns about COVID-19 [3].

Conclusion

Stigma can create detrimental barriers not only for the stigmatized individuals, but also globally in eradicating the virus. These discriminatory attitudes are causing inequality in access to basic and essential services and can be very harmful to an individual's recovery. It is important to understand stigma to develop effective interventions to mitigate disease transmission. Anti-stigma interventions and educational programs will need to be put into action to initiate recovery of both individuals affected and populations globally. It is crucial that future research avenues include the assessment of stigma experiences of those who have survived COVID-19, as well as commencement and evaluation of pilot studies of anti-stigma interventions to determine efficacy. Whether it be social stigma, self-stigma, stigma by association or structural stigma, all facets are impacting individuals during the COVID-19 pandemic and mitigating this impact of stigma is critical in strengthening our community for unity and survival during this unprecedented time.

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A Bestiary of COVID Conspiracies

Aleksandar Vujin[1*], Kevin Dick[2]

[1]McGill Univeristy, Montreal, QC, Canada; [2] Carlton University, Ottawa, ON, Canada
*Author for correspondence (aleksandar.vujin@mail.mcgill.ca)

Abstract

An infodemic of false information and conspiracy theories has followed closely in the wake of the ongoing COVID-19 pandemic, exacerbating the public health disaster. In order to curb their spread and counter their effects, conspiratorial beliefs must be catalogued and understood. Drawing on examples from social media video and audio sharing platforms, we provide a non-exhaustive list of conspiratorial beliefs related to the COVID-19 pandemic, and categorize them into three groups: A) beliefs concerning the motivation of the conspirators, including bringing down a rival nation-state, bringing about planetary depopulation, and/or imposing global tyranny; B) beliefs concerning the nature of the COVID-19 disease, including that the disease is made-up, that its impact is exaggerated, that it is caused by a bioengineered virus, and/or that it is caused by a non-viral agent; and C) beliefs concerning the public health response, including that masks and vaccines are harmful to health, and/or that vaccination is an insidious way to track and control the population. We conclude by reflecting on the necessity of tracking and understanding the continuously evolving epistemic ecosystem of pandemic-related conspiracist beliefs in order to implement effective strategies to "quarantine" harmful conspiracy theories and "vaccinate" individuals against conspiracism.

Introduction

In the wake of the accelerating pandemic of COVID-19, such an extraordinary number of conspiracy theories arose that the World Health Organization (WHO) Director-General Tedros Adhanom Ghebreyesus declared that "We're not just fighting an epidemic; we're fighting an infodemic"(1). Conspiracy theories can have a real impact on health, interpersonal relationships, and safety even in the absence of a global public health disaster [2], and the need to catalogue and understand them is all the more pressing during a pandemic. In this paper, we review some of the most widespread conspiratorial beliefs related to the pandemic and categorize them into three groups: A) the motivation of the conspirators; B) the nature of the disease; and C) the nature of the public health response. Through examples from each category, we provide a non-exhaustive but representative snapshot of the epistemic ecosystem generated or influenced by the worldwide spread of COVID-19.

The list of conspiracy theories was compiled by a selective keyword search to identify the original source publication (where possible; a sufficiently similar surrogate document was considered as an alternative) for each belief considered in this work. This generated a non-exhaustive, yet representative set of documents to analyse further. Among identified posts, publications, tweets, and articles, select statements considered most salient to the individual beliefs comprising that conspiracy theory were tabulated in Appendix Table 1. The inclusion criteria of each statement of each document required one or more of the set A beliefs as well as at least one or more of the set B and/or set C beliefs for inclusion within our analysis (discussed later). The union of all beliefs from all statements of a given document was produced to summarize the belief set represented in that document. The following sections define each of these A,B, and C sets of beliefs.

A: Beliefs concerning the motivation of the conspirators

The first set of beliefs is concerned with providing an explanation of *why the conspirators have effected the*

pandemic, regardless of what the nature of the disease is. Three views on the motivation of the perpetrators are particularly illustrative: i) to smear or damage a rival nation-state or ideology; ii) to reduce an excessively inflated world population; iii) to curtail civil and political liberties and bring economic destitution to the population.

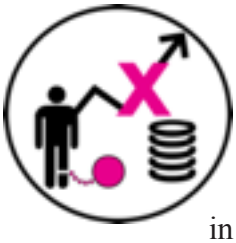
A.i: A weapon against national rival(s)

The view that COVID-19 is a form of biological warfare is exemplified by theories that it was weaponized by the United States against the People's Republic of China or vice versa (3). In March 2020, as the epidemic in China was being contained with great and costly effort and the initial wave of cases in the US was rapidly growing, ordinary citizens and state officials in both superpowers had slung accusations in the direction of the other. The belief that COVID-19 was introduced to China by a US military athlete participating in the 2019 Military World games in Wuhan spread among Chinese social media users in March 2020 (4), and was amplified by Lijian Zhao (5), a Chinese foreign ministry spokesperson. Conversely, the view that SARS-CoV-2 may have accidentally escaped from a laboratory in Wuhan was promoted by US Senator Ted Cruz (6). President Donald Trump, who in March 2020 repeatedly referred to SARS-CoV-2 as "the Chinese Virus" (7), later echoed these views, suggesting in April 2020 that the virus may have been mistakenly or intentionally released from a Chinese laboratory.

A.ii: A means of planetary depopulation

The view that the pandemic has been organized by a shadowy global elite or a secret world government to depopulate the planet is an updated iteration of existing conspiracist beliefs. In the 1990s, far-right organizations in the United States, including the John Birch Society, interpreted the text of a non-binding United Nations (UN) sustainable development action plan known as Agenda 21 as an outline of a UN-organized political takeover of the planet which would include both the destruction of the American way of life and depopulation through mass murder in order to create a collectivist environmentalist dystopia (8). Such views are mirrored in the 1994 book "The World Government Conspiracy: Russia and the Golden Billion" by the Russian economist and conspiracist, Anatoly Kuzmich Tsikunov (9). In Tsikunov's scenario, the depopulation plot of the world government is ultimately prompted by an impending global Malthusian catastrophe. The pandemic itself or the public health response have been incorporated into these or similar narratives as the tools of the conspirators (10,11). Vaccination in particular has sparked fears of this kind, with social media posts decrying Bill Gates' vaccination advocacy (12) or the lack of vaccine safety data in pregnant women or data regarding effects on fertility (13) as indicators of a depopulation plot.

A.iii: A way to impose global tyranny



Closely related to and indeed often paired with the purported depopulation agenda is the view that the pandemic represents a means with which to curtail civil and political liberties and bring economic ruination to society in order to impose authoritarian rule. Like the beliefs on depopulation, such views are essentially recycled forms of earlier ideas about the purported "fascist", "socialist", or "tyrannical" takeover and the abolition of democracy. One popular Facebook post emblematic of this belief connects the COVID-19 "plandemic" with supposed Agenda 21 goals to abolish personal and economic liberties, including "the end of national sovereignty", "the end of all privately owned property", and "government raised children", among others (14). While beliefs about the other motivating factors discussed above are not likely to be supported by anything in the believers' lived experience, the belief in an authoritarian takeover is perhaps bolstered by the public health response and the economic fallout of the pandemic. Even liberal democracies adopted strict and illiberal disease control measures, including lockdowns, inter- and intranational travel restrictions, and in some cases mobile phone surveillance, in the name of the public interest of outbreak control (15). The resulting impact on economic security was devastating, with the World Bank estimating that ~100 million people worldwide may be pushed into extreme poverty (16). These developments may thus have lent a degree of believability to otherwise outlandish claims concerning Agenda 21.

B: Beliefs concerning the nature of the COVID-19 disease

Other beliefs that constitute pandemic conspiracy theories concern the nature of the disease itself. Four views are most illuminating, if far from exhaustive: i) the disease is entirely made-up; ii) the disease is caused by a natural virus, but its impact is greatly exaggerated; iii) the disease is caused by bioengineered virus (whether created from scratch or modified from a natural virus); and iv) the disease is caused by another (non-viral) agent.

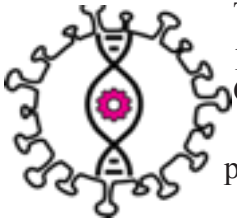
B.i: The disease does not exist

The view that there is no COVID-19 disease is exemplified by a video which claims that the pandemic is a media driven hoax perpetrated on a global scale in order to serve as a cover for the inevitable collapse of the current economic system (17). The video alleges that the virus was never isolated and that its existence has never been proven. It also claims that all deaths are being recorded as COVID-related, and that healthy people and even non-biological substances are testing positive because the tests are not specific and are really detecting "RNA viruses" and "genetic material". In March 2020, the belief that the pandemic is a hoax started being promoted by social media posts using the hashtag #FilmYourHospital. Self-described "citizen-journalists" undertook to record the activity in hospitals in order to demonstrate that the healthcare system is not under strain and that therefore there is no pandemic (18,19). Between March 28 and April 9, more than 40 thousand users on Twitter had posted or retweeted using the hashtag (20), and similar incidents of hospital filming were still being reported in February 2021 (21).

B.ii: The impact of the disease is exaggerated

A somewhat less radical view than the disease being a complete fabrication is the belief that it is caused by a natural virus, but that its impact has been greatly overhyped. In a video posted on Youtube in March 2020 (22) Wolfgang Wodarg, a German physician and former parliamentarian, spoke out against what he saw as excessive pandemic panic caused by politicians and profit-driven scientists. He questioned whether the new virus was truly novel, alluding to data from a publication showing that coronaviruses are commonly isolated from patients with respiratory disease (23), but failing to differentiate between SARS-CoV-2 and common cold-associated CoVs to which the data shown was referring (229E, NL63, and HKU1). While accepting the possibility of a new virus, he stressed that its impact was unknown. A narrative then developed questioning the severity of COVID-19, with social media posts claiming that it is no more dangerous than the flu (being deadly only to people with serious health conditions) (24) or even that it is killing 14 times fewer people than the flu (25) or is less deadly than a common cold (26). Dolores Cahill, an Irish immunologist and Euroskeptic politician, has also claimed that COVID-19 has the same death rate as "normal influenza" and that the public health response is causing more harm than good (27).

B.iii: The disease is caused by a bioengineered virus



The view that bioengineering has played a role in the origin of SARS-CoV-2, making it in effect a bioweapon, is another common element in pandem-ic-related conspiracy theories This belief was bolstered by the findings of a study posted on BioRXiv in January 2020, which identified a high degree of similarity between a number of short sequences in the SARS-CoV-2 Spike protein and in the HIV proteins gp120 and Gag (28). A subsequent analysis found no evidence of these sequences being HIV-specific since they are also present in other eukaryotic and even prokaryotic viruses, as well as in CoVs closely related to SARS-CoV-2 (29). However, despite these conclusions and the withdrawal of the original BioRXiv paper, the original findings have been echoed and amplified as direct evidence of a laboratory origin of SARS-CoV-2 by Luc Montagnier, a French virologist who received a Nobel Prize in 2008 for his work on the discovery of HIV (30). While professor Montagnier has made controversial claims in the past (including the existence of "water memory" and "DNA teleportation") (31), in April 2020 social media posts also attributed the claim of SARS-CoV-2 being "not natural", "manufactured", and "completely artificial" to the Japanese Nobelist Tasuku Honjo, which he denied in a statement released by Kyoto University (32).

B.iv: The disease is caused by a non-viral agent

Perhaps the most bizarre set of beliefs regarding the nature of COVID-19 is that it is caused not by a virus, but another agent or toxin. These beliefs are often but not exclusively predicated on the claims by the German virologist Stefan Lanka, who denies the existence of pathogenic viruses (33). A video by the US psychiatrist Andrew Kaufman, posted on YouTube in late March 2020, is particularly illustrative on the range of purported non-viral disease agents (34). While acknowledging that some people are getting sick and that therefore there exists "some kind of insult that occurs and causes the damage", Kaufman claims that a virus has never been isolated, that RT-PCR detects non-specific endogenous nucleic acid molecules, and that electron micrographs of SARS-CoV-2 virions instead represent exosomes (lipid-based extracellular vesicles). In Kaufman's view, the unknown causative agent induces the production of exosomes ("indistinguishable" from the virus) whose physiological role is to "soak up the toxins like a sponge" and remove them from the body. Among the possible causes of the disease, he lists poisons or toxic substances, stress and fear, "regular" flu or cold (and "whatever causes those"), electromagnetic radiation caused by 5G infrastructure, and possibly a combination of these and other causes. In the first few months of the pandemic, the claim that 5G is responsible for COVID-19 has gained substantial traction on social media, starting off with the supposed temporal connection between the 5G rollout in Wuhan and the first COVID-19 cases, later being supplemented with a mechanism ("5G destroys oxygen"), and eventually leading to physical attacks on 5G towers in the UK and elsewhere (35).

C: Beliefs concerning the public health response

Finally, a third set of beliefs that represent a common constituent of COVID-19-related conspiracies are those concerning measures taken to combat the pandemic, particularly mask-wearing and vaccination. Two views are emblematic: i) vaccines and/or masks are actively harmful to health or human dignity; and ii) vaccination represents a nefarious way to mark and track individuals, thus controlling their lives and destinies.

C.i: Vaccines and masks are harmful

The belief that vaccination is harmful is a key tenet of the anti-vaccination movement that existed long before the pandemic and has not subsided in its wake (36). One social media post has described a COVID-19 vaccine as "rushed, dodgy, unlicensed" (25) while another has claimed that the vaccine will affect the DNA, react with electromagnetic frequencies, damage the brain, and cause sterility, cancers, and dementia (37). The development of RNA and DNA vaccines for COVID-19 in particular has promoted fears that they represent an insidious way for human genetic editing, with the virus denier Andrew Kaufman stating that "they want to make us into genetically modified organisms" (38). COVID-19 vaccines have also been portrayed as containing ingredients which may be seen as abhorrent or harmful to human dignity. In one video (39), the AstraZeneca vaccine is claimed to contain lung tissue from an aborted fetus, a conclusion based on the mistaken assumption that the human embryonic cell line MRC-5, which was used to test vaccine mRNA expression, is actually a constituent of the vaccine. Such concerns are echoed in the not-strictly-conspiratorial opposition to vaccines developed using cell lines from electively aborted fetuses, which was voiced early in the vaccine development cycle by several faith groups opposed to elective abortion (40). Roman Catholic groups in North America have been particularly vocal, with the Diocese of Bismarck (North Dakota) declaring the Janssen vaccine "morally compromised" (41). The official doctrinal position of the Roman Catholic Church, however, has declared such vaccines morally acceptable in the absence of alternatives (42).

In addition to vaccines, face masks have also been the subject of conspiratorial belief. As public health agencies started recommending the wearing of face masks, claims that masks may be harmful started appearing on social media, including that mask wearing "reduces oxygen up to 60%" and "increases risk of CO2 poisoning" (43), or that "people who wear masks are actually "collecting" the virus in their masks" (44).

C.ii: Vaccines are a way to mark, track and control people

Apart from the view that vaccines are directly harmful to health or dignity, the pandemic has also spurred the belief that vaccination may be used to mark, track, and/or otherwise control individuals and populations. Under one theory, vaccination is a merely ruse, with the real goal being a massive implantation of subdermal radio-frequency identification (RFID) microchips to achieve tracking and control. This belief pre-dates the current pandemic, but has gained substantial traction on social media in the early months of the disease's global spread (45). It has two main variants: in the secular form, RFID chipping is seen as a way for a New World Order or similar nefarious secret society to control people's lives; in the religious form, RFID chipping is equated with the "Mark of the Beast", described in the Apocalypse of John (13:16-17) as a mark on the right hand or forehead without which it would be impossible to conduct economic activity. While some social media posts only present the secular version (e.g., "everything about you will be tracked and stored for later use") (46) others contain both secular and religious elements (e.g., "the COVID-19 vaccine [...] will contain RFID chips [...] The Bible says you will break out into boils.") (47). Some posts go further and ascribe to the chip (or, sometimes, nanomachines/nanocomputers) (48) a control function that goes beyond tracking, such as making birth control possible by allowing remote manipulation of contraceptive hormones in women's bodies (49). Although lacking the aspects of real-time tracking and direct biological control, the concept of granting special privileges to holders of "vaccine passports", or certificates of vaccination, also features in conspiratorial narratives of state control and limitation of rights. Some jurisdictions, such as Israel and New York state, have already implemented special privileges (e.g. access to entertainment venues) for holders of vaccination certificates, while others are debating the feasibility of their implementation (50). The currently limited vaccine supply, the unequal geographic and socio-demographic distribution of vaccines, and the lack of clear data on vaccine efficacy regarding virus transmission have prompted debates on the ethical permissibility of vaccine passports (50). The WHO position statement released in February 2021 advises against an explicit requirement for vaccine passports for international travel on ethical, legal, and scientific grounds (51). Anti-vaccination groups have echoed and amplified these concerns. One salient example is the March 2021 "position paper" from Vaccine Choice Canada, which concludes that vaccine passports represent "a coercive and unconscionable violation of the rights and freedoms of Canadians", while at the same time dismissing approved COVID-19 vaccines as "medical devices" which are not really vaccines since "they function through the injection of synthetic genetic technology" (52).

Discussion

Conspiracist beliefs like those mentioned above represent building blocks of full-fledged conspiracy theories. Under one definition offered by the Merriam-Webster dictionary, a conspiracy theory is "a theory that explains an event or set of circumstances as the result of a secret plot by usually powerful conspirators". Using this definition, a pandemic-related conspiracy theory would have to include at least one belief concerning the plot (discussed above as the motivation of the conspirators) and one belief about the event (in this case the nature of the disease or the nature of the public health response). Many pandemic-related conspiracy theories shared on social media or video sharing websites contain more beliefs than this basic minimum (Table 1 presents some examples). Conspiracy theories sometimes include contradictory beliefs (e.g., "there is no virus" and "COVID is the flu"), with one study (53) suggesting that this can occur when mutually incompatible beliefs are independently associated with a belief in a "cover-up" by the authorities.

One analysis has suggested that three psychological motivators play important roles in conspiratorial beliefs, including a desire for a stable and accurate worldview (epistemic motivation), a desire for safety and autonomy (existential motivation), and a desire to maintain a positive view of oneself or the in-group in the wider society (social motivation) (54). In periods of crisis, such as the ongoing COVID-19 pandemic, fear and uncertainty increase such motivators leading to a rise in conspiratorial beliefs (55). Demographically, conspiratorial beliefs are more common among people with lower incomes, lower educational attainment, weaker social networks, and ethnic minorities (56) - in short, the most disadvantaged persons in society.

Table 1 - Breakdown of Beliefs Underpinning each Conspiracy Theory Source

Source	A: Motivation of the Conspirators			B: Nature of the COVID-19 Disease				C: Concerning the Public Health Response	
	Damage Rival Nation/Ideology	*Reduce World Population*	*Damage Liberties/ Economy*	*Disease is Made-Up*	*Natural virus, but Exaggerated*	*Bioengineered Virus*	*Caused by Another Agent*	*Vaccines/Masks Harmful*	*Vaccines Mark/Track Individuals*
	A.I	A.II	A.III	B.I	B.II	B.III	B.IV	C.I	C.II
Ref.: (12)		X				X		X	
Ref.: (13)		X						X	
Ref.: (14)	X	X	X			X		X	X
Ref.: (17)	X		X	X			X		X
Ref.: (24)			X		X			X	
Ref.: (25)					X			X	
Ref.: (26)			X	X	X		X		X
Ref.: (27)			X	X	X			X	
Ref.: (37)	X	X		X	X		X	X	X
Ref.: (39)			X			X		X	
Ref.: (40)		X	X					X	
Ref.: (41)		X			X			X	
Ref.: (43)			X						X
Ref.: (44)		X	X						X
Ref.: (45)				X				X	X
Summary	20.0% (3/15)	46.7% (7/15)	60.0% (9/15)	33.3% (5/15)	40.0% (6/15)	20.0% (3/15)	20.0% (3/15)	73.3% (11/15)	46.7% (7/15)

Conclsuion and Recommnedations

As first introduced, a considerable challenge of the next months and years may be in combatting the infodemic along with the pandemic itself. Some parallels may be drawn between the approaches used to combat a viral pandemic and those recommended herein to counter the conspiracist infodemic. First, "anti-viral therapies" and "quarantining measures" in the context of an infodemic would mean curbing the spread of conspiracy theories through fact-checking initiatives and vulgarization of legitimate information with links to verified official sources. Three of the largest social networks, Twitter. YouTube, and Facebook have implemented fact-checking initiatives to curtail the spread of misinformation specific to the vaccine, however their efficacy has been repeatedly questioned (64). Secondly, "vaccination" in the context of an infodemic might mean rendering an individual "immune" to conspiracy theories. To that end, the populations most susceptible to conspiracism should be provided with widespread access to free education, social programs, and resources in order to improve their ability to consume and critically evaluate information. As stated in (59): "Facts Are the Most Potent Antidote". Where the former can be accomplished in the immediate to near future, the latter is necessary in the mid- to long-term future through government policy. Finally, much like a naturally evolving virus, it is of critical importance to follow how conspiracy theories evolve within a population, in order to produce more effective "antidotes" based on the nature of evolving beliefs. Exemplified in this work is both the nebulous nature of conspiracy theories as they have evolved over the past year and the difficulty of providing a definitive categorization. This "bestiary" illustrates what a beast it is to track original sources of conspiracy theories as many primary sources are deleted from social media, necessitating archival platforms. In summary, it is our hope that this work may orient future research into the conspiracy theories of the COVID-19 pandemic and provide a framework for future studies on conspiracism.

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Rest of references are available upon request

NEWS

Biosurveillance in the Time of COVID-19

BY KARISSA BECKNEL

The cracks in our current Western healthcare systems split and collapsed under the pressure of the COVID-19 pandemic. New variants of SARS-CoV-2 eluded much of modern science and medicine. With doctors and scientists scrambling for solutions, the general public was forced into controlled confinement for longer than any of us ever imagined. Most importantly, the COVID-19 pandemic has unearthed a startling revelation in our healthcare system: how can we prepare and quickly adapt to an ever-changing ecosystem?

Photo credit Lakshmi Puri

Development of biosurveillance methods increased to address to the challenges of the COVID-19 pandemic

Since the acceleration of climate change, events like pandemics may increase in likelihood and occurrence [1]. Archaic forms of viral and bacterial strains once encased in glaciers may be re-introduced into our current ecosystem[2]. Some of these ancient pathogens are unknown to modern science and medicine[2], thus we are not fully equipped to handle unknown viral outbreaks on such a large scale. This situation, coupled with the massive loss of biodiversity, places humans in a difficult coming reality. Many diseases can be transmitted between species through the consumption of infected animals, contaminated water, and being bitten. A process termed zoonosis, in which a communicable disease jumps from non-human animals to humans, is estimated to account for approximately 75% of infectious diseases[3]. Some even theorize COVID-19 originates from a pathogen jumping from bats to humans[3]. In an effort to address these coming challenges, the development and use of biosurveillance methods has increased. Biosurveillance is the systematic way in which disease outbreaks are detected, monitored, and analyzed[4]. Biosurveillance adds more layers of depth in disease detection and analysis proving it effective for long-term technical use. Imagine a network where each node consists of a various entity (sector, persons, or system). These nodes comprise a large interconnected system whom's role is to examine potential or imminent biological threats. The more nodes within the network, the better the system at detecting and tracking. Most importantly, biosurveillance is a continuous process since disease outbreak is largely covert in nature, and the people responsible for measuring changes in the environment must be ready to plan a course action when needed[4].

The most important of these methodologies involves the use of artificial intelligence and machine learning. Artificial intelligence and machine learning have pioneered the ways in which epidemiologists and scientists' study communicable disease pathology. Machine learning can identify specific treatment regimens for various disease models, and these systems can also extrapolate and compare prior techniques in the process of intervention for a disease outbreak. Moreover, we

can model ways in which a communicable disease will behave over time. Effective modelling is an invaluable technique in tracking communicable diseases and requires many variables to realistically simulate the efficacy of disease outbreaks in a community[5]; indeed, these models are highly complex. The common sources of information that power these models are national databases such as EpiSpider, BioCaster, and HealthMap[6]. If you wonder how these large databases collect data, look no farther than your smartphone. Many utilize popular media sites to extract common elements or keywords from users worldwide[6]. Not surprisingly, prominent organizations,like the National Institute of Health (NIH), are making significant progress in developing mathematical models by creating large interconnected research communities[7]. Within the NIH, the Fogarty International Centre's Division of International Epidemiology and Population Studies (DIEPS) created the Research and Policy in Infectious Disease Dynamics (RAPIDD) program[7]. RAPIDD consists of a collaborative research network and focuses on infectious disease modelling. This program made significant strides researching transmission routes and risk factors of the Ebola and Zika epidemics; in addition, they are identifying emerging disease threats from zoonotic and non-zoonotic pathogens[7]. By solving leading research questions such as human behaviour and mobility during disease outbreaks, they are also able to create innovative methodological approaches to advise policy makers[7]. Disease-outbreak predictions do not simply serve as likelihood estimators, but as the degree of detriment or degree to which a population will be infected[5]. Some diseases raise more concern than others since some diseases may only be life-threatening to a subset of the population. With the rise of particularly concerning variants of COVID-19, some of which are much more contagious[8], experts are utilizing artificial intelligence within genomic studies. Investigating the viral or bacterial genome involves genome sequencing to specify each genetic code. Mutations in genetic code happen acutely, especially for viruses[9]. At particular points in time, a viral vector can be at its highest potency for infection and replication[9]. Some even hypothesize that an algorithm which predicts genotype-based antibiotics can provide specific clinical diagnoses[10]. Every bacterial or viral organism has its own genetic fingerprint which makes genotype-sequencing a daunting yet crucial task. Creating a genomic intelligence system will arm officials with specific spatiotemporal information in preparation for a potential disease outbreak. Databases such as the Global Initiative for Sharing All Influenza Data (GISAID) are uncovering the sequence code for different strains of COVID-19[11]. This database in particular, pools many clinical, epidemiological, and gene sequencing data to create an overarching picture of current or potential viral outbreaks[11]. As many strains of COVID-19 as possible are sequenced to uncover the genetic code for each, thus allowing us to synthesize target therapies and procedures for combating this disease[12].

Just last year, researchers discovered a particular mutation which increased the infectivity of COVID-19; this mutation happens to be responsible for the spike protein of SARS-CoV2 found in Europe and the United States[8]. Machine learning coupled with genome sequencing will continue to uncover more about the coming COVID-19 strains. In fact, there is great possibility that the burgeoning strains will bypass some antibodies provided in current vaccines. Initial small-scale studies have suggested that Moderna and Pfizer vaccine efficacy is greatly reduced for some new SARS-CoV-2 variants[13]. Despite this, the building of large data-sharing networks have immense potential to accelerate the discovery and development of novel therapeutics and clinical treatment protocols before the onset of communicable disease global outbreaks. In the future, as the landscape of infectious disease begins to change and the emergence of novel disease outbreaks become more commonplace, there remains immense potential for the capacity of machine learning to improve the landscape of communicable disease research and biosurveillance. In preparing ourselves for all possibilities, we are also learning to save lives.

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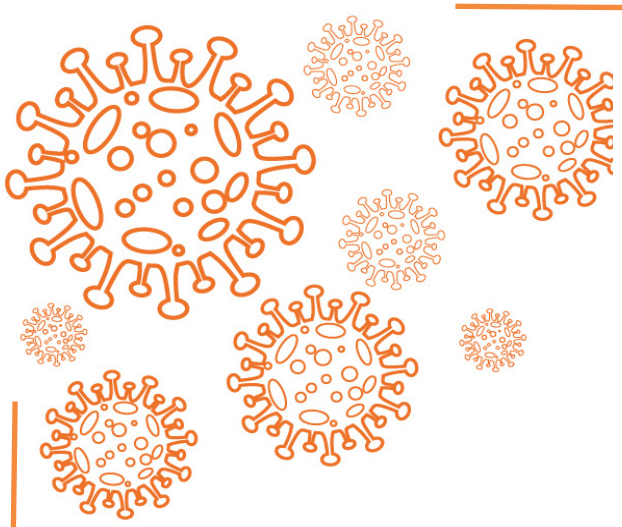

Obesity as a risk factor for severe COVID-19 outcomes

BY EVELYN K. HENNEKAM

Since the COVID-19 pandemic exploded in Canada over a year ago, perhaps the most vital question for Canadians looking to gauge their personal health risk is this: why do most COVID-19 patients experience relatively innocuous symptoms like fatigue, dry cough and fever while approximately 10% of affected individuals develop severe conditions like pneumonia and respiratory failure that require hospitalization (1,2)? What determines whether an individual is likely to be infected by the SARS-CoV-2 virus, and what factors increase their risk of death from the disease? Answering these questions begins with an understanding of the virus that causes COVID-19, which is classified as a severe acute respiratory syndrome coronavirus (2). Coronaviruses like SARS-CoV-2 belong to a group of viruses that are responsible for a spectrum of upper-respiratory tract infections, including some as mild as the common cold (2). However, there is little that is mild about COVID-19; since the virus began spreading in Canada, 930,500 people have been infected and at least 22,643 people have died (3).

Among those most severely affected are adults over 80 years of age; this age demographic has by far the highest proportion of both hospitalizations and deaths (approximately 32.6% and 69.0%, respectively) (4). The likelihood of a COVID-19 patient being admitted to the ICU also increases dramatically with age; adults in the 60-69 age group are over 5 times more likely to be admitted than adults half that age (4). Unsurprisingly then, a great number of global studies have found age to be the greatest risk factor for a severe COVID-19 outcome (2). While aging is unavoidable, an alarming number of studies have found obesity, which is preventable, to be a major risk factor associated with the severity of a patient's COVID-19 symptoms (2). Obesity is the second strongest, independent predictor for COVID-19-related hospitalization worldwide. A recent study of 383 patients found that obese individuals are 140% more likely to develop severe pneumonia (2). In addition, obese individuals of any age are more likely to test positive for SARS-CoV-2 than individuals with a lower Body Mass Index (1). This correlation is likely a direct result of the fact that obese individuals have more adipose (or fat) tissue and therefore more receptors that facilitate SARS-CoV-2 infection than individuals of a healthy weight (5). The internalization of the SARS-CoV-2 virus happens via the integral membrane protein angiotensin-converting enzyme 2 (ACE2), which is more highly expressed in adipose tissue than in other COVID-19-targeted tissues like the lungs and heart (5,6,7,8,9). Thus, the excess fat which characterizes obesity makes obese individuals more likely to be infected by COVID-19 (9).

Interestingly, high-fat diets are thought to increase the expression of ACE2 in adipose tissue (6). A dietary study involving mice found

that one week of consuming a 60% fat diet significantly increased the expression of ACE2 in adipose tissue by nearly three-fold as compared to mice fed a low-fat diet (6). This robust difference was maintained over the extended study period, during which time the expression of ACE2 in the heart did not change (6). This data suggests that individuals consuming high fat diets are also more likely to be infected by COVID-19 due to the increased number of SARS-CoV-2-receptors in their cells (9). Beyond increasing the chances of initial infection, the excess of highly ACE2-expressing adipose tissue in obese individuals is also likely to serve as a reservoir for SARS-CoV-2 viral particles during the period when the patient is contagious (1,5,9). In this respect, COVID-19 is similar to the Influenza A (IAV), H1N1 and Human Immunodeficiency (HIV) viruses, wherein()the latter are just two have been found in the adipose tissue of obese individuals and have been demonstrated to shed the viral particles causing person-to-person transmission for 42% longer than individuals of healthy weights (5).

Once infected, obese individuals are also more vulnerable to severe COVID-19 symptoms and death due to the excess weight on their lungs, which are then additionally stressed by the SARS-CoV-2 virus (7). As a respiratory virus, SARS-CoV-2 primarily attacks the lungs, causing air sacs to fill with fluid and airways to become inflamed and narrowed (5,7,10). As such, COVID-19 patients need increased oxygen intake, which many hospital staff achieve by placing the patient in the prone position (7,10). Multiple observational studies have suggested that the prone position improves oxygenation, or the amount of oxygen in the lungs, as well as the amount of circularinng oxygen in the blood by opening parts of the lungs that would otherwise be compressed by the weight of the chest (11).

Photo credit Juanmonino

Obese individuals are more vulnerable to COVID-19 symptoms than others

However, the benefits of the prone position have been found to be significantly challenged when caring for COVID-19 patients suffering from obesity (7,11). These patients, therefore, carry a greater respiratory burden that may have lethal consequences (7). Unfortunately, this correlation between obesity and COVID-19-related death is particularly high in the 20-39-year age group, which also has the highest rate of viral infection in Canada (4,12). In fact, a cohort study in Italy found a significant inverse correlation between increasing age and body mass index (BMI); in other words, younger COVID-19 patients who are obese are more likely to develop severe symptoms and die than older obese patients (1). Although the precise reason for this correlation is unclear, it is likely that the effect of obesity in older COVID-19 patients is eclipsed by the effect of tions that become more prevalentn with age (7). Nevertheless, the fact that obese 20-39-year-old adults are at increased risk of death by coronaviruses like SARS-CoV-2 is extremely concerning, especially given that 20-39-year-old Canadians account for nearly 35% of the country's total case count (4,12).

In light of this growing body of knowledge, greater emphasis should be placed on informing younger Canadians about the COVID-19-related dangers of obesity. Increased social discourse surrounding improved public health messaging on obesity prevention and management in Canada has the potential to positively propel knowledge transfer. Internationally, similar initiatives in Norway, Denmark and Japan have worked to encourage and improve healthy eating habits in younger children (13). While these measures would have direct public health benefits, additional initiatives in Canada should also be focused on supplementary training for health care providers. Indeed,

this was identified as the greatest barrier to obesity treatment by the World Obesity Federation (14). At a workshop in 2018, the National Academies of Sciences, Engineering and Medicine identified "lack of knowledge and awareness" as the second most important barrier to obesity prevention worldwide (14). Therefore, by going beyond its current measures of listing obesity as a COVID-19 risk factor, Canadian leaders and policy makers in public health should consider implementing the online COVID-19 weight management program Drop 5 Mission (15,16).

Direct advertising campaigns that outline the health risks and prevalence of obesity, as well as those which provide specific examples of what Canadians can do to maintain a healthy lifestyle, such as maintaining a Body Mass Index of 18-25, eating more than 5 servings of fruits and vegetables per day and exercising for 30 minutes five times a week, are tangible examples of what the Canadian government can do to increase knowledge and awareness (17). By helping increase social discourse around obesity and COVID-19 risk in this way, individuals and communities can be better protected from adverse ancillary health outcomes in future pandemics. Indeed, as the number of Canadians suffering from obesity is set to increase to approximately 8.54 million by 2023-2024, Canada needs to prepare for the potential ancillary health consequences of future viral pandemics by addressing obesity as another ongoing heath crisis (18). After all, history has set a grim precedent; obese individuals have a higher risk of death from COVID-19, just as they did during the 1918, 1957, 1968 and the 2009 Influenza pandemics (1). As such, Canadians should consider maintaining a healthy weight as a means of reducing their risk of death from the next viral pandemic.

"Obesity is a modifiable risk factor of COVID-19 and one goal of public health bodies should be to achieve a healthy weight at the population level that might reduce adverse outcomes of COVID-19."

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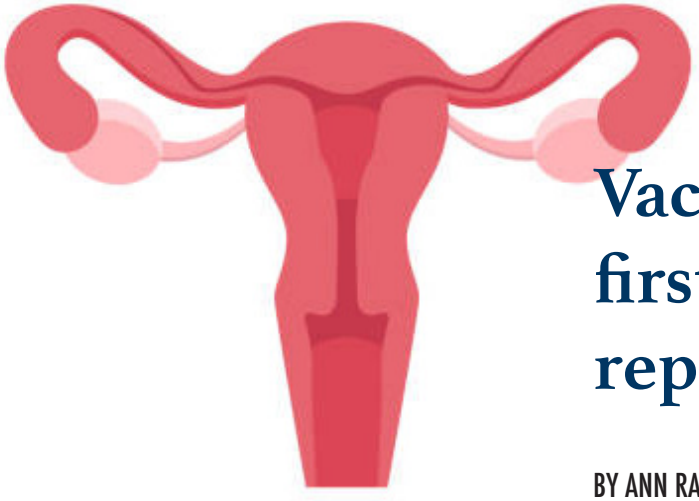

Vaccines are not the only first-line defense against reproductive tract infections

BY ANN RAM

Menstruation is a naturally occurring physiological process in which menstrual practices and sexual health education are impacted by cultural and socio-economic factors. In rural areas of developing nations, people of reproductive age are not prepared or aware of menstrual hygiene management (MHM) and the importance of maintaining reproductive health which becomes known as a global issue called period poverty. Menstrual hygiene management entails the use of clean material to collect blood with the facilities to change in privacy, wash and dispose of used menstrual hygiene materials (Budathoki, 2018). Impediments to proper MHM stems from cultural influence and economic status, which includes misconceptions and personal preferences. In addition, menstruation and the concept of reproductive health are shrouded in shame and societal taboos (Kaur, 2018). For example, over decades and in various nations, menstruation and its misconceptions have ranged from mystical, toxic, and impure (Wood, 2020). Certain cultural norms require secrecy and deter women from working, cooking, participating in intercourse, bathing, and eating specific foods during menstruation which stem from the perceptions that menstrual blood is contaminating and unclean (Drakshayani, 1994). These beliefs and restrictions enforced by society are the forefront barriers for good menstrual hygiene practices. The education of both men and women about reproductive health and hygiene is crucial but not implemented in certain rural areas which promotes fear, embarrassment and false beliefs about menstruation and sexual health. Young girls that are unprepared and anxious about their menarche are likely to develop negative attitudes about menstruation and their overall reproductive health (Budathoki, 2018). Due to these misconceptions, girls in particular countries of south and southeast Asia and Africa, stay away from flowing water during menstruation, do not use toilets in fear of staining it, and skip school (Kaur, 2018). The materials used as menstrual blood absorbents in low-income countries range from commercial pads and tampons, paper towels, bamboo to reusable pads repurposed from cloth which can be sanitary or unsanitary depending on the wash and drying facilities available (Kaur, 2018). However, reusable cloths and towels are more commonly reported to be used due to socioeconomic factors and the costliness of commercial menstrual hygiene products which women often have to sacrifice menstrual hygiene over other necessities of life such as food (Nabwera, 2021, Kaur, 2018). Whether it be a low- or high-income country, young people affected by period poverty often display absenteeism of 1 or more days of school during their menstrual cycle which can begin to negatively impact their education and in some parts of the world students would miss approximately a fifth of their school year or drop out (Miiro, 2018, Davis 2018).

When menstruators cannot access hygienic absorbents, proper wash and disposal facilities and a holistic education about their reproductive health, it poses risks of reproductive tract infections (RTIs) and other serious long-term health issues. The burden of RTIs is a major pub-

lic health concern around the world and is rampant among low-income settings (Cousins, 2020, Sumpter 2013). Poor MHM breeds endogenous infections such as bacterial vaginosis or vulvovaginal candidiasis (Sumpter, 2013). These infections are most likely introduced to the reproductive tract through poor menstrual hygiene products and lack of clean washing amenities (Cousins, 2020). In a low-income urban area of India, RTIs were significantly associated with the use of cloth rather than sanitary menstrual absorbents where 76.7% used cloth during menses in a study with 802 women (Bhilwar, 2015). These easily treated endogenous infections can become problematic as they are associated with increased risk of human immunodeficiency virus (HIV) and human papillomavirus (HPV). Another prevalent issue in developing nations, is HPV and associated development of cervical cancer. Cervical cancer and precancerous cervical lesions can arise from certain oncogenic HPV strains (Burd, 2003) and is the fourth most common cancer afflicting women in the world with more than 86% of deaths occurring in low- and middle- income countries (Arbyn, 2020, Dey, 2016). Rampant rates of HPV have been related to poor menstrual hygiene and lack of reproductive health education (Dey, 2016). Many studies and initiatives are focused on the first-line response to control HPV and vaccination, however secondary factors related to cervical cancer development, such as menstrual and reproductive hygiene, are studied less (Dey, 2016). The consequence of poor MHM propagates the advancement and persistence of RTIs and is associated with aiding the development of cervical cancer (Dey, 2016, Franceshi, 2003, Abulizi, 2017, Cousins, 2020). Another secondary factor that increases the incidence of HPV and associated cervical cancer is the lack of awareness and sexual health education in certain countries (Hindin, 2015). Commonly in wealthier countries, HPV vaccines, such as Gardasil, were instilled in large-scale use in public healthcare systems and national vaccination programs, usually through schools to adolescents (Koulouva, 2008, Graham, 2011). However, this was not easily translated in low- and middle-income countries, as vaccines are not available through mass vaccinations programmes (Agosti, 2007, Graham, 2011). The main barrier to equitable distribution of HPV immunization is cost since these countries have limited health budgets that is already strained to cover multiple public health priorities (Brisson, 2020). Recently, certain low- and middle- income countries, such as Bangladesh, Uganda, and Sri Lanka have invested in HPV vaccinations; however, traction of immunization is low which is an effect of poor public awareness of HPV and lack of enforcement of reproductive health education for men and women (Banik, 2020, Kadian, 2020, Nabirye, 2020, de Silva, 2019). Research indicates that the poor vaccine intake, particularly of women in rural areas, is related to lack of sexual health education in terms of cervical cancer, hygiene, and Pap testing (de Silva, 2019, Banik, 2020, Nabirye, 2020).

Photo credit Flo

Feminine hygiene is important to avoid reproductive tract infections

Studies conducted in Ethiopia and India indicate that regular changing of menstrual blood absorbents was protective against the risk and development of RTIs (Ademas, 2020, Pandit, 2017). Also, it has been reported that women who use disposable pads were less likely to develop RTIs than women who use reusable pads (Das, 2015). Findings of these studies amplify the need for accessible sanitary products for menstruators as it directly affects their health and is a preventative action for possible infections and disease. Furthermore, in terms of RTIs such as, HPV, in rural areas only 5.3% of women had been vaccinated against HPV, however the willingless to be immunized was high (76.6%) among those who have not received the vaccine (Banik, 2020). Research has found that the core reasons for the reluctance of women to receive

the HPV vaccine fall to the cost of the vaccine (40.1%), particularly in countries with no universal health care or national vaccination programmes, and the lack of knowledge towards reproductive health (40.1%) (Banik, 2020). This emphasizes the need for educational intervention and awareness programmes on menstrual hygiene and cervical cancer, while supplemented by the implementation of national policies for mass HPV vaccinations that provide accessibility for vulnerable populations.

Currently, initiatives by government bodies have made great impact in diminishing poor MHM and promoting sexual health awareness. Recently, New Zealand announced that menstrual products would be free in schools, while India is pushing to cap the price of sanitary products. Little leeway has been done for low- and middle-income countries, however, global non-profit initiatives, such as UNICEF and Days for Girls, have made strides in these countries to fight period poverty and provide empowerment and reproductive health education to people in need. In Canada, the "tampon tax" was eliminated, however education and health is regulated provincially, so there is less cohesion with government to address MHM. In 2019, British Columbia made period products free in all schools and currently some Ontario school boards have begun to implement this as well. However, to fully eradicate the inaccessibility of MHM in rural and vulnerable communities of Canada enactment of financially accessible or free menstrual products need to stretch nationally or provincially. Moreover, countries tackling HPV and cervical cancer continue to strive to apply immunization programmes interwoven with targeted educational interventions to improve awareness. Governments have begun cervical cancer and HPV awareness training of nurses, social workers, teachers in rural schools, and female representatives to further help educate their community about HPV, cervical cancer risks and hygiene as a primary preventative measure when nation-wide immunization is unavailable or inaccessible to all socioeconomic backgrounds (Nabirye, 2020, Kadian, 2020). Overall, period poverty and the lack of sexual health education is not just a health issue but a human rights issue. The global imperative by the World Health Organization (WHO) is to fulfill empowerment to people of reproductive age, specifically those in vulnerable situations, by reducing the taboos and stigma about menstruation by providing accessibility for proper MHM practices and promoting sexual health education.

"In 2020, Scotland became the first country to make menstrual products free and designated public places must also make these products freely available, as outlined in "The Period Products (Free Provision) Bill"."

During the COVID-19 pandemic, the hard-won gains against HPV has begun to recede. Amongst COVID-19, HPV and other infectious diseases still continue to be fought and yet to have a uniform and effective implementation of the vaccines that are already created to eradicate these other silent killers (Abel, 2020). Despite having HPV vaccines validated and mass produced, nearly 341,831 people die from cervical cancer in 2020 (Cancer Today, 2020). This poses the question as to why vaccinations rates are low and implementation fragile in high- and low-income countries despite decades of research (Abel, 2020). This is further aggravated by the COVID-19 pandemic where HPV vaccine orders and deliveries have dropped by >70% in March 2020 and remained decreased by 25%-50% in June of that year (Gillkey, 2020). The pandemic's timing causes missed opportunities for mass delivery of HPV immunizations that usually take place during spring and summer months for adolescents (Moss, 2016, Gillkey, 2020). The COVID-19 pandemic is likely to have longer term consequences for HPV vaccination since there will be a reduction of face-to-face interactions that will limit the chances for providers, either through clinics or schools, to educate, discuss and deliver the vaccines (Gillkey, 2020). To overcome both the challenges of the pre- and present COVID-19 era, there must be evidence-based interventions executed. HPV vaccination promotion and awareness should be applied whenever providers have opportunities to make recommendations to parents of adolescents (Gillkey, 2020), for

example doctor check-ups and informational leaflets given through schools. Providing information was crucial during the pandemic to promote awareness and decrease fear, which can be translated seamlessly to preventing reproductive tract infections by decreasing taboos and anxiety associated to sexual health. Also, similar to the COVID-19 vaccine rollout, HPV immunization can get back on track by clinics providing reminders that communicate COVID-19 precautions and assure parents that vaccines are freely available or covered under programs for countries without universal health care. Also, COVID-19 immunization initiatives have shown a creative aspect for mass vaccinations which can be applied to HPV vaccination protocols to prevent the regression of HPV immunization rates. This can be implemented using "drive-through" appointments through patients' existing communities or family clinics and by offering HPV vaccine alongside seasonal influenza vaccinations (Gillkey, 2020). Learning from the pandemic and the COVID-19 vaccine rollout programmes, there must be a prioritized effort to bring long-term protection against diseases like HPV and associated cervical cancer as essential services. As the COVID-19 vaccines are tested and delivered its imperative to acknowledge that there are vaccines for HPV that is yet to be used to its full potential despite the 15 years of rigorous research displaying its safety and efficacy (Abel, 2020). From the momentum garnered from the collective bout against COVID-19, a similar framework can be used to improve reproductive of health by applying reproductive health education and vaccinations in tandem to eradicate reproductive infectious diseases.

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ASK AN EXPERT

COVID-19 Trials with Dr. Michael Grant

BY DR. MICHAEL GRANT

Michael Grant received his PhD in Molecular Virology and Immunology from McMaster University. He is a professor of Immunology and Infectious Diseases at Memorial University of Newfoundland. His main interest is the immunology of viral infection with a focus on human immunodeficiency virus, hepatitis C virus, cytomegalovirus and most recently, SARS-CoV-2, the cause of COVID-19.

Your current project includes investigating antibodies of participants who think they may have contracted the virus. Could you briefly describe this project? What about these antibodies in particular interests you?

Our research involves investigating humoral immunity (antibodies) against SARS-CoV-2 in persons who recovered from COVID-19 with illness severity ranging from asymptomatic to requiring hospitalization. We also recruited close contacts of confirmed cases and people who believed they may have contracted SARS-CoV-2 but never tested positive. Features of the antibody response against SARS-CoV-2 directly relate to the role of immunity in protection from infection or from illness. The first question we posed is how does the antibody response against SARS-CoV-2 relate to illness severity? The consensus from previous studies, corroborated by our data, is that persons with more severe cases of COVID-19 make stronger antibody responses against SARS-CoV-2(1-3). Of concern is whether weaker antibody responses associated with mild illness leave persons at risk for re-infection with the possibility of more severe illness. The second question we are addressing is how stable is the antibody response against SARS-CoV-2? Previous studies were contradictory with some reporting rapid decay of antibody levels and others reporting stability(1-6). In our study, confirmed cases infected in March and April 2020 had high levels of antibodies when first tested in November 2020, and these levels were stable over the following three months. Stability of the response is also a key issue with vaccinees for gauging the duration of protection following vaccination. We are now enrolling vaccinees into our study to compare the strength and stability of their responses to those of recovered persons. So far, we have observed responses similar to those of persons recovered from severe cases of COVID-19. In parallel, we are studying functional features of anti-SARS-CoV-2 antibodies such as virus neutralization, antibody dependent cell-mediated cytotoxicity and antibody dependent enhancement of infection. These features relate to the strength, fine specificity and protective efficacy of the antibody response.

Dr. Michael Grant

As Newfoundland has had remarkably low COVID-19 infections compared to other provinces, are you concerned about participation numbers? How has the response from the public been since your call for participants late last year?

While Newfoundland was fortunate to have relatively few

cases during the first wave of COVID-19, persons with confirmed infection enthusiastically joined the study to learn what sort of immune response they had made. We also identified 15 cases of recovery from COVID-19 where people were in close contact with a confirmed case, but were negative for SARS-CoV-2 RNA at time of testing by public health.

"Many people volunteered for the study because they believed they may have had COVID-19 and wanted confirmation"

Almost all turned out negative for antibodies against SARS-CoV-2, but testing them now provides us with pre-vaccination baseline samples for our expanded study of vaccinees. This part of the study is growing rapidly with the ongoing vaccine rollout and the second wave of COVID-19 hitting Newfoundland relatively hard in February 2021. More recovered persons and others who think they were exposed are volunteering for the study, and virtually exclusive infection with the B.1.1.7 variant in St. John's during the second wave offers a unique opportunity to compare immunogenicity and study cross-neutralization of the different strains.

Are there similar projects in other parts of Canada? How are you collaborating with other teams at the Canada's COVID-19 Immunity Task Force?

Research groups across Canada linked through the Canadian Immunity Task Force were funded to study different aspects of immunity against SARS-CoV-2 following infection. We share protocols, data and perspectives regularly and will employ consensus protocols in future studies of the vaccine response against SARS-CoV-2. While a standardized format to study antibody responses can be readily agreed on by multiple labs, best methods for addressing complex aspects of cellular immunity against SARS-CoV-2 following infection or vaccination remain a work in progress. There is nothing comparable to an antibody neutralization assay that applies to cellular immunity against SARS-CoV-2. Thus, discussions are ongoing regarding the optimal application of flow cytometry, enzyme-linked immune absorbent spot (ELISPOT) and other platforms to study cytokine production, cytotoxicity, proliferation and memory formation by SARS-Cov-2-specific T cells.

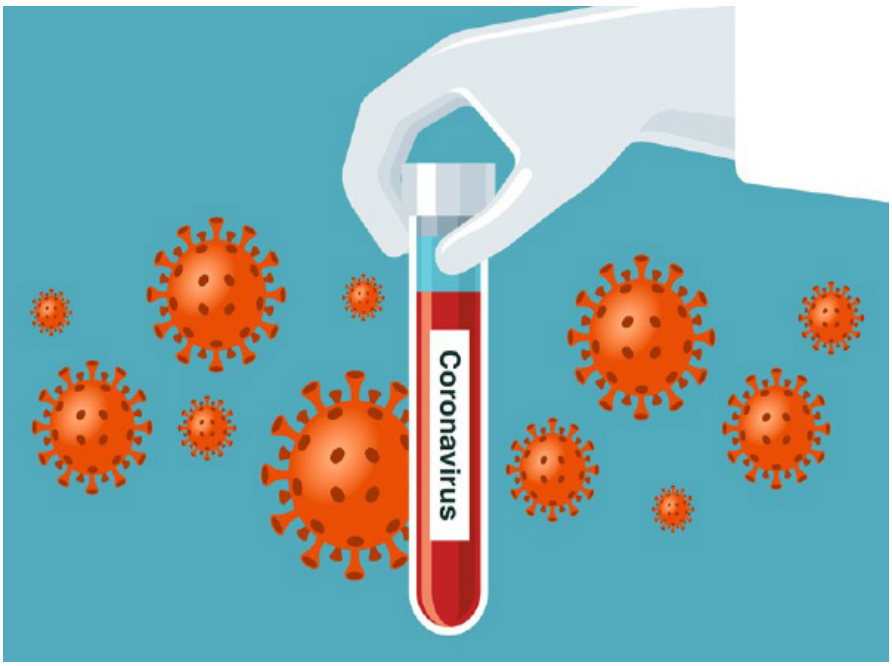

Photo credit Nature Medicine

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COVID-19 mRNA Vaccines

BY MATTHEW S. MILLER[1] & KAYLEIGH MELCHER[1]

[1] Michael G. DeGroote Institute for Infectious Disease Research, McMaster Immunology Research Centre, Department of Biochemistry and Biomedical Sciences, McMaster University, Hamilton, ON, Canada

How are mRNA vaccines unique compared to other commonly administered vaccines (such as a live-attenuated or inactivated virus), and are there differences in how mRNA vaccines are evaluated for safety/efficacy?

Many common vaccines contain inactivated ("killed") viruses or live-attenuated viruses. Live-attenuated virus vaccines are composed of genetically manipulated viruses that are incapable of causing disease in healthy individuals. In contrast, mRNA vaccines encode a viral protein. Upon delivery into the cell, the mRNA is translated into a viral protein which is typically expressed on the surface of these cells. This elicits an immune response against the viral protein, ultimately leading to protection against future infection. The COVID-19 vaccines developed by Pfizer/BioNtech and Moderna use this technology to deliver mRNA into cells that encode for the SARS-CoV-2 spike protein.[1,2]

Although the process of development and approval of COVID-19 vaccines was expedited, the standards used to evaluate the safety and efficacy of SARS-CoV-2 mRNA vaccines in clinical trials were largely the same as commonly administered vaccines. The accelerated COVID-19 vaccine development process was facilitated by modifications in how vaccines are reviewed: "rolling reviews" by regulators in real-time, rather than regulators waiting until the end of the trial to review all data. Companies were also willing to assume increased funding risks for these large clinical trials due to the urgent need for COVID-19 vaccines globally. Although mRNA vaccines had not been approved for widespread human use before this pandemic, they have been studied in humans for more than a decade against viruses such as influenza, Ebola, and Zika.[3] Clinical trials have also been performed to evaluate mRNA vaccines as treatments for specific forms of cancer, including melanoma7 and prostate cancer.[8]

Photo credit RF Studio

It is important to inform the public that the vaccine development has gone through the same regulatory process as other vaccines

With the possibility of virus mutation, what factors might impact vaccine efficacy, and do you think current vaccines will offer the same level of protection from novel strains of COVID-19?

Since the current COVID-19 mRNA vaccine encodes only the spike protein, mutations that result in antigenic changes to the spike could influence vaccine efficacy. When tested against the UK variant (B.1.1.7), the mRNA vaccine showed no significant reduction in antibody responses.[4,5] However, reduced spike binding by antibodies was observed when

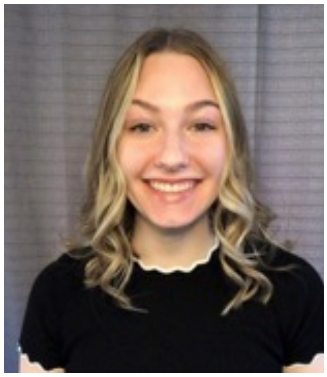
the vaccines were tested against the South Africa (B.1.351) and Brazil (P.1) variants.[4,5] It is not entirely clear the extent to which reductions in antibody binding influence vaccine effectiveness. While most current studies have focused on antibody-mediated responses, T cell response must also be considered. Preliminary studies suggest that T cell responses are much less impacted by variants than antibody responses, indicating that they may still provide sufficient protection despite reduced antibody binding.[6] Another important factor to take into account when evaluating vaccine efficacy is that immunity is not binary. A vaccine that does not completely protect against symptomatic infection may still be very effective at preventing severe disease.

What may explain vaccine hesitancy/pushback from the public and in your opinion, how could scientists and/or politicians better address these concerns?

In our modern, virtual world dominated by social media, there is a plethora of misinformation circulating about vaccine safety and efficacy. It can be difficult for non-experts to untangle this web of misinformation, so it is critical to help the public determine how to identify credible sources of information. The safety profile of COVID-19 mRNA vaccines is excellent. Participants in clinical trials for both mRNA vaccines displayed the same types and general frequencies of acute reactions typically experienced after administration of common vaccines that have been approved for years/decades (i.e., pain/swelling at the injection site, fatigue, etc.).[1,2] Any severe adverse effects seen in these trials were extremely rare. The general public is not familiar with the vaccine evaluation and approval process, leading many to believe the accelerated approval of COVID-19 vaccines somehow compromised safety evaluation. An important way we can address vaccine hesitancy is by explaining how this process was expedited without compromising safety. By conveying reliable scientific information to the public in an accessibly way, scientists and politicians can provide reassurance that the protective benefits of these highly effective vaccines outweigh the minimal associated risks.

About the Authors

Dr. Matthew S Miller is an Associate Professor in the Department of Biochemistry and Biomedical Sciences at McMaster University. He completed his BMSc and PhD in Microbiology and Immunology at the University of Western Ontario, and a postdoctoral fellowship in Virology at the Icahn School of Medicine at Mount Sinai in New York, NY. Dr. Miller's research program is focused on prevention response to viral pandemics, including influenza virus and SARS-CoV-2. Dr. Miller is also a member of the National Advisory Committee on Immunization High Consequence Infectious Disease Working Group.



Kayleigh Melcher is an undergraduate student in her third year of the Honours Biochemistry (Biomedical Research Specialization) program at McMaster University. She is currently completing her co-op term in the Miller Laboratory. Her academic interests include immunology; specifically, investigating SARS-CoV-2 and the current COVID-19 pandemic.

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Using Ferret Models to Study the Pathology of SARS-Cov-2 and General Vaccine Development

BY THANESWARY RAJANDERAN

Dr Alyson Ann Kelvin is an assistant professor at Dalhousie University and a scientist with the Vaccine and Infectious Disease Organization at the University of Saskatchewan. Born into student life and watching her parents work in academia, she developed an early interest in research. After completing her undergraduate degree in Canada, she decided to travel to Europe to learn how science is conducted in other countries and cultures. She received her PhD from Queens University in Belfast. Her research primarily focuses on emerging viruses, such as influenza viruses and the novel SARS-CoV-2, and vaccine development against these threats.

Dr. Alyson Ann Kelvin

Here she discusses the effectiveness of using ferret models to study the pathology of SARS-CoV-2 infection and the development of vaccines against this virus. Identifying the next "pandemic virus" and developing measures to mitigate its effect has always been a pertinent part of virology and global health. Like Dr Kelvin, many scientists have studied the patterns of emerging viruses, reservoir species and the mechanisms behind these pathogens, but it remains an ever-evolving area of study. Dr Kelvin started her journey in emerging viruses by working on influenza viruses in Italy to identify how avian influenza outbreaks occur. However, the following "pandemic virus" was influenza A subtype H1N1, originating from swine which spilled over instead, causing a pivot in her research. She became more interested in understanding the difference in disease severity and how H1N1 affects diverse populations, stating .

This led her to refine the ferret model to allow the investigation of age and previous infection as host-risk factors. Ferrets are naturally susceptible to human clinical isolates of many different viruses, including Ebola, influenza viruses, coronaviruses (CoV) and Respiratory Syncytial Virus (RSV) rendering them an appropriate model for also studying the effects of age or previous infections. In 2008, she was a part of a team that published work demonstrating the efficiency of the CXCL10 ferret model to understand the biology of ferrets during severe acute respiratory syndrome (SARS-CoV) (2). Ferrets were chosen as a model organism due to the similarities in lung infection patterns observed in SARS-CoV patients. Due to its efficiency in modelling viral infections in human, the ferret model enabled future studies to investigate intersections between certain

"H1N1 was causing more severe disease in infants and possibly the elderly. I became very interested in knowing why certain people are more susceptible to severe disease"

variables, such as age, pre-existing conditions and sex, as well as the severity of viral infection. For example, Dr Kelvin used a pregnant ferret model to study why pregnant individuals were more susceptible to Zika than other groups (4).

When studying SARS-CoV-2, she could use the readily available ferret models and apply them to this new virus. The objectives of this new work were to use the ferret models to better understand the pathogenesis of SARS-CoV-2 and why the older population as well as males were more susceptible to severe disease than younger people. Experiments were conducted to study the impact of age and sex on the severity of SARS-CoV-2 infections. Aged male ferrets exhibited prolonged viral replication and virus shedding compared to young female ferrets; this is possibly because the female ferrets had a higher interferon response than the males (3). This study shows that older males have a decreased antiviral response to SARS-CoV-2 compared to other populations. Therefore, the ferret model is essential for understanding the pathogenesis of SARS-CoV-2 across various conditions.

The ferret model can also be used for vaccine and therapeutic evaluations. A 2012 paper reveals that the ferret model is a great candidate for developing influenza A subtype H5N1 vaccines because it shows immunological memory and cross-protective immunity (1). These features are ideal, especially when it comes to testing the safety and efficacy of human vaccines. In addition to her work in older male ferrets, Dr Kelvin also developed and applied a similar ferret model to evaluate and test the efficacy of potential SARS-CoV-2 vaccines. Currently, she is working with multiple groups throughout Canada including Entos Pharmaceuticals, Immovaccine, and researchers at the Canadian Center for Vaccinology (CCfV) towards developing various types of vaccines. An essential goal is to develop a more broadly reactive vaccine, to curve the impact of emerging virus strains.

Overall, Dr Kelvin's work using the ferret model to study emerging viruses, including SARS-CoV-2, has largely impacted the field. This use of this model has the potential to make further significant strides in vaccine development.

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SPOTLIGHT ON CAREERS

Making Innovation Meaningful: Dr. Paul Gratzer on Elevating Research for Clinical Translation through Academia & Entrepreneurship

Q&A with Dr. Paul Gratzer, Associate Professor at Dalhousie University

BY LILY TAKEUCHI

BIOGRAPHY

Dr. Paul Gratzer is an Associate Professor at the School of Biomedical Engineering at Dalhousie University. During his academic tenure, an opportunity arose to elevate the technology being developed in his laboratory to clinical translation. Together with his former student and business partner, Shawn, they founded DeCell Technologies where Paul currently acts as the Chief Scientific Officer. DeCell Technologies is a Biomedical Technology company working to develop innovations in wound healing with applications towards surgical reconstructive materials, treatment of diabetic ulcers, and transplantation.

Dr. Paul Gratzer

"I have a theory that "what—" and "why—" are the two words that preclude great discoveries. Great discoveries are often made by happenstance, and more importantly, observing/recognizing when that happenstance is interesting."

Given that you've had quite a diverse career journey of government, academia, and entrepreneurship, can you walk us through what led you to your current career as a Faculty member and Chief Scientific Officer?

Since I was 6 years old, I was always interested in science. I was always interested in why things happen and how they work and frequently got into trouble for taking this apart. I studied Chemical Engineering at university because of its variety of specialties, but near the end of my degree, I wasn't too keen on designing distillation columns and reactors. Instead, I took a course in Biomaterials and did a research stint in a lab developing biomaterials for dentistry. I had an offer to continue my studies with Dr. Mike Lee, which at the time, I had to turn down as my wife was finishing school, and so I went on to spend a year working at the Ontario Ministry of Environment. Eventually, I came back and did my Master's degree and PhD. It happened my former supervisor received a grant to start a new department at Dalhousie, and I applied and received one of the three faculty positions. In 2006, a former student whose committee I sat on, Sean Margueratt, who was now manager of the Queen Elizabeth Tissue Bank, approached me on applying the decellularization technology that my lab was developing into tissues to make transplants more tolerable. In 2007 we began product and business development and by 2012 we incorporated DeCell Technologies.

What are the major advantages of the DermGEN platform that DeCell has developed that you believe enabled its clinical translation?

One of the successes of DermGEN] was that we met advantages such as ready to implement in the body, long shelf life, and low or no preparation. This allowed our product to be useful in cases that are time sensitive and situations where time for planning is limited. One thing I want to emphasize to graduate students is that when you're doing research, you don't have to come up with something that is absolutely novel. A lot of existing solutions work fine, but they have a long way to go to be effective. Along with that, when you're developing technology make sure you're assessing and developing it in a way that you know aligns with the workflow of the end users and enables larger scale manufacturing. Ask questions such as: How are you going to store it? Is it going to need extreme temperatures? How are you going to transport it to get it to the end user? How are you going to do this in an economical way?

What are some tips you have for those interested in implementing their research clinically?

First, interface with end users to understand the problem at hand. Workflow for clinicians is very important so even if the science is great, if a surgeon has to stand on one leg in order to get something to work, they won't use it. Second, make sure you have a way to stand out from the competition and show the value of your solution. Perhaps your product costs more, but the overall treatment saves time or money to get a better result.

What's the importance of collaborations in translational research?

When it comes to research, it's important to seek out beyond what we do locally to get solutions to the right places. From a business standpoint, it's a mandate to collaborate because it allows you to explore new markets. For example, the United Arab Emirates (UAE) has the highest number of diabetics and diabetic foot ulcers in the middle east. [When we developed our collaborations with the Middle East and North African regions] we learned to work with a new country's regulatory structure, private and public insurance agencies, understand who makes the decision to buy the products, deal with local distributors, work with international physicians to find out what are they doing and using now. More locally, we were introduced to working with indigenous populations in Northwestern Ontario through a partnership with RegenMed. Indigenous communities often have the highest rate of diabetes and diabetic amputations. We had a trusted nurse in the community, who was interested in setting up a wound healing clinic and was seeking the best technologies to help us meet with an indigenous leader and former chief. [In going through] a trusted advisor in the community, they believed our product would make a difference. One important factor [in establishing collaborations] is outreach and getting treatments to the places where they can make the most difference.

What are three pieces of advice you would give to graduate students and trainees?

First, trust your gut. One thing that's often difficult for students to do is to be confident in themselves, know what they know, and know what they don't know. If you're not sure about something, get a second opinion, ask to talk to someone else, and get extra information to help you. Second, try not be stressed out. At the worst of times, new opportunities can arise if you think about things as a learning experience. Lastly, take time for yourself. You wouldn't rent a car if it was not operating and run it to the maximum. Realize that your brain and body are a machine that requires time to recoup and downtime.

What has been the most rewarding part of your career?

In teaching and supervising: it's seeing students have the "aha" moment in their eyes and the moment when you're able to describe something in a way they understand. In entrepreneurship, I see [the company] as the only way I would have been able to see my research at work helping patients. Reading the letters from patients expressing how [our work] has changed their lives is my drug. In research, it's discovering and seeing new things that others haven't for the first time.

A Look into Community Health Medicine During a Pandemic

Q&A with Dr. Christina Bancej, Chief of Influenza and Emerging Respiratory Infections at the Public Health Agency of Canada

BY BAYONLE AMINU

Dr. Christina Bancej is the Chief of Influenza and Emerging Respiratory Infections at the Public Health Agency of Canada. She earned a BSc (Hons) in Physics and Biology at York University in Toronto, Ontario during which she received an undergraduate National Science and Engenieering Research Council (NSERC) award for genetics research. For her master's degree in Epidemiology and Biostatistics at McGill University, she examined the intersection of work and health in immigrant women, and at the same time, was involved in Statistics Canada's longitudinal study, the National Population Health Survey, until mid-2010. During that time, she also worked at the Jewish National Hospital in Montreal conducting health services research in the emergency department, looking at factors contributing to overcrowding and readmissions. After her master's, she worked at the Laboratory Center for Disease Control (LCDC), the public health arm of Health Canada, researching pesticides and their impact on maternal-child health and reproductive health, particularly in farming populations. She obtained her PhD in the same program as her master's, studying nicotine dependence and tobacco control in youth, while working at the newly created Public Health Agency of Canada.

What influenced your career choice, and what were the key events that led you to your current position as Chief, Influenza and Emerging Respiratory Infections at the Public Health Agency of Canada (PHAC)?

The choice of my career was more of a gradual unfolding of who I was. I was interested in math and sciences, and my parents were involved in the sciences. My father was in forestry and engineering, my mother was a laboratory technician in a public health laboratory, and she always talked about microbiology, tuberculosis, and related things. I knew that I would have a career in the sciences because I had always been interested in health and research, so I pursued an undergraduate in the basic sciences. I ended up going into epidemiology to apply methodological

Dr. Christina Bancej

contribute to human health. When I first started, I thought that my interests were broad, but they were relatively narrow. Hence, during my master's degree, my view of what could be done with epidemiology and human health determinants became much broader. At this point, I knew that I wanted to build my methodological foundation in epidemiology and that I wanted to get a doctoral degree, but I wanted to first get better at identifying the research questions that are most important to society. These research

questions were not the ones that I was able to come up with on my own. So, I think the researchers' agenda in public health needs to be something that is not just the aim of individuals or scientists – as remarkable as they might be, and many of whom I admire, but rather more of a collective endeavor. From reading an annual report from the LCDC, I loved that the organization was uniquely positioned to investigate certain health-related issues, which was the sort of work that I felt I could not do anywhere else, including an academic or university environment. A couple of years in, I started my doctorate studies, a family, and continuing to work at the newly created Public Health Agency of Canada at that time, where I was working on chronic disease matters on cancer screening.

My work on chronic disease surveillance and epidemiology subsequently expanded from the narrow focus on diabetes and cardiovascular disease to neurological, musculoskeletal conditions, mental illness and health. It was definitely a very exciting time. Around 2014, I had not had a lot of exposure to communicable/infectious disease epidemiology. My major step in that direction would have been on human papillomavirus because I was working on cancer screening at the time, with a vaccine in the pipeline that could prevent the onset of cervical cancer, a significant cancer globally in terms of women's health. In 2014, West Africa had a multi-country outbreak that constituted a public health emergency of international concern for Ebola Virus Disease. The PHAC was looking for people to work in the emergency operations center in planning and logistics in various areas, so I took an assignment to work there for many months. I felt a calling to do something more active than scanning our policies and how the epidemic was unfolding.

The opportunity came up to be assigned as a scientific contributor to the mission for the Global Outbreak Alert and Response Network (GOARN) of the World Health Organization (WHO), and that was my introduction to field epidemiology in infectious diseases — my couple of months in the emergency operations center and subsequent mobilization to Guinea. I worked at the National Coordination Center in Guinea and learned more about emergency management and how an Incident Management System (IMS) functions. I also worked in the field doing case finding and contact tracing in affected areas. When I was in West Africa, WHO was conducting the vaccination trials of a vaccine against Ebola that our National Microbiology Laboratory developed here in Canada, with vaccine shipments submitted to the WHO, and that vaccine was being tested. So, when I came back to Canada, I decided I wanted to know more about vaccines and moved to PHAC's Infectious Disease Prevention and Control Branch. I had an excellent foundation in pharmacoepidemiology in my master's and doctoral training at McGill, but I had not really applied it yet. Vaccines are drugs, and post-market surveillance of vaccines is a main aspect of pharmacoepidemiology. While I was working on vaccine safety, there was a need, and I had the interest to help build up the Influenza team in Influenza and Emerging Respiratory Infections, so I took that on in addition to vaccine safety. When the Influenza team grew, I left the vaccine safety behind, but I still support other colleagues in that area. I have been doing influenza and emerging respiratory infections epidemiology ever since — something I definitely see myself doing for the next 15 years, if not more.

What does your average day look like, and what excites you most about your work?

Even prior to coronavirus, my day usually starts with a scan of the situational intelligence from event-based surveillance from platforms like the Global Public Health Information Network (GPHIN). I also follow so many credible blogs and listservs like the PROMED from the International Society of Infectious Diseases, and an independent blog called Avian Flu Diary owned by a retired paramedic named Michael Coston. I follow those because they are often early and often right about what is going on, so I pay attention to those because it is an informal network of intelligence. I do look at research scans and summaries of some of the key journals; we have some formalized processes to check, track this information, and assess it to decide actions. The balance of my day is routine surveillance, collaboration

on surveillance, and epidemiologic research or longer-term capacity issues. Sometimes I am reactive by responding to action requests; you never know what might come up, and that can be a double-edged sword, interrupting me from the important work that I'm doing today, on the other hand, it's this constant feedback of what is important to the public, to the news media, to the minister of health or parliamentarians. So, it is good tension, I would say, that we have these things.

Your publication at the beginning of the pandemic in 2020 reported on respiratory syncytial virus (RSV) vaccine readiness in Canada. Has your focus shifted in response to the pandemic? Has this impacted any other projects that were formerly in the works?

It is not like we are singularly focused on COVID-19, but I would say my focus has shifted somewhat, as has that of our surveillance partners, but I see it as more of a temporary shift. You know, hospitals, primary care practices, research networks, surveillance networks, all of them have really shifted to focus on similar insurgencies as the COVID-19 pandemic is a global public health emergency. It has also been interesting to see how the COVID-19 pandemic and the unprecedented stringent public health measures have radically changed the landscape and the circulation of respiratory infectious diseases. That said, I have still been working on RSV vaccine readiness. The burden and impact of RSV, especially on infants and children, is still incredibly high, but with the low circulation and public health measures this year, normal circulation is not happening, but this will resume; we will not be on lockdown forever. My program does continue to do the laboratory surveillance for RSV, and I still am working with surveillance networks like the Canadian Pediatric Society's Immunization Monitoring Program ACTive (IMPACT) network, on RSV vaccine readiness and analysis. We have been in touch over the last several months, almost weekly, and I have also been working with global partners through the WHO RSV surveillance global pilot. The shift has changed because COVID-19 is a priority, but other essential pieces of public health are continuing and really must continue. So, the RSV vaccine readiness is one of those, influenza surveillance is another, influenza pandemic preparedness is another that needs to be continued; just because we have a COVID-19 pandemic does not mean that the threat of an influenza pandemic or any other type of outbreak disappears.

How do you think the journalistic media and social media technology, in general, influenced the current pandemic when compared to others in the past?

I am saying this certainly from an observer's perspective, not as an expert; what I noticed with the SARS-CoV-2 is that it really opened things up for citizen scientists. The journalistic media has really pushed transparency which I think is an excellent thing. However, it has also complicated the communications, for example, the definition of official government sources or official sources — the Canadian government, governments worldwide, or organizations like WHO always have to give a list of reliable sources for vaccination information. I think this list expanded quickly with COVID-19, and new reputable/reliable players came into the picture. The definition of official government sources has really changed; the first announcement of person-to-person transmission of SARS-CoV-2 did come from the WHO, from their Western Pacific regional office, via Twitter. That, to me, was quite a surprising change. I am not directly involved in the PHAC's monitoring of COVID-19, but we also use a the GPHIN, which is an event-based surveillance platform that scans global news media and crawls through it all every day and picks up infectious disease threats or health-related threats. GPHIN did find the news media announcements of the atypical pneumonia in Wuhan back in December of 2019, later identified as COVID-19. But GPHIN uses news media; it has not evolved to include social media. Inclusion of social media and ways of analyzing that would have to be incredibly complex enough to separate a signal from noise, but it does need to be done, although we are not just quite there yet. In terms of the journalistic media, I think it has been that positive in terms of opening things up for citizen scientists, pushing transparency, putting data out there in the open. However, my word of caution is that data is not meant to be only analyzed, it needs to be interpreted within the theoretical foundation and the approach grounded

in statistics and statistical theory.

Have opportunities changed for students (high school or undergraduate) interested in public health/epidemiology?

I think that the opportunities over the last 15 years have changed enormously. I have seen master's in public health programs spring up very high-quality programs in several universities, and the field of data science and bioinformatics have also grown. There are newer technologies that allow us to work with big data; public health has been impacted by the growth/explosion of technology in the same way or more so than other fields, as we have always been working with big data before the technology was even there. I think that the advantage is that epidemiology can bring a science-based approach grounded in the principles of statistics to data analytics. In big data analytics, the substance of public health, community, and population medicine can be disconnected from statistical theory at times. Therefore, although the opportunities have changed and grown, it is not all about technology; it is also really about having the theoretical foundation underpinning the field of public health, data analytics, biostatistics, and so on. The two together can be incredibly powerful.

What advice would you give to undergraduate and graduate students interested in pursuing a similar career path?

I would say that for students who have a methodological inclination and an interest in community health/medicine, I think they have enormous potential to contribute to the field and that they should go for it. Try it out, understand and grow in your knowledge of the science, use the methods as a foundation, explore different experiences because they will constantly bring you back to test your methodological foundation.

That has been such a pleasure for me – being a constant learner. As a new graduate in the field of public health, bioinformatics, or molecular epidemiology, this is all relatively a new science. So, you can innovate, contribute to the progress and knowledge base, so keep doing that sort of call and response: of coming back to the methods, and seeking out new/relevant questions on which to apply them.

"Explore your interests, do not be afraid to be a beginner, start again and again"

Infectious Diseases and Their Association with Drug Use

Q&A with Dr. Thomas Brothers, Internal Medicine Fellow at Dalhousie University & PhD student in Epidemiology & Public Health at University College London

BY SUPRIYA HOTA

Dr. Thomas Brothers recently completed his residency in internal medicine at Dalhousie University in Halifax, Nova Scotia, Canada, and certification in addiction medicine through the International Society of Addiction Medicine. He is currently a general internal medicine fellow at Dalhousie University and a PhD student in Epidemiology and Public Health at University College London in London, England His clinical and research work focuses on improving health care for people who use criminalized drugs and people experiencing homelessness. Dr. Brothers is currently involved in various research projects that aim to understand and prevent bacterial and fungal infections associated with injection drug use. In addition to high-impact research work, he is leading an interprofessional hospital Addiction Medicine Consultation Service (AMCS) and worked with HaliFIX Overdose Prevention Society to organize Atlantic Canada's first safe injection site.

You are a resident physician and the path to become a physician is a very long one. What led you to pursue a PhD in Epidemiology and Public Health following your MD graduation?

When it comes to clinical work, I am interested in caring for people who use drugs and who are experiencing homelessness. As I went through my medical training, it became clear that our mainstream and traditional approaches to healthcare haven't incorporated these patients' needs. In medical school, when I started caring for hospitalized patients with infectious complications of injection drug use, my colleagues and I didn't understand how to help – we let patients down and we caused harm. In many areas there was evidence we weren't implementing, and in other areas we didn't have enough research to guide care. I wanted to pursue research training to try to improve prevention and care throughout my career. I have also been encouraged by some wonderful research mentors throughout medical school and residency, including Dr. Ken Rockwood, Dr. Susan Kirkland and Dr. Duncan Webster.

What does your average day look like?

Before October, I was a full-time internal medicine resident. Depending on the day and month, I would be on a different clinical rotation, whether in the hospital or in the clinic. I would spend the whole day there and then come home and try to tackle the academic and research work on evenings and weekends. Now, I'm completing a research fellowship

Dr. Thomas Brothers

and a graduate degree in Epidemiology and Public Health from University College London in London, England. Because of travel restrictions due to COVID-19, I Zoom in for courses and meetings. Every day is very different; some days are split between research and clinical work and others are fully spent doing one or the other. For example, I'm doing a general internal medicine call shift once per week in the evenings or over the weekend, and I spend a full day at the clinic once a month. I provide addiction medicine care in the hospital on an as-needed basis throughout the week. I also lead some education sessions, centered on caring for patients with medical complications from addiction. The rest of my time is spent working on my research.

Since you are managing so many different roles, do you have any tips on time management for us?

Priorities are always changing. Things that I have found helpful are listing out my tasks, breaking down tasks into subtasks and using my Google Calendar to remind me of my deadlines. I have also started using a white board to keep track of the projects I'm involved in and my progress on them. This allows me to have a visual representation on everything that I'm currently working on; it tells me if and where I'm dropping the ball so that I can go back and reserve a bit of time for projects that need it. Finally, if there's an important task that I'm not able to dedicate enough time to, I block off time in my schedule as if for a meeting and dedicate it to the task.

Your research focuses on infectious diseases and injection drug use. What sparked your interest in your current research?

My clinical work introduces me to new questions that I don't have answers for, and this is where most of my research questions stem from. I was interested in going into medicine in part because I wanted to work towards social and health equity. Early on in medical school, I happened to meet someone who became an influential mentor in my life: Patti Melanson. Patti established a street nursing service in Halifax called Mobile Outreach Street Health (MOSH). MOSH provides primary care to people living outside and in shelters, alongside Mainline Needle Exchange outreach. I was fortunate to spend time with Patti, MOSH and Mainline throughout medical school. This is where I was introduced to the philosophies of harm reduction, compassionate and non-judgmental care, supporting people with their own goals, and recognizing that individuals are experts in their own complicated lives; I thought these lessons were incredibly powerful. When I started my clinical rotations, I learned that these philosophies of care aren't necessarily common in mainstream medicine, especially in acute care. This is where I saw the disconnect between what could be offered in the community with harm reduction-based healthcare and what we were currently offering in the hospital. Early on in medical school, I participated in the care of patients who injected drugs and were subsequently hospitalized. These patients were forced into opioid withdrawal, which led many to have to leave the hospital and medicate themselves only to come back even sicker. There was a lot of stigma and judgment, and we created a lot of harmful situations for these patients. The combination of being exposed to harm reduction as a philosophy, having inspiring mentors, seeing the possibility of how things could improve, and building relationships with these sick patients but not having the necessary tools was a big motivator for me. Some of these patients unfortunately passed away, but they were great teachers and I'm encouraged by their memory. They shared their wisdom and experience on how things could be better.

I'm fortunate to continue to learn from people who use drugs, as well as my colleagues and friends in the Canadian Association of People who use Drugs (CAPUD) and Halifax Area Network of Drug-using People (HANDUP).

"These unanswered questions motivate me to understand how we can provide better care to people who experience infections from injection drug use so that these patients, who are mostly young adults, don't face death, disability or serious health complications later in life."

What are some projects that you are currently working on?

My thesis project focuses on understanding and preventing bacterial and fungal infections associated with injection drug use. When it comes to harm reduction practices, safer drug use and public health messaging, there has been a big focus on viral infections such as human immunodeficiency virus (HIV) and hepatitis C. We're also seeing increasing incidence of bacterial and fungal infections associated with injection drug use on a global scale, but the reason behind this rise in infections is poorly understood. Historically, the focus on prevention has mostly centered around individual risk practices and health behaviors (e.g. cleaning hands and sterilizing skin before injecting). However, individuals who experience homelessness, poverty and criminalization related to drug use can't always do that. How can you wash your hands and clean your skin if you don't have access to clean water or alcohol swabs, or can't take your time if you're worried about being arrested? I'm really interested in the potential of addressing social and political determinants, community health re-

sponses and different approaches to addiction treatment. I'm starting off by conducting a systematic review to identify the social and structural factors associated with these infections, with the goal of identifying opportunities for prevention that go beyond individual skin cleaning and hand washing. I'm also working with a dataset containing patients who have been on opioid addiction treatment in New South Wales, Australia. Their addiction treatment information has been linked to their hospitalization records, incarceration records and vital statistics (e.g. death). Using this dataset, I'm focusing on the potential role for opioid addiction treatment (and other risk factors) in the prevention of injection-related bacterial and fungal infections.

Addiction Medicine Consultation Service (AMCS) is a current project that you are really excited about. What were some challenges that your team faced in this project? What factors makes these services successful? What factors could have made it more successful? Are there any plans of making this service official?

A big part of my mind and heart is being invested into the Addiction Medicine Consultation Service (AMCS). Patients come into the hospital with medical complications of addiction and our AMCS team of medical residents do assessments, treat withdrawal and pain, and offer to start addiction treatment while still in the hospital. We published our first evaluation of the program and have a few more projects on the way. What we're doing right now, which is unofficial, is enabled by our supervisors and mentors, who are community-based addiction physicians who volunteer their time to supervise us. One mentor in particular, Dr. John Fraser, has been incredibly generous with his time and teaching, and the program would not be possible without him. We do need a funding model that will allow the service to be sustainable. Another barrier, initially, was a lack of training. In mainstream medicine and hospital-based care, we haven't traditionally integrated addiction medicine into training, so part of the reason that patients weren't getting the standard-of-care was because we didn't have the education, expertise or skills to deliver it. We have since had several residents and attending physicians join our team, and everyone continues to teach others. Moving beyond our current program and looking at teams that exist in other provinces, we would like to create a multidisciplinary model that involves physicians, individuals with lived experience of substance use (such as peer workers), social workers, nurses and pharmacists. These individuals would not only contribute their expertise to the development of care plans for patients, but could also educate colleagues throughout the hospital. I think we are doing good work with basic tools, but so far, our team has only consisted of physicians and medical residents. It would be wonderful to expand to a multidisciplinary team that involves people with lived experiences to help design and deliver care.

Has COVID-19 opened any new avenues in your research?

The fact that I didn't move to London was incredibly disappointing at first, but it actually meant that I could stay involved in the clinical work and harm reduction community here in Halifax. The fact that so many people have moved their lives online means that I can meet with people and get their advice across the world quite easily. Right now, I'm working with a big dataset housed in Australia. Before COVID-19, I would have had to fly to Australia for a few weeks or months to work with them, but now they're creating a portal where international team members can login and analyze the data from the computer in their lab. Their research collaboration would not have happened without COVID-19. Staying in Canada, I also get to work closely with the CAPUD, an advocacy group for people who use drugs. Rates of overdose deaths have continued to increase during the pandemic, due to increasingly toxic and unpredictable illicit drug supply, social isolation, and loss of income and housing. This is a big motivation for advocacy groups like CAPUD to push for urgent solutions, such as decriminalization of drug use and providing a "safe supply" of drugs as an alternative to the illicit drug supply. I have co-written a couple of papers with CAPUD about the rationale of safe drug supply and we are working together on a research grant to conduct a scoping review to look at the barriers and facilitators to providing safe drug supplies during pandemics and public health emergencies.

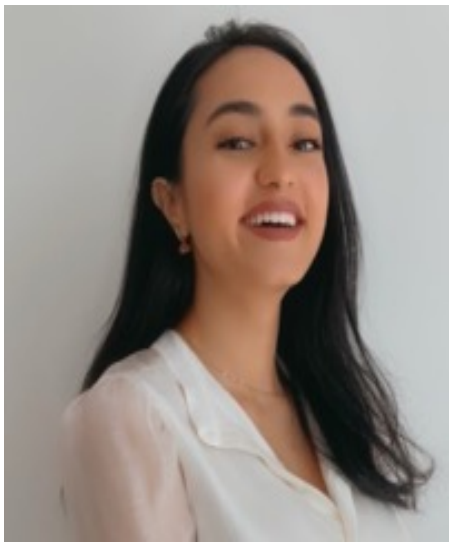
Infectious Disease Surveillance: As Science-to-Business Perspective

Q&A with Yasmeen Al-Fahoum, Public Sector Partnerships Lead at BlueDot Inc.

BY SARAH SHAWKY

BIOGRAPHY

Yasmeen Al-Fahoum completed her Honours Bachelor of Science degree with a specialization in Neuroscience at the University of Toronto. Before pivoting into the business world, Yasmeen conducted research at Toronto Western Hospital, where she studied the use of gene therapy as a potential treatment for Parkinson's Disease. During her undergrad, Yasmeen gained significant start-up experience as a Business Development Representative at iMerciv Inc., a company that develops smart wearable products for the visually impaired. Today, Yasmeen is a Public Sector Partnerships Lead at BlueDot Inc., a Toronto-based digital health firm that has developed a first-of-its-kind global early warning technology for tracking over 150 infectious diseases in 65 languages. BlueDot has developed risk assessment and infectious disease surveillance platforms that empower public health agencies, businesses, and hospitals to anticipate and respond to emerging threats on a global scale. At BlueDot, Yasmeen is responsible for building consultative relationships with leaders in the public health sector.



Yasmeen Al-Fahoum

What led you to pursue a career at BlueDot Inc.? How has this work been during the COVID-19 pandemic?

I first heard about BlueDot through the news just last year, as the company was one of the first in the world to identify the emerging risk and spread of COVID-19. As it turns out, BlueDot successfully predicted eight out of ten cities as the next outbreak locations. Naturally, I became intrigued by the company's mission, and inspired by the CEO, Dr. Kamran Khan – a practicing infectious disease physician and Professor of Medicine with the Division of Infectious Diseases at the University of Toronto. BlueDot's mission of safeguarding and protecting the global population really resonated with me, so I applied and was hired as their Public Sector Partnerships Lead. As BlueDot is a very forward-thinking company - in terms of building risk assessment platforms to alert end users of infectious disease risk – we have had to maintain high adaptability in order to stay relevant across the pandemic curve. For instance, after successfully detecting the spread of COVID-19, our product team was great at rapidly generating both a variant and vaccine tracker.

How did your university education prepare you for your current position?

My experience at the University of Toronto truly taught me how to work well under pressure. In resonance with the Yerkes-Dobson law, there exists an empirical relationship between pressure and performance, and I have essentially learned how to hover around the optimal level. In other words, I have learned how to use pressure and stress to my own benefit to excel on the job. My current role is majorly client-facing – frequently with C-level executives - so, I am

required to be very quick, efficient, and dynamic, while handling the associated pressure. Additionally, my research experience during my university career trained me to be highly meticulous – and this is a skill that now helps me perform thorough research on prospective clients and identify any challenges or gaps in the process. As a business development representative, it is important to keep clients interested by presenting the company relative to their needs, so my research skills have definitely remained applicable.

What does your average workday look like?

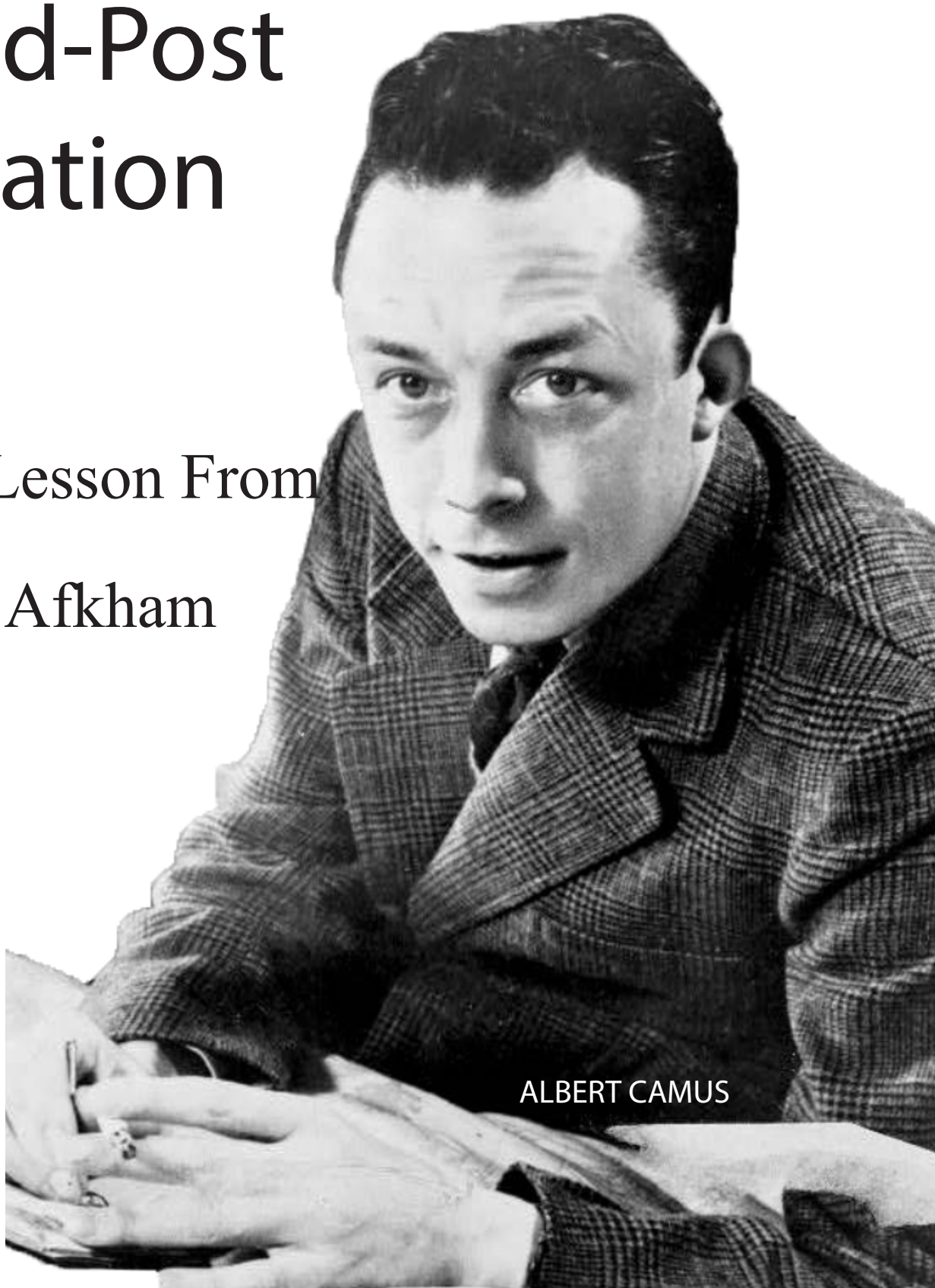
Typically, my days are meeting-oriented. I often start my workdays early to accommodate for time differences when there are calls with international clients. A large portion of my day is allocated to prospecting the right government officials and identifying the key representatives whom I should be contacting regarding new partnerships. I spend time interacting with these individuals via email and phone and learning about clients' organizational structure and their existing tools prior to initial meetings. For these meetings, it is really a balance between understanding the client's current software, identifying weaknesses, and building credibility, trust, as well as a need for BlueDot's platforms. After establishing this need, we figure out whether they can integrate it, and whether they have a budget – the whole process is really a problem-solving experience. Additionally, I collaborate with the product team to be aware of product updates and releases to relay back to the client. There exists this "symbiotic" relationship where we tailor our products to their needs. What advice would you provide science students who are interested in pursuing a similar career path? Particularly for those who are interested in business development, but don't necessarily have "business" experience? To gain exposure I would highly advise students to look out for their university-affiliated business development centre, such as the University of Toronto's Centre for Entrepreneurship. This is basically a home to entrepreneurship and business education, co-curricular programs, and venture incubation. They typically offer related innovation and entrepreneurship-based courses, and while I was at the University, I took one that offered me an internship with an affiliated start-up – and that was iMerciv Inc; this was how I transitioned from the sciences into start-up culture. Here, I became exposed to the fast-paced climate associated with working in a small company, where I had the opportunity to wear many different hats.

"Leveraging your university's partnerships and affiliations to gain real-world experience and build your resume can really help you shape what you pursue later on!"

PROFILES

Pre-and-Post Vaccination Eras

A History Lesson From Dr. Emand Afkham



BY BAHAREN BEHROOZI ASL

PHOTO CREDIT NEW YORK WORLD-TELEGRAME AND THE SUNNEWSPAPER PHOTOGRAPH COLLECTION

"Everybody knows that pestilences have a way of recurring in the world; yet somehow we find it hard to believe in ones that crash down on our heads from a blue sky. There have been as many plagues as wars in history; yet always plagues and wars take people equally by surprise"- Albert Camus: The Plague

At the time of publication in 1947, the book, "The Plague" by Albert Camus could have just considered as an allegory of society, relationships, and politics. At the time, it was difficult to imagine tangible experiences of fear, quarantine, and the inability to see loved ones. The COVID-19 pandemic, however, has made many of these feelings a stark reality. The COVID-19 pandemic has consumed global news outlets for over a year now, instilling an overwhelming amount of information, protocols, and preventive measures for society to navigate. What is the likelihood of returning to our normal routines of hugging and kissing? What could be the economic, social, and sustained health effects sustained from enduring a long pandemic? For many of us, it is the first time that we are facing a multi-year, global pandemic. Historically, however, humanity has faced even worse outbreaks.

Over history of vaccination from the time of Louis Pasteur – who in 1879 coined the word "attenuated" and showed that the non-sporulating cultures of viruses can be inoculated into animals and induce immunity1- to making advances in the development of safer and more efficient RNA-based vaccines used today2-there has been an abundance of knowledge gained on vaccine development. These advances in biotechnology have been used to improve treatment design and the rapid development of new vaccines in such a short time, such as in the case of the COVID-19 pandemic. Moreover, we carry the effects of these events in our genes; ultimately affecting our susceptibility to future infection and the strength of our immune response. This is also true for the evolution of human social and biological adaptation to infectious disease outbreaks throughout the history of pandemics.

Emad Afkham is a Ph.D. student in the Department of History & Classics at the University of Alberta. Emad's interest is in the economic and social history of subaltern social "classes". For his doctoral thesis, he is researching the interconnectedness between social unrest and power relationship in Persia and Austria in the early modern Age (mid-sixteenth to mid-seventeenth centuries). He mentioned he got interested in this topic when working on his MA thesis on peasant revolts during the French war of religion in the late sixteenth century. Emad also has a background in architecture and earned his BA and first MA degrees in architecture. Throughout this interview, we navigate through time and discuss the most influential pandemics in the history of human beings. Emad believes there is much to be learned from this history.

A quick search on the internet will provide a long list of different pandemics which can be divided into two groups: the time before modern medicine and knowledge about infectious diseases and the time after; In other words, the pre-and post-vaccination eras. "We hear about the plague in the various types of historical documents, namely: holy books, scriptures, annals, chronicles, archival documents, etc. In the Bible, there are few suggestions about the plague and outbreak of a pandemic among people" Emad mentioned.

"As one of the most important pandemics in the pre-vaccination era, the Black Death, the pandemic that swept over Europe and Asia from 1347 to 1351, had long-term consequences on human life in many ways. As the name implies, societies at the time had little information about the real source of the disease. The name "black death" originates from a symptom of the disease, known as "acral necrosis," in which the skin of affected individuals would blacken due to subdermal hemorrhages. Interestingly, recurring outbreaks of the Black Plague lasted for more than two centuries." According to Emad, "the Black Death originated in either Central or East Asia, spread to Crimea and arrived in Europe about 13 years later. We know that some parts of Europe were not infected by the plague, such as the vast area of the kingdom of Poland that was like an island among the plague invaded territories". He added: "it claimed approximately

75 to 200 million lives, an estimated 30-50% of the European population. An astonishing number, considering the world population was around 450 million at the time. Not surprisingly, this depopulation event caused social, demographic, and economic changes throughout Europe. Although the world map was different than today, they were experiencing a worldwide phenomenon like the COVID-19 pandemic." Emad considered the sharp depopulation of many regions as the very immediate effect of the pandemic: "In agrarian societies (almost all economies before the "Industrial Revolution"), depopulation resulted in a labor shortage which offered freedoms to peasants and laborers and placed pressures on employers, leading to an increase in wages and benefits. As a result, despite the recession that happened due to this pandemic, peasant prosperity was increased in some places. From a political perspective, the black death broke down the normal divisions between the upper and lower classes and led to the emergence of a new middle class. As landlords competed for peasants with wages and freedoms, some argue it represented the roots of capitalism."

All these permanent effects accompanying the lack of any medical knowledge raises curiosity about the societal reactions to these changes. "Most people regarded those catastrophic events as the wrath of God, which on one hand weakened the predominant organized religion, the Roman Catholic Church, as religious officials could not keep their promise of curing the disease. On the other hand, they were looking for the sinners. Consequently, many of the minorities including lepers, Jewish, and people with mental disorders were mistreated. Other supernatural causes – like the devil's work, the alignment of the planets, and bad air were also considered."

Interestingly, many of the challenges related to mental health during COVID-19 were also paralleled by societies during the Black Death. Emad mentioned that depictions of depression can be traced in the artwork from the 1300s, wherein the portrayal of death was common in both paint and sculptures. Danse Macabre (Dance of Death) was the actual personalization of death leading the row of dancing figures to the grave.

Another prominent pandemic with multiple waves like COVID-19, that occurred in the setting of modern medicine in 1918, right in the middle of World War I, was the Spanish flu. "We are not sure about the origin of the virus as soldiers were traveling between nations and more importantly the significant censorships were in place as governments did not want to distract the soldiers from war. The Spanish Flu is named after Spain unfairly because the press in neutral Spain announced its progress battling the pandemic, unlike news outlets in other nations. So, the late announcement of the pandemic was also the problem for this pandemic." According to Emad, it is difficult to delineate the societal impacts of the Spanish flu from World War I, however, we cannot disregard the effect of the Spanish flu on the improvement of the public health system. It incorporated sociology into medicine, which had previously only centered around biology and experimentation. Very soon after, the US started a national disease reporting system and the establishment of the health ministers in many countries - a direct effect of the 1918 pandemic.

"In comparing the pandemic-related restrictions of that time to what we are experiencing today, measures such as quarantine or closing of public spaces were suggested but not soon enough. Other measures included closing schools and places of public amusement, enforcing "no-spitting" ordinances, encouraging people to use handkerchiefs or disposable tissues, and requiring people to wear masks in public." Emad mentioned.

Considering the huge impact the Spanish Flu had on people's lives, many historians refer to it as a "forgotten pandemic"3. "First of all, we should know that all pandemics, to some degree, challenged the socio-cultural norms of societies. These challenges could reach very fundamental social, cultural, and economic levels, as we have seen in the Black Death, or alter some aspects of these norms. Therefore, all big shocks to the process of our everyday life brought fundamental changes and alterations. We can always talk about the new adoption and adaptation between the pre- to post-pandemic worlds." Emad added.

"What's true of all the evils in the world is true of plague as well. It helps men to rise above themselves." – Albert Camus: The Plague

Advances in science and modern medicine, as well as increased demand for open access to journals and data, have greatly improved our ability to respond to and manage emerging pandemics. Indeed, viral sequences of SARS-CoV2 were available within the first few weeks of the COVID-19 pandemic; accelerating the development of effective viral testing, but also the global race for vaccines in unprecedented ways. Although the cumulative knowledge in biotechnology throughout centuries enabled us to develop the vaccine in a timely manner, however, as a society, we are still seeking to solve fundamental issues for which science does not have a straight answer: the globalization of science and health, and the equitable access to information and health resources.

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MEET
DR. VINCENT AGYAPONG

Area of Expertise - A coalition of the willing for the mental health of Albertans

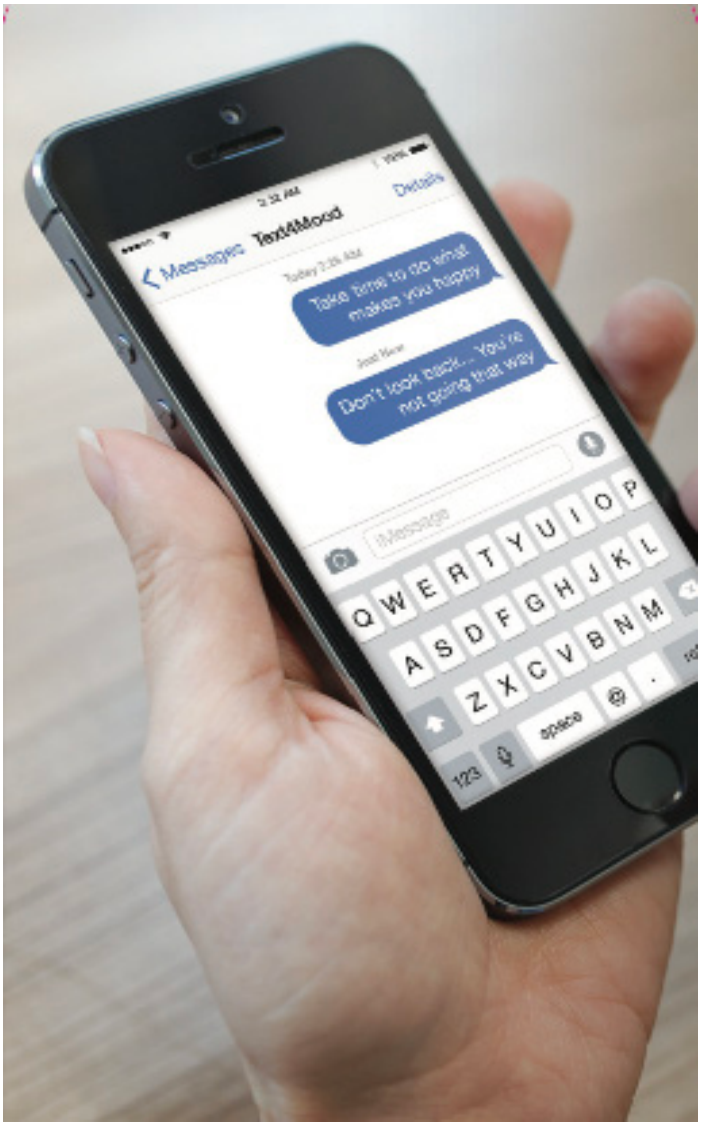
BY MIGUEL PRIETO

PHOTO CREDIT BRYAN COOPER OF COOPER & O'HARA PHOTOGRAPHY

We all know the COVID-19 pandemic has taken a toll in our well-being. However, Albertans were fortunate to receive support from the Text4Hope initiative. The Text4Hope program is an innovative initiative aimed to help individuals navigate the circumstances of the pandemic with the daily delivery of evidence-based text messages to support the psychological wellbeing of subscribers. When the first cases of COVID-19 began growing overseas in early 2020, Dr. Vincent Agyapong braced for its potential effects on mental health: "I was in Fort McMurray when the wildfire happened, I had the first-hand experience of what people experience during a traumatic event. The pandemic is no different in terms of how traumatic it has been. Many people lost their jobs, businesses have been shut down, and there is so much uncertainty. It was only natural to expect that levels of anxiety, stress and depression would increase." In 2016, Dr. Agyapong was one among 88,000 residents of Fort McMurray, Alberta, who were urgently evacuated from their homes due to an unprecedented wildfire. The wildfire caused not only the highest financial loss by a disaster in Canada (calculated as $3.6 billion), but a persistent detrimental effect on the mental health of the population. Several sources of data support the increase in self-reported symptoms of post-traumatic stress, anxiety, and depressive disorders across the Fort McMurray population after the wildfire (1,2). The effects on wellbeing for the community did not go unnoticed for a mental health researcher like Dr. Agyapong, who was working on implementing the Text4Mood program (aimed to reduce depressive symptoms) in northern Alberta (3).

Instead, faithful to his public health roots, he supported the community by extending his mental health practice outreach activities and implementing more text-based supportive programs in the region. Based on the previous successes of text-delivered interventions for depression and alcohol abuse, the group strengthened their collaboration with Alberta Health Services to launch the Text4Hope initiative in the early stages of COVID-19 lockdown. The aim was to mitigate the impact of the pandemic on stress and anxiety using a platform of daily text-delivered messages that were in line with local isolation rules, required minimum logistics, and easily accessed through any mobile phone for low-cost mass delivery. In addition, the text messages were scientifically sound and based on effective therapeutic knowledge (cognitive behavioral therapy) created by experts. Some of the messages included were:

- "Put yourself on a media diet. It's important to stay informed, but only check the news and social media intermittently, rather than continuously."
- "Notice when you're feeling sad, angry, lost or overwhelmed about life changes. Don't push the feeling away, acknowledge these feelings and let yourself grieve."



Text4Mood has helped many Albertans with their mental health

The service was made available to all Albertans in March 2021 and the uptake was amazing. "We had an objective of recruiting 500 people over 6 months and within just a month we were close to 40,000 subscribers" describes Agyapong (4). Furthermore, self-reported validated screening scales included in

the program [Perceived Stress Scale (5); Generalized Anxiety Disorder 7-item scale (6) and the Patient Health Questionnaire-9 for major depressive disorder (7)] showed a decrease in symptoms of anxiety and stress at 6 weeks compared to baseline (8) and a control group assessed prior to intervention. These effects were sustained up to 12 weeks after enrollment of respondents. The authors report that up to that timepoint, the program maintained 40,000 active subscribers (9) and had similar effectiveness to a cycle of web-based counselling for general anxiety disorder (8). Dr. Agyapong highlights the need for innovative programs like this in mental health: "it will not be possible to have enough psychiatrists or psychologists to meet the needs of everyone. If we have interventions that can be delivered to large groups of people, you can have 20 people interact with a therapist for a single session and they all benefit". The Text4 initiatives are a step towards bridging the gap in access to quality care in mental health.

So, how did this all start? Dr. Agyapong's career in psychiatry was a fortuitous turn of events as he explains,
"I didn't want to do psychiatry when I was in medical school, I wanted to do public health". However, on his journey to advanced studies in public health, a temporary job in psychiatry captivated him and led him to focus on the "public health aspects of mental health". In his first doctoral dissertation, he implemented the first supportive text message program for mental health disorders which eventually became the cornerstone for the Text4 initiatives. The initial and sustained success of all Text4 initiatives belongs to "the coalition of the willing" according to Dr. Agyapong. He describes the conformation of this multidisciplinary team as a snowball effect: "I started very small. I did not really have anything at all, and I came up with the idea of translating research in a clinical program, the Text4Mood program, when I was in Fort McMurray". Dr. Agyapong continued, "then, I collaborated with the health services managers, as well as the mental health therapist in Fort McMurray. I also brought on board some researchers from Edmonton and people from Alberta health services who were interested in this kind of work, to form a team that I call a 'coalition of the willing'". In the current pandemic, the coalition has strengthened and added multiple collaborators across Canada and overseas. This think tank has help to expand the horizons to implement text-delivered interventions while providing the necessary skills to support the process. Among the successes of the coalition is the recognition of the initial program, Text4Mood, as an innovation by the World Health Organization (10). He states it was recognized "because we have been able to publish measures which show that the program was benefitting a lot of people in a really meaningful and scientifically researched way". He describes the focus of his research as "what immediately benefits the patient". "How can we improve the psychological well being using very simple things?" In his words, "it is not like they [people who use these services] are suffering from very severe and enduring mental health problems like bipolar disorder or schizophrenia. People are coming in with very common, treatable conditions… so, that makes it very easy to design interventions and test those interventions." Looking forward, he believes in the importance of keeping the momentum of mental health relevance seen in the last years.

"Unfortunately, stigma still exists, but I think mental health literacy has improved quite significantly. Not only in Canada, but also in the so-called third world countries."

Dr. Agyapong also advocates that as clinical researchers "everybody should have some level of interest [in mental health research]". He also promotes a perspective of psychological wellbeing as relevant across all diseases, explaining that "in the general medicine ward, most of the people meet the criteria for one mental health disorder or the other. It may be anxiety, stress, an adjustment disorder, depression…". "So, you can definitely do some basic [mental health] research within your patient population." To conclude, as the pandemic has raised awareness about the importance of mental health for society, he states "in the next few years, we are going to be less reliant on face-to-face interventions and medications. People are really going to incorporate more digital health solutions as well as exercise and natural ways to improve their psychological wellbeing". Finally, he also mentions how important is to maintain the skills that we have

developed while navigating the COVID-19 pandemic and to continue building resilience for future stressful events.

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Myles McLean

BY AITEN ISMAILOVA

IMPACT OF COVID-19 ON MY RESEARCH

With regard to all the viruses that attack humans, coronaviruses are large. They belong to a family of viruses that use RNA to replicate, but they really stand out for their extraordinarily giant genomes that encode almost 30 different proteins (1). As a comparison, their genomes are more than three times as large as HIV and hepatitis C (2). In addition, coronaviruses are among the few RNA viruses that have a genomic proofreading mechanism that prevents it from accumulating mutations that may weaken it (3).

SARS-Cov-2, the coronavirus responsible for the globally widespread COVID-19 disease, possesses an array of adaptations to help it breach human cells — the first step in causing the disease (4). It infects the throat and lungs by rupturing the protective membrane of host cells using its spike proteins. The protein's receptor-binding domain then binds to a receptor called ACE2, which is perched on the surface of the host cell. Enzymes such as TMPRSS2, on the exterior of human cells break the spike protein; this in turn exposes fusion peptides that fuse the viral membrane with that of the host cell. At that point, the virus's RNA has entered the human cell, where it will hijack the host's machinery to start making its own viral proteins (4).

Much interest revolves around the viral replicating proteins of SARS-Cov-2. These proteins that commandeer the machinery of human cells to sustain viral replication are thought to be important for causing the infection (1). For Myles McLean, a third-year doctoral student in the Physiology department at McGill University, the smaller SARS-CoV-2 accessory proteins that are not required for viral replication are equally as important. "A lot of these proteins are hypothesized to interfere with the immune system in various ways," he says now.

When the COVID-19 outbreak was first declared a pandemic by the World Health Organization (WHO) on March 11, 2020 (5), Myles, like other McGill graduate students, reluctantly went home. But a short two months later, he returned to the lab to tackle a new project on coronaviruses. With his viral expertise, it seemed like the perfect fit — his research interests are centered around innate immune proteins that, via various mechanisms, interfere with viral replication and life cycle.

Montreal-native Myles McLean completed his undergraduate degree at McGill University with a major in Physiology. Interested in pursuing research, he started his master's degree in Physiology at the Lady Davis Institute in Montreal's Jewish General hospital before fast-tracking to a PhD. "What made me pursue grad school was a combination of an interest in research/not fully knowing what to do as a career yet," Myles says. "I did enjoy my master's but didn't feel like I had enough time to complete it, that's why I decided to fast-track."

Co-supervised by Mark Blostein and Chen Liang, associate professors in the departments of Physiology and Microbiology & Immunology respectively, Myles began working on a collaborative project on Gas6, a vitamin K dependent protein involved in the blood coagulation pathway (6), and its potential role in Zika virus infection. The Zika virus, transmitted by the bite of infected mosquitos, became the first major infectious disease connected to human birth defects to be identified in more than half a century (7). During the 2015-2016 Zika virus epidemic, outbreaks of the virus were recorded in Africa, the Americas, Asia and the Pacific (7). It, too, spurred such global alarm that the WHO declared it a Public Health Emergency of International Concern (8). Myles's hypothesis was that Gas6, which usually binds to phospholipids on apoptotic cells, may also bind to a phospholipid on an envelope of the virus and link it to a family of kinase receptors. He anticipated that the cascade of events initiated by the protein would ultimately facilitate the Zika virus to infect cells.

However, after working on the project for two and a half years, the data did not suggest that Gas6 had a substantial effect on the outcome of the virus. "We did have a mouse colony for Gas6 knockout mice. We had some data, but the phenotype wasn't strong enough. There were definitely things that were there, but I guess the main part was whether the mice expressed Gas6 or not didn't affect their outcomes of the virus. They both survived the same number of days; it didn't really matter whether it was there or not." After abandoning the Gas6 project, Myles helped his lab mates with their research on the underlying molecular mechanisms of host restriction factors, which are anti-viral proteins that constitute a first line of defense in preventing viral replication and propagation (9), in HIV infection. Six months later, McGill University began ramping down all research activities due to the COVID-19 pandemic.

Fortunately for Myles, he was granted a new project to discover the functions of SARS-CoV-2 accessory proteins. Coronavirus accessory proteins are highly variable in number, location and size; although not required for virus replication, they are associated with pathogenicity in the host (10). However, the molecular functions of many accessory proteins continue to be unknown due to the scarcity of commonalities with accessory proteins of other coronaviruses (11). To explore these new proteins, Myles screened all the different proteins in various cell lines and is currently working on generating mouse models for each of these proteins to observe how they

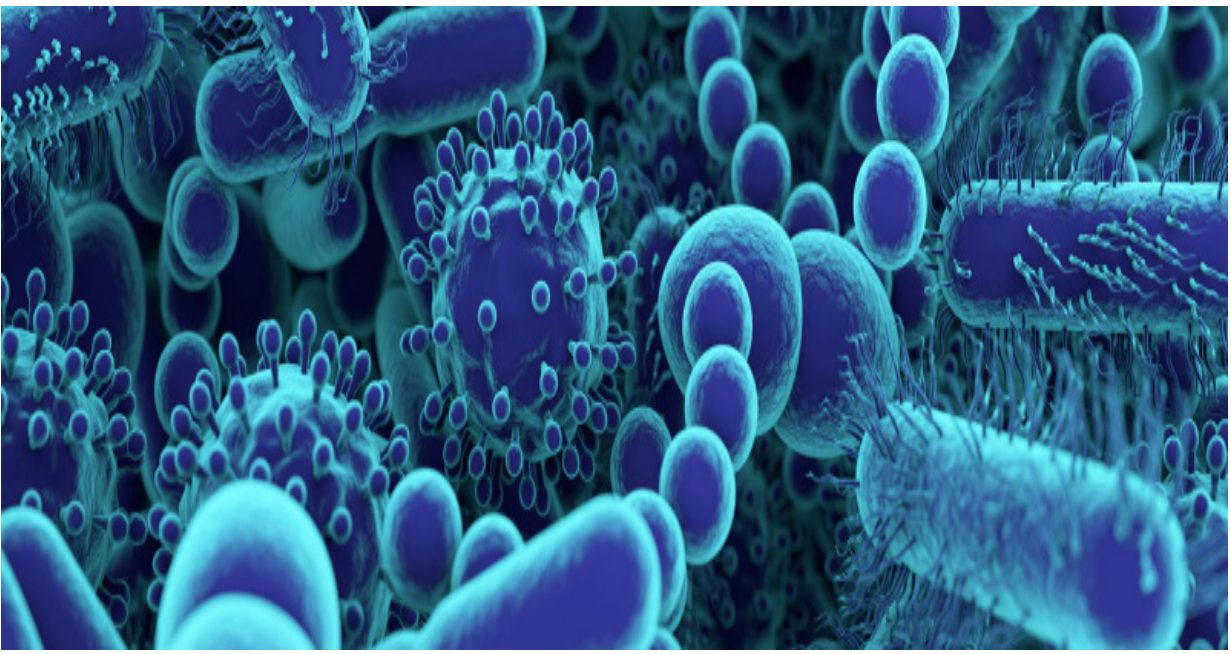

Photo credit Cedar Sinai

function individually in vivo. When asked about hiccups along the way, Myles admitted that a new technique he is using for generating adeno- or adeno-associated viral vectors to express the proteins to infect mice with was a little tough and has taken a lot of time to perfect. But he says that his challenges are not unique to him. "Most grad students spend a lot of time trouble-shooting, you try a new system that you haven't done before, try a bunch of different things and hope that it eventually works. I had plenty of support from my two supervisors and lab members. Right now, pretty much the rest of the lab is also working on COVID and there's only one other person who's working on HIV."

Although Myles's project is not in the hopes of developing new drugs or vaccines for SARS-Cov-2, understanding the mechanisms by which the accessory proteins function is just as crucial and will pave the way for future advances. "We think it's important to see how these viruses' function because they are quite complicated, as far as viruses go. And this is the third major outbreak of a highly pathogenic coronavirus in the last 20 years. So, this might be something we'll have to deal with more and more in the future. Understanding how these proteins work and how they suppress our immune system is kind of important."

In addition to Myles, other investigators are also cur rently uncovering accessory proteins in the novel coronavirus. For instance, Nevan Krogan's research group at the Quantitative Biosciences Institute in University of California San Francisco recently predicted nine accessory protein open reading frames, which are sequences in DNA that have the ability to be converted to protein (12). Moreover, Michel and colleagues in Strasbourg, France, used a computational tool to further delineate sequence properties of SARS-CoV-2 accessory genes (10). Research from dedicated scientists just like Myles continue to help piece together how the new coronavirus behaves and reveal the complex biology that is powering the COVID-19 pandemic.

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FEATURES

PODCASTS FOR PANDEMIC TIMES

BY ERIKA SCOTT

Are you curious to learn more about infectious diseases as a result of the COVID-19 pandemic? Looking for science-related conversation topics for that future social gathering? Or just sick of staring at the same four walls of your bed-living-office room day-in and day-out? Then you've come to the right place. There are so many science-related podcasts out there that it is often difficult to know where to begin. I've listened to a few and have put together a list of some of my favourites so far (including some Canadian content) to get you started. The following podcasts will provide you with some fun science-related facts to help make your work-from-home days a little less boring and socializing in that post-pandemic party a breeze.

PHOTO CREDIT WALLACE CHUCK

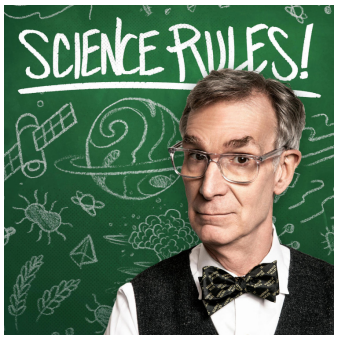
This Podcast Will Kill You

Have you ever wondered what cocktail pairs well with smallpox? Believe it or not, this podcast will answer that, as well as your other cocktail-infectious disease pairing questions. Despite the ominous title, this is a fun i podcast that was started by two disease ecologists and epidemiologists while they were still in graduate school. Erin Walsh and Erin Allmann Updyke begin each episode with a short introduction to the infectious disease that will be the focus of the episode, and then it's "quarantini time" – the two Erins give the name and recipe of their infectious disease-inspired "quarantini" (alcoholic version) and "placeborita" (non-alcoholic version) that the listener can drink while listening to the episode. The rest of the episode typically includes information on the history of the disease by one of the Erins and then a deep dive into its biology by the other Erin. Neither Erin claims to be an expert on most of the topics discussed, but both have a genuine interest in researching and discussing what they know about different infectious diseases. This, in addition to the laid-back and unscripted style, is what makes the podcast easy to listen to; the Erins reportedly don't practice or even know what the other will talk about beforehand so that their conversation is more natural. Infectious diseases covered include influenza, botulism, Lyme disease, and of course, the COVID-19 pandemic.

During the COVID-19 pandemic, This Podcast Will Kill You started a series called "Anatomy of a Pandemic", in which the Erins discuss the biology of SARS-CoV-2, the COVID-19 disease, epidemiology, vaccines and economic impact of the pandemic.

In the interest of open science, this podcast's website(1) provides links to the sources used to find information on each disease. The website also gives more information about the two hosts, transcripts of each episode, and provides recipes for the "quarantinis" and "placeboritas" featured in each episode – time to start planning that post-pandemic party!

Science Rules! with Bill Nye



Hosted by none other than Bill Nye the Science Guy, along with science writer Corey S. Powell, this podcast is essentially an extension of the old 90s TV show, bowtie and all (at least that's what we're led to believe from the logo). It tackles common scientific topics such as genetics, evolution, climate change and antibiotic resistance, and aims to make the discussion around those topics readily understandable to the average listener. The style is similar to a radio show where Nye discusses a scientific topic, usually alongside a guest who is an expert in the field, and then takes questions from listeners who either call or write in about that particular topic.

When the COVID-19 pandemic began, the podcast started a "Coronavirus Edition" series that seeks to answer everything related to the pandemic from the risks associated with grocery shopping to the differences between the vaccines available. Notable experts that have joined Nye on the "Coronavirus Edition" of the podcast include Drs. Francis Collins (director of the USA National Institutes of Health), Anthony Fauci (head of the USA National Institute of Allergy and Infectious Diseases), and Siddhartha Mukherjee (author of The Emperor of All Maladies and The Gene). Science rules!

Science Vs

The "myth-buster" of science podcasters, Wendy Zukerman, a science journalist, aims to get to the bottom of controversial topics and fads. Ever wondered if you should be taking vitamins and supplements? If vegans are onto something others aren't aware of? If organic food truly is better for you? These (and other non-food-related) topics are all investigated by Zukerman and her team, and sometimes the answer isn't what you wanted to hear.

Zukerman starts the podcasts by introducing the topic or fad, often in a witty or sarcastic way (complete with lame sound effects), and draws us in with her catchphrase that goes: "when it comes to [insert fad here] there are lots of opinions…but then there's science."

Part of what makes this podcast interesting is that Zukerman doesn't always interview academic or clinical experts. For instance, in the episode about organic food, Zukerman talks to farmers who grow both organic and non-organic food to get their opinions on the farming practices associated with both. She also will occasionally interview consumers or "everyday" people as well. As a result, we often get to hear from both "sides" or from those who have first-hand experience.

Throughout the COVID-19 pandemic, Science Vs hosted a "Coronavirus" series. In the same style as the regular episodes, Zukerman works to debunk myths that have arisen during the pandemic, such as those around asymptomatic spread, wearing a mask and vaccine development.

Since each episode often addresses a number of questions about the topic through interviews with a variety of individuals, Zukerman gives a recap at the end of each episode so the listener knows where the scientific evidence falls compared to public opinion. The topics presented in each episode are heavily fact-checked by Zukerman and her team, and all sources used are at the end of the transcripts that can be found in the show notes for each episode on their website(2). So, if you're one of those people who likes to bring up controversial topics at Zoom socials, be sure to give this one a listen.

Minding the Brain

Hosted by Drs. Jim Davies and Kim Hellemans, professors and experts in psychology and neuroscience at Carleton University in Ottawa, this podcast discusses all things brain-related including factors such as stress and drugs, sleeping and dreaming, brain disorders and mental health. Although they do occasionally interview other experts, this is more of a laid-back conversational podcast between the two hosts. The fact that the hosts draw upon many of their own experiences as professors and researchers makes it understandable and easy to listen to. As this is a neuroscience podcast, the hosts do not discuss the COVID-19 pandemic to the same extent that other podcasts in this list do. However, they do have one important pandemic-focused episode (so far) that discusses the effects of social isolation on mental health and well-being, what makes people believe in conspiracy theories, and how to encourage compliance to public health restrictions.

The podcast's website(3) provides more information about the hosts and episodes.

The Dose

Another Canadian podcast, The Dose, is hosted by Dr. Brian Goldman, a physician and medical reporter, and is part of the CBC Podcasts network. Similar to Science Rules! with Bill Nye, through short 20-30 interviews with (Canadian) experts, this podcast offers a Canadian take on different scientific topics and aims to break down the science to answer the most pressing questions in a way that is easily understandable to the average listener. As the podcast only began in February 2020, the majority of its episodes are related to COVID-19; these "give you a dose of smart advice" on topics such as the effectiveness of masks, whether it's safe to get takeout food from restaurants, how contact tracing apps work, and let's not forget the topic that has been on all of our minds throughout the pandemic: how to lose the "quarantine 15."

Nature Podcast

If you want to impress all your science friends with your knowledge of the latest research "from astronomy to zoology" published in Nature, this podcast is for you. Essentially a Nature RSS feed for your ears, each episode of Nature Podcast features a main topic, which is usually a research article published that day, and often includes an interview with one of the authors of the paper. Additional "Research Highlights" are also presented, as well as a discussion of the weekly "Nature Briefing." Although not necessarily geared toward making science understandable to the average listener, the hosts do a good job of breaking down and highlighting the main points of the research articles.

During the COVID-19 pandemic, Nature Podcast released a weekly "Coronapod" series that gives Nature's perspective on the latest developments of the pandemic often supported by interviews with experts. Topics covered include the pandemic origin story, COVID-19 antibody treatments and the development of vaccines.

Science Weekly

This is another great podcast if you're interested to know a little bit of everything. Hosted by science correspondents from The Guardian, this podcast covers a wide variety of topics including quantum mechanics, gene editing, the psychology around climate change denial, artificial intelligence and many, many others. Through interviews with experts, listeners get to hear about the latest research being conducted on each of these topics.

At the beginning of the COVID-19 pandemic, Science Weekly started a "COVID-19" segment where listeners can send in their questions and the science correspondents will ask these and other pressing questions to experts involved in the response to the pandemic. Relevant topics include why we're feeling burnt out by the pandemic, how vaccines can be modified to work against new variants, and how space travel and historical events, such as the London blitz, can teach us how to cope in isolation and stress.

Whether you're just wanting to pass the time or curious to learn new information about the pandemic itself or a variety of other science-related topics, the aforementioned podcasts are both interesting and informative. Through regular updates and interviews with experts, many of these podcasts have shown just how far scientific research has advanced throughout the COVID-19 pandemic, from learning more about the virus itself to developing and producing vaccines. As we eagerly look forward to those post-pandemic parties, for now, let's virtually bond with each other and the podcasters over our shared love of science. To echo Bill Nye: "Now, more than ever, science rules!"

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The COVID-19 Pandemic:

Nature's Unexpected Reset Button

BY HEATHER GERRIE

PHOTO CREDIT TECHBAST

With over 115 million cases worldwide and a staggering 2.55 million deaths, the impact of the COVID-19 pandemic on human health has been severe [1]. While the health outcomes of the pandemic are apparent, the global lockdowns aimed at slowing the spread of the disease have negatively affected other areas of human life as well, including mass economic downturns, political polarization, and international border closures [2].

However, a series of environmental silver linings have emerged from the ongoing global disruption. As industry, transportation, and businesses ground to a dramatic halt under the strict lockdown measures that had 2.5 billion people staying at home in 2020, there was an equally dramatic reduction in pollution and greenhouse gas emissions [2-3].

As traffic decreases, air quality improves around the world

A striking example of this can be seen in New York City. Within a month of the March 2020 lockdown, air pollution levels in the city were down 50% compared to the previous year [4]. This could largely be attributed to the massive reduction in city traffic, as motor vehicle exhaust is a significant factor in urban air quality and contributor of greenhouse gases like CO2 [4]. In addition to CO2, the burning of fossil fuels in the form of motor vehicle exhaust produces 80% of the world's NO2 emissions. When NO2 interacts with oxygen and water molecules in the atmosphere, the product is acid rain – a known culprit behind several respiratory diseases in humans [5]. Due to the COVID-19 lockdowns and resulting reduction in car and truck exhaust, NO2 levels decreased by 30-60% across Europe, 25% in the United States, and an impressive 70% in Delhi, India in 2020 [6-8].

The coronavirus lockdowns in India significantly improved the air quality

In addition to motor vehicles, aviation is a significant contributor to air pollution and greenhouse gas emission. Due to the worldwide restrictions on air travel, air traffic decreased by over 90% in 2020 [9]. The positive impact this has had on air quality is clear. In China, decreased international and domestic flights caused a 17% drop in national CO2 emissions [10].

Industry closures reduce greenhouse gas emissions

Transportation is not the only sector which contributes to air pollution. The COVID-19 lockdowns also resulted in the forced shutdown of industries and factories, which produce a significant amount of greenhouse gas emissions [2]. As a result, atmospheric scientists reported steep declines in the levels of greenhouse gases produced by countries with high volumes of heavy industry. For example, levels of N2O have dropped by 50% in China as a direct result of COVID-19 lockdowns. While N2O accounts for only 6.5% of greenhouse gas emissions – compared to 81% from CO2 – it is markedly more potent. The impact of 1 pound of N2O on global warming is 300 times more than 1 pound of CO2 [11].

Greenhouse emissions dropped due to halted flights around the globe

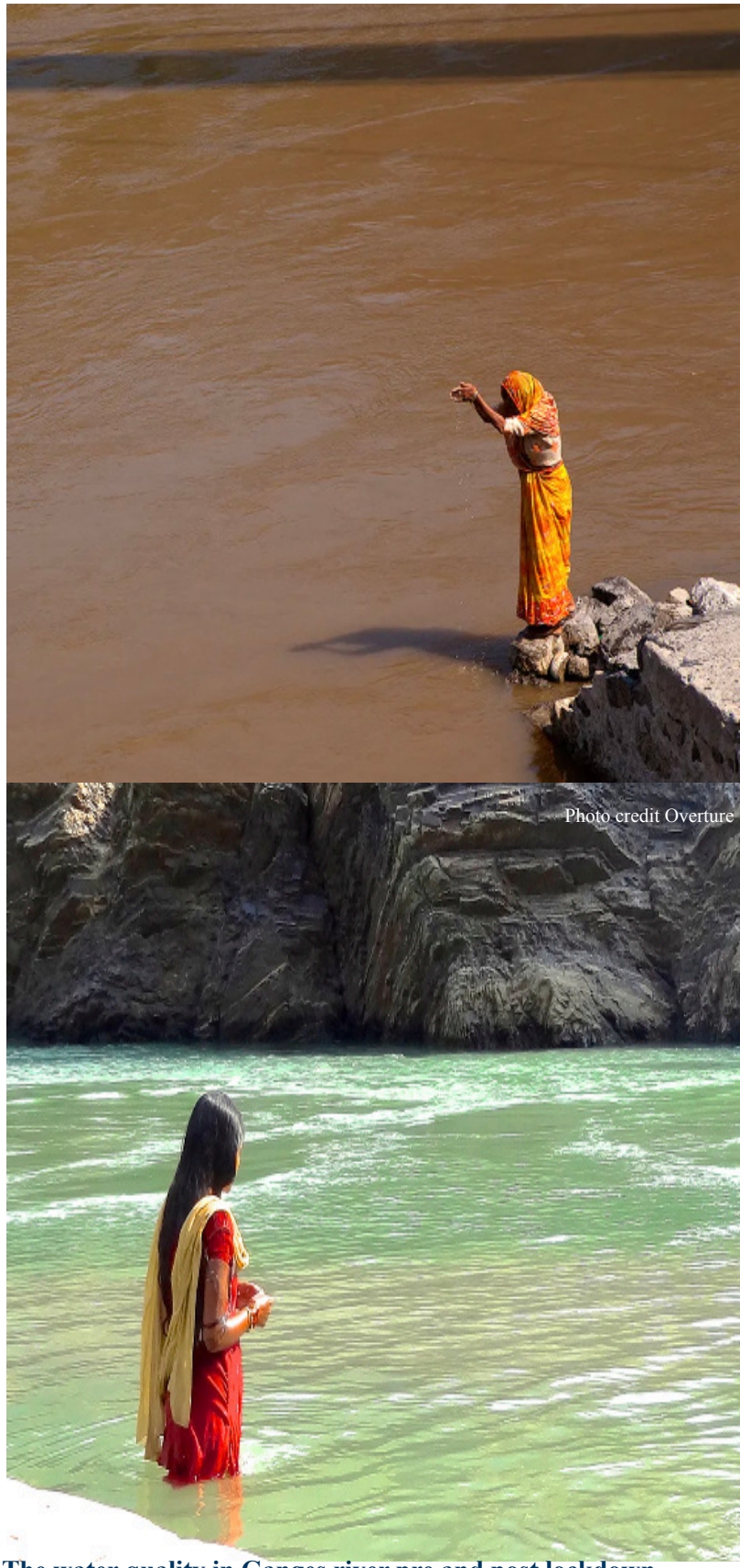
While reducing air pollution and greenhouse gas emissions are critical for combating the effects of cli-

mate change, there are also significant implications for human health. Upwards of 90% of the global population lives in areas with poor air quality, and indeed air pollution is the third leading cause of death worldwide [12]. The decline in air pollution due to reduced emissions from transport and industry also represent an encouraging step towards improving global health.

Water pollution decreases and the rivers run clear

Just as the air quality has improved during the COVID-19 lockdowns, water systems are clearing up as well. Flowing through India and Bangladesh, the Ganges River is one of the largest rivers in the world. The Ganges is a lifeline, providing daily water for over half a billion people, home to 140 species of fish and 90 species of amphibians, and revered as holy by Hindus [13]. However, the Ganges is also famous for being severely polluted with human and industrial waste. Prior to 2020, the bacterial levels in the Ganges were more than 100-fold above the limit for safe drinking water [13]. Due to the COVID-19 lockdowns shuttering factories and reducing the number of visitors to the river, the Ganges has seen a 500% reduction in pollution [14]. For the first time in decades, over half of monitoring stations along the river reported that the Ganges met the national drinking water quality standard [15].

While the Ganges is a landmark example of how quickly water systems can clear up when natural systems are given a respite from pollution, it is not the only place where the water is cleaner. Due to the COVID-19 lockdown reducing water traffic and pollution, the Grand Canal in Italy ran clear for the first time in a decade and many long unseen aquatic species reappeared in the waterway [16]. Reduced tourism and a slowing of the shipping industry resulted in less emission and marine pollution. The beaches of Bangladesh, Malaysia, Thailand, and Indonesia are also showing markedly cleaner water and a return of native species as a combined decrease in tourism and the shipping industry resulted in less emissions and marine pollution [2].



The water quality in Ganges river pre and post lockdown

Tourism declines and ecological restoration improves

The tourism industry accounts for almost 10% of global greenhouse gas emissions, and while travel restrictions have lowered the amount of emissions, the starkest changes are the behaviour of animals around the globe [17]. With the reduced pollution and waterway traffic, dolphins returned to the Bay of Bengal in Bangladesh and the canals and ports of Italy [18-19]. As noise pollution and air traffic also diminished, bird species of all kinds began flourishing, with migratory birds staying longer in sanctuaries and bird populations surging. In Albania, the population of pink flamingos along the coastlines increased 30% between 2019 and 2020 [20]. The waters off of Thailand have seen an increase in the population of dugongs, or sea cows, which are classified as a vulnerable species due to water pollution and detrimental fishing practices [21]. While overall poaching rates in Sri Lanka have increased, the lockdowns did give Asian elephants a reprieve from the criminal act. Elephant kills were down 40% in 2020 compared to 2019, a definite win for Sri Lanka's 7,000 remaining endangered Asian elephants [22].

Deserted St. Mark's Square Venice Italy on May 13 2020

Moving forward: what comes next?

COVID-19 provided nature with an unexpected opportunity to hit the reset button. However, the positive effects of the pandemic on the environment are short-term and indefinite. As international borders and industries begin to reopen as the COVID-19 vaccine becomes available, it is likely that business will resume as usual unless individuals make choices and governments make policies that will maintain the positive environmental outcomes we now know are possible.

Practically, conservation authorities could implement periodic closures of natural spaces with high levels of tourism to decrease the pressure on ecological systems and promote habitat restoration [2]. It could also include improvements in the infrastructure of both municipal and industrial wastewater treatment to maintain the increased health of marine ecosystems [2]. It is now apparent that restricting fossil fuel emissions from both industry and transportation sectors results in a sharp decrease in air pollution. To maintain the improved

Governing bodies should invest in more clean energy resources to maintain improved air quality

air quality in the future, governments should look to invest in and encourage the use of green transport and renewable energy sources as an alternative to fossil fuels like coal, oil, and natural gas [14].

Working together: what COVID-19 has taught us about global efforts

While these may seem like impossible tasks, the global effort shown over the past year to develop a vaccine and mitigate the spread of COVID-19 have demonstrated the power of international cooperation and humanity sharing a common endeavour. Just as COVID-19 represents a threat to human life, so too does the climate crisis. Thus, the positive environmental effects witnessed during the pandemic should encourage us that it is still possible to change the trajectory of the Earth's health and inspire us to seek a sustainable future.

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Countries are coming together and working with each other to sustain the world's health

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LIFESTYLE & IMMUNITY IN THE AGE OF COVID-19

BY DEVIN BOX

Photo credit DisobeyArt

In many ways, the COVID-19 pandemic has affected the lives of all Canadians. Dramatic changes in our social and work lives, the donning of face coverings, and increased sanitation practices are just some of the ways life has looked different over the past year. With the goal of preventing the spread of COVID-19, most of these lifestyle changes revolve around the protection of physical safety. Limiting exposure through physical distancing was and is still considered one of the best ways to slow COVID-19. In spite of this, social discourse on the health benefits of meaningful human connection has increased, and consequently, a growing emphasis has been placed on investment in physically distant human connection. Indeed, it has become increasingly evident that the often underdiscussed social and psychological changes adopted over the past year have had direct implications on the biological health of communities. A growing body of literature in the field of psychosocial determinants of health has demonstrated the intimate connection between our biological, psychological and social health; showcasing the negative impacts of poor social connectivity

on our immune system (1). To many, the psychosocial approach may seem foreign, as the traditional view of health focuses heavily on biomedical factors. However, a more nuanced understanding of psychosocial factors can provide a more holistic approach to a healthy lifestyle, even beyond the pandemic. A summary paper written by Dr. Sheldon Cohen in Perspectives on Psychological Science eloquently highlights the importance of psychosocial factors for immune function in response to upper respiratory infections (2). Due to the pathological similarities of other upper respiratory infections to COVID-19, insights from the work of Dr. Cohen and colleagues has the potential to influence policy and decision making during the COVID-19 pandemic. This piece seeks to highlight and provide context for a series of experiments conducted by Dr. Cohen on psychosocial health determinants and their implications for the COVID-19 pandemic and beyond.

Lead in/biopsychosocial model

To contextualize the work of Dr. Cohen and its importance for the COVID-19 pandemic, it is first important to understand the integration of psychological and sociological factors of health into the well-known biomedical model. The biopsychosocial model of health is our current understanding of this relationship. First proposed in 1977, the biopsychosocial represented a novel conceptualization of health (3). The emergence of the biopsychosocial model directed more attention to psychological and sociological health research fields; with greater emphasis placed on the subjective experience of health today. In this context, the subjective experience of illness can exert effects on the biological course of illness, and vice versa. In examining COVID-19 through the biopsychosocial model, it becomes apparent that our physical and social environments can have a powerful effect on our illness experience and have the potential to influence our ability to mount an effective immune response.

Contrast the traditional social analysis with a more integrated one

Social determinants of health can be approached in a myriad of ways. For the sake of the overview provided herein, social determinants will be broadly categorized into population level and individual level determinants based on the outcomes measured. At the population level, this field of research aims to identify differences in health metrics across a variety of demographics. For example, recent studies have shown emerging inequities within racial and socioeconomic groups regarding the number of cases and deaths from COVID-19.

> **"A doubling of the death rate has been observed in New York when comparing black and white populations (20 and 10 deaths per 100,000 respectively)."**

As of April 27th, 2020, Toronto's lowest income quantile saw 113 cases per 100,000 compared to 73 cases per 100,000 in the highest income quantile (4)(Public Health Ontario 2020). Analyzed at the population level, many determinants of health relate directly to the ability of the system to address individual health needs (i.e. access to health care, cultural barriers between physicians, and lack of financial resources)(5). Going beyond the provision of, and access to health resources, a more challenging question to answer is whether the quality of individual social connections can be considered a determinant of health, and importantly, affect immune response. Population level social determinants cannot capture the level of detail required to answer such questions. In contrast, analyzing social determinants of health at the individual level, through measures such as validated self-report questionnaires, can. The work of Dr. Cohen and colleagues emphasizes highly

controlled and individualized interventions to answer these questions on both social and psychological levels.

Psychosocial vulnerabilities to upper respiratory infections paper summary

A series of experiments outlined by Cohen and colleagues illustrate how different psychological stressors can affect our immune response to upper respiratory infections. Psychological stress occurs when an individual perceives that environmental demands exceed one's capacity to adapt (6). In their 1991 study, Cohen and colleagues found that participants who scored higher on a self-report stress index were 2.16 times more likely to develop a cold when exposed to rhinovirus particles (7). Cohen and colleagues also found that interpersonal problems and underemployment were two of the most powerful predictive factors for subsequent infection; a particularly concerning realization when considering the psychosocial consequences of the COVID-19 pandemic (8). Given the significant psychological stress associated with reported increases in underemployment caused by COVID-19, a greater emphasis should be placed on employment protection (9).

Photo credit Lauren Bauer & Adrinna Pita

The COVID-19 pandemic impacted the unemployment rate in many nations

Cohen et al. note that the extended duration of these types of stressors that may put the immune system at risk. In a follow up study, Cohen et al. identified proinflammatory cytokines as a mediating factor in this relationship (10). Released in response to an infection, cytokines act to coordinate the overall immune response. Appropriate amounts of cytokines are vital in the elimination of viruses; too many cytokines, however, can have toxic effects. Investigating this relationship, Cohen and colleagues measured cytokine levels in nasal secretions before, and five days after viral exposure. Participants who recorded higher perceived levels of stress at baseline, produced higher levels of cytokines and subsequently experienced more symptoms. The researchers hypothesized that chronic stressful life events could potentially alter the feedback pathway governing cytokine levels, potentially leading to more inflammation. Indeed, when exposed to synthetic cortisol, immune cells were found to be unresponsive (11, 12). Under times of high stress, it is hypothesized that immune cells may become desensitized to cortisol, resulting in decreased immune function as a consequence of increased inflammation. The implications relating to COVID-19 are quite clear: major stressful life events can interfere with our ability to coordinate our bodies' defense systems. Should high states of psychological stress be left unattended, large portions of the population could be more susceptible to severe viral infections. This very effect has already been documented in a recent study that found evidence linking increased cytokine levels to disease severity in COVID-19 (13).

In examining social determinants of health, two main factors can be considered: social integration, and social support. Social integration refers to the degree to which an individual participates in a broad range of social relationships (14), and is generally defined as the number of social roles one plays (spouse, parent, volunteer etc.). Greater social integration is predictive of many health metrics and is thought to operate based on social pressures to adopt healthy behaviours. These healthy behaviours then reinforce healthy psychological states. Cohen and colleagues found that individuals with the lowest social integration scores were 4.2 times more likely to develop a cold following viral exposure. In contrast, the most socially integrated individuals were not only at decreased risk of developing colds, but those who did also experienced less severe symptoms (15). In mediating the effects of social integration, social support refers to the resources provided by an individual's social network in the face of adversity (16).

> **"It has been shown that greater levels of perceived social support can protect against the increased infection susceptibility caused by lower levels of social integration."**

Individuals with a lower number of social roles can benefit from higher levels of social support (17). In examining the COVID-19 pandemic from this lens, it becomes increasingly important to adopt balanced and targeted approaches to reducing transmission whilst considering the implications of meaningful social interaction and connection. Finding this balance has not only illuminated the impact of quality social interactions on overall health, but also expanded our understanding of which social and environmental factors have the greatest impact on our immune function.

Conclusions

The variety of lifestyle changes brought forth by the pandemic highlight the importance of holistic approaches to health. Under the guidance of the biopsychosocial model of health, continued efforts to promote psychosocial wellbeing should be undertaken in conjunction with physical forms of health promotion. Evidence suggests that the often-forgotten psychological stress and social isolation experienced during the pandemic may serve to negatively impact the ability of our immune systems to fight future infections. Moving forward a variety of steps can be taken to better promote our collective health. It is imperative that both individuals and communities play a vigilant role in upholding physical distancing practices whilst addressing and nurturing overall psychosocial health. Raising awareness about the importance of psychosocial wellbeing during the pandemic has the potential to protect communities from potentially deadly consequences of COVID-19. In a technologically advanced society, it has never been easier to connect with those around us at a distance. Successfully navigating the pandemic requires a delicate balance of policies, practices, and individual actions. Although a great challenge, the importance of psychosocial health during the COVID-19 pandemic serves as a message of empowerment. Our understanding of health need not be limited to a narrow view of pathology alone. The role we all play in the promotion of collective health may indeed, be more important than we previously thought.

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The crux of research ethics in pandemic-driven decision making for resources allocation

An exclusive look at the concerns of the acting human research ethics board chair in one of the most historic global pandemics

BY MARK IMAN
& TAMANA YOUSOF

VISUAL ROBERT RYAN

COVID-19 has had a major impact on everyone. As many readers know, the impact of COVID-19 on the research community has been profound – access to research resources, including space and money has been greatly restricted. Researchers, on one hand, are those individuals who should be able to help us deal with the pandemic, and on the other hand have struggled to keep their labs running. While COVID-19 has made it more evident, this conflict of interest is present all the time; researchers decide where valuable research funding should go, and researchers need money in order to perform their own research. The purpose of this article is to remind researchers to be aware always of how their research might be helpful and who is paying for it.

Although the disease associated with the SARS-CoV2 virus is known as COVID-19, for most of us it is linked to most of 2020 and hopefully less of 2021. I remember the first time that I thought "Whoa, this is serious" was when the first Hamilton resident, a physician tested positive. I taught a class that afternoon and that was the last live teaching that I have done. The next day I bought a Zoom account and that is where I now spend much of my life.

Picking an aspect of this pandemic to write about was not easy; there have obviously been, and will continue to be devastating consequences for many people. I do not want to belittle this impact. However, we can't ignore the fact that there have been many unexpected positive outcomes (I've had 106 weekly Zoom meetings with extended members of my and my wife's family). I try not to think too much about how it took a lethal pandemic for us to start an activity that we should have been doing anyway.

I've chosen to write briefly about the impact of COVID-19 on research activities. Since the start of the pandemic, HiREB (the Hamilton Integrated Research Ethics Board) has processed 167 new research studies requiring human participants and directly related to COVID-19. Most of those seemed to come in the first week. Many of these are amazing and vital. Studies aimed at developing and validating rapid diagnostic tests have already put important tools into the hands of front-line workers. Studies aimed at demonstrating the safety of personal protective equipment were started at McMaster and have been embraced by the WHO as being essential in ensuring the safety of front-line health care workers.

Research on PPEs started first at McMaster University

McMaster researchers rapidly started essential clinical trials that quickly demonstrated the futility of interventions that were put forward as being useful in combating COVID-19. Chairing the research ethics during this time has been immensely rewarding. The HiREB team worked round the clock for the first two months of the pandemic to ensure that essential research was structured in an ethically feasible manner and that studies started as quickly as possible.

There is no doubt that the crisis has acted as a catalyst for research, and much of it has been outstanding. But, 167 is a big number! Many of you work in labs that have been shut down for periods of the last year, based on research activity deemed nonessential. Sound oversight from above, aimed at preventing spread of the virus shut down research activities not addressing COVID-19 or deemed not essential for other reasons. Not surprisingly we received many applications where researcher simply inserted the word COVID into existing research activities. Rather than point fingers, I will use an analogy. If you are a baker and make your living writing books on how to bake cakes and are told that the only books that can be published need to deal with COVID-19, you are going to write a book with the title "How to bake a cake during the COVID pandemic".

I was also asked to sit on a "rapid call" CIHR grant review panel, assessing applications aimed at improving COVID diagnosis. In the past, every CIHR panel I have been on involved applications with an average score above 4 on a scale from 0-5, with rare grants receiving scores less than 3. This reflects the outstanding quality of medical research in Canada. On this rapid COVID panel, however, of the 12 grants I looked at, only one of them received a score greater than 3 (it was outstanding!). The rest were diabolically bad.

I have thought about these two observations, where researchers are putting in research of questionable relevance (baking a cake during COVID-19 is not that different to baking it at any other time) and quality. It reminds me that our jobs are based on an ongoing conflict of interest. One way in which we look at a call from the CIHR to address COVID-19 is "Oh good, my ideas can be used to help fight the pandemic",

while another view is "Ooooh, Money!!". I have run a lab for many years, I know that I have often thought "Ooooh, Money!" As researchers we need money to run a lab, to pay students, to buy mice – none of that is cheap! I have written grant applications with aims that are versions of baking cakes in the face of adversity.

Four years ago, something happened that changed the way that I think about research money. The Firestone Institute for Respiratory Health (where I work) decide to raise money in a fund-raising activity. I wrote a letter that I sent to my family and friends, describing the unmet needs of patients with lung disease. I talked about my father, who had suffered from severe asthma his whole life. I told people that I knew that their money was precious and that they needed to choose where to give it carefully, but that if they chose to give it to us, it would be well spent. My letter better than I had hoped. I raised $11,000 and my brother who had just retired after working for 40 years at the post office gave us $5,000. That knocked me over. For the first time in my career, I looked at the money completely differently. I asked the Firestone director where the money was going to be spent – to buy a new bronchoscope that would be used by clinicians in procedures that they would be able to bill for. "Not a chance not with my brother's money you're not!". As a result, I was put in charge of a committee to decide where the money would go, and we used it to create several graduate studentships.

We all work as researchers; the goal of research is creation of knowledge that addresses needs. Those needs (especially over the past year) are manifest and clear. The work that we do as researchers costs money, which we need to find. That creates confusion, where the finding of the money can be equated with success. When I was forced to ask myself whether I would be prepared to take my brother's retirement savings and spend it on a new way to bake a cake, I became profoundly uncomfortable. I am not suggesting that we need to be better at sorting out who is doing the best research, there are all sorts of tools in place to do that. I do think that as researchers we need to be constantly aware of who the research is for, and who is paying for it.

Mark Inman, MD PhD
Professor, Dept of Medicine
Chair, Hamilton Integrated Research Ethics Board

De-Bunking COVID-19 Misinformation

BY SARAH LAFRAMBOISE

VISUAL ALBERTO MIER

In the midst of a worldwide pandemic, COVID-19 has drastically impacted lives around the world. In the early days of the pandemic, information was changing on an hourly basis; news outlets, and social media were filled with contradicting advice, opinions and coverage of the virus's progression.

Termed an "Infodemic" by the World Health Organization, this "overabundance of information" (1) has infiltrated the lives of billions around the world and has found to be incredibly harmful to physical and mental health. Indeed, a glimpse into the dangers of this was given to the world when former President Donald Trump hailed chloroquine as the "game changer" treatment for COVID-19. A man and his wife decided to take this information into their own hands and proceeded to ingest chloroquine found in aquarium cleaners. Unfortunately, the man died, and his wife was left in critical condition (2).

Astonishingly, a survey done in May of 2020 from the School of Journalism and Communication at Carleton University showed that nearly half of Canadians believed in one of the major COVID-19 conspiracy theories. Interestingly, individuals who believed these conspiracies spent more time on social media and were thought to potentially share this content on their social feeds (3).

What is Misinformation?

During the COVID-19 pandemic, misinformation has flooded our timelines and scientists have struggled to keep up with the combat against each permutation of new "information". Misinformation is "false information that is spread, regardless of intent to mislead" (4). Importantly, misinformation does not have malicious intent behind it, and most often is spread without meaning to cause harm. In contrast, disinformation is spreading "deliberately misleading or biased information" (4).

A large contributing factor fueling misinformation is inconsistent messaging and inaccurate sources of information. These factors are amplified on social media platforms, where algorithms can create echo chambers. This occurs when users are only exposed to information that they already agree with. This can be dangerous as it reinforces the users belief by continuing to expose them to conspiracy theories and misinformation (5). Studies have shown that most COVID-19 information on social media is obtained on Facebook; with Reddit, Twitter, TikTok and YouTube as the next most popular (6). As a vital source of information to the public, social media platforms often struggle to balance the right of freedom of speech and opinion with information that could cause harm.

Now more than ever, we are understanding the true consequences of these actions, since the impact of this information could save lives.

Three COVID-19 Myths:

1. COVID-19 is no worse than the flu

In the early days of the Pandemic, even before COVID-19 had reached North America, arguments arose about how COVID-19 compared to the flu (caused by the Influenza virus). What really sets the two apart, is the death toll. The trouble is that the measurement of deaths caused by the flu is purely estimation. As such, the CDC estimates that the between 25,000 and 60,000 people die every year in the United States from the flu (7,8). These stats were highly publicized by President Trump when he relayed these facts to the media is astonishment and attempt to downplay the severity of COVID-19 (9).

To reach this estimation, the CDC takes the amount of confirmed deaths per year (an average of 3,448 to 15,620 per year over the last five years), and multiplies it by various coefficients that help project the total amount of unreported flu deaths. This makes it incredibly difficult to compare the severity of the two infections. The best way to compare would be the strictly compare confirmed deaths (9). In this case, COVID-19 deaths in United States over the last year have surpassed 550,000 (10). It becomes obvious that this is significantly worse.

In addition, given how common the flu is, people typically have some form of immunity against it. Since COVID-19 is new, this is not the case, meaning individuals are more likely to become infected and become ill.

2. You don't need to wear a mask.

In the early days of the pandemic, health officials reported that healthy individuals did not need to wear a mask. However, mere months later, health officials recommended mandates to enforce mask-wearing as a means to combat the spread of the virus. It is now, over a year later, that mask-wearing is universally accepted amongst health officials. This contradictory information led to vast confusion amongst the public. Public figures, such as President Trump, rejecting these guidelines only fed the anti-mask movement (11).

At the end of the day, all research suggests that wearing a mask is the best way to protect yourself and others from COVID-19. Additionally, individuals who are asymptomatic or pre-symptomatic can also spread COVID-19 (12). This is mainly because of the mode of transmission of COVID-19, which typically spreads through aerosol droplets. This is released into the air when someone talks, coughs or sneezes (13).

3. Any COVID-19 vaccine is unsafe.

Conspiracy theories have driven many misconceptions about the COVID-19 vaccines. Before they were even released, stories of Bill Gates using the vaccines as a way to microchip the population spread like wildfire. In general, misinformation around the vaccine has suggested malicious intent from wealthy individuals attempting to harm or brainwash populations with the vaccine.

These extreme allegations have always been without evidence, but they have a large impact on perception of the vaccine. A recent poll showed that only about half of Canadians would get the COVID-19 vaccine (14).

The COVID-19 vaccines are safe and effective. We now have a variety of options on the market, which can get a bit overwhelming, but the best vaccine for you is the one that is available for you to get. The benefits of the vaccine strongly outweigh the risk of COVID-19 (15). The vaccines have been under heavy regulations over the last year, and are approved by the corresponding regulatory boards. Most recently, cases of rare blood clots after the Oxford Astra-Zeneca vaccine have caused turmoil in vaccination efforts (16). It is important to remember that the scale of vaccination (reaching 1 billion people) is incredibly large (17). This means that incredibly rare events are bound to happen, but they are still extremely rare.

How can you combat misinformation?

#ScienceUpFirst is a new social media initiative to combat the spread of COVID-19 information. Backed by dozens of scientists and communicators, the goal is to amply voices of trusted and respected scientific information. Ultimately, the way to combat misinformation is by empowering the public to think before they click, share or engage with information online (18). You can follow them of social media for the most up to date data to fight COVID-19 misinformation.

We each have a role to play, and despite our best efforts this is not an issue that will be going away anytime soon. Take the time to talk to family and friends. Most COVID-19 misinformation comes from a place of fear, so listen empathetically and meet them where they are.

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SHORT FICTION

Photo credit Alin Luna

Pandemonium

Story by Kevin Mercurio,
University of Ottawa

It happened to everyone overnight.

Every.

Single.

One.

The software just continued adding names to the list. Person after person, with details of when, where and how they broke the rules. The real problem was that we couldn't stop watching the list grow. The more people who tuned in, it seemed, the faster the list grew, as if hits were feeding the artificial intelligence. Governments and privacy activists urged the public to delete the software, but this only induced the social phenomenon known as the Streisand Effect.

How could this have happened? It was only just over a year that a seemingly innocuous headline appeared out of the Hubei Province in Central China. Around the end of 2019, the local government of the largest city in Hubei, Wuhan, confirmed that health officials were treating many cases of pneumonia. At the end of January 2020, the World Health Organization declared a global health emergency.

In February 2020, a man in the Philippines died due to the disease caused by the novel coronavirus (still yet to be given the name COVID-19), followed by France, Italy, Iran, Brazil and the United States. Canada followed suit with its first reported death in early March 2020.

Then a tsunami of lockdowns ensued. Non-essential businesses were closed down such as restaurants, fitness centres, and retail stores. These were the first of a multitude of government rules that propagated through the globalized community. Social distancing advised people to either reschedule their plans to a later, undetermined date, or keep a 2-3 meter distance from each other at all times. Indoor gatherings required participants to wear face coverings like surgical masks or cloth masks. N-95 mask stocks required by frontline healthcare workers were getting slimmer and slimmer by the day.

People were scared. People were anxious. People were confused. Will people's livelihoods ever bounce back to normalcy? Will residences be foreclosed, or will renters be able to stall eviction? Will local shops lose their businesses, leaving the top superstores scarce in any competition? Will children and adolescents have the same productive experience through online learning? These questions continue to be asked even to this day.

What people imagined life would be like in a new decade was effectively sterilized like bacteria on hands after a suggested 20-second hand wash. Yes, no longer were the days when people would think about whether to wash their hands after a trip to the washroom. Even a trip to the grocery store needed sanitizer upon entry and exit, using what stores provided as well as your own private collection. Every trip outside just felt better concluding with a clean pair of hands.

With people locked away in their households, governments and firms were forced to evolve. People adapted to a virtual culture, both in their work life and in their social life. The face-to-face conversation became screen-to-screen mimicry, yet somehow the intimacy remained and even blossomed in productive introverts. Nonetheless, we were all still learning to utilize tools that seemed so excessive, so targeted to computer experts in your organization's IT Department. Applications like Zoom sprung into existence and were accepted with open arms. Who cares about privacy when one can seamlessly manage the artform of holding meetings.

It wasn't just governments and firms. People evolved. We didn't anticipate that in the span of only months, we developed this heightened sense of awareness. One could argue that as people transitioned online, our focus was mainly on electronic devices. That was, and is still, indeed the case. What I meant was that people began to notice incidences, both in the real and virtual world. When someone attended a rally in support of some group, when someone expressed opinion against some cause, people were there to publicize and criticize. No matter whether their political views, gender pronouns, or racial privileges were known, groups with opposing opinions were loud in their fervour. It wasn't so bad when draconian governments and firms were boycotted. But when people were boycotted, it felt different. The reasonings for boycotts seemed to be independent of time, of the situation of concerned individuals. Worst of all, there was no neutral stance on an excommunicated person. You were either in support of them or against the mainstream cause while participating in this polarized game.

The phenomenon was given the name "cancel culture". Of course, this was occurring before the COVID-19 pandemic, and most of this came from good intentions. Social justice movements like #MeToo and Black Lives Matter arose with cancel culture as a major component of each movement's machinery. Upheaval was easily coordinated through online groups and widespread communication methods. Smartphones were recording atrocities every second of the day, most were frequent occurrences that

were just hidden from public scrutiny for decades. People slowly became empowered and found their voice. Today, in pandemic times, this empowerment escalated exponentially.

With differences in national, regional and local policies, as well as individual opinions, people would be caught breaking some government restriction implemented to "flatten the curve". Evidently, flattening the curve became such a overused, political term that when epidemiologists and virologists tried to explain the scientific meaning behind the idea, people were already tired of hearing about it. They instead wanted to blame, wanted to point their gavel at those guilty of the unwritten law of transmission reduction. Citizens would be filmed hosting monstrous parties, refusing to wear masks inside Costco warehouses or outside on sidewalks, packing to travel for long delayed vacations. These videos were instantly uploaded to sites like Facebook, Twitter and the recently popular Tik Tok, combined with catchy-captions and humble-hashtags for search engine optimization. You were either a "flat-curve believer" by following public health guidelines perfectly, or a "flat-curve denier" in cahoots with a viral murderer. Platforms once used for correcting systematic oppression were now funneling videos of candid slip-ups, leaving a trail of life-shattering destruction along the way.

Then, it appeared, out of the virtual ether. The first records of the MASKaren platform were linked to posts by anonymous users of sites like 9gag and Reddit. MASKaren was originally a platform that allowed users to upload videos of people not wearing their masks. This was adopted by millions of users in just two weeks, oddly as long as the SARS-CoV-2 incubation period, shared through word-of-mouth and mainstream news alike. What was great about the platform was its innovative artificial intelligence; using facial identification software to effectively single out the rulebreaker's name and location, while giving them a "Karen Score" based on the rule they are breaking and their reaction to getting caught. Users were fighting to release videos in order to achieve a maximum Karen Score of 10. The highest score, being a 9.9, is currently a video of a white woman calling the police feigning being in danger, after a black man told her to put her mask on and leash her dog in Central Park, New York City. She was fired from her job less than a week later.

Names of every man and woman who was seen breaking government rules in a MASKaren video populated the platform's global ranking list. Its memetic popularity was extremely successful, as the world wanted to know which country had the highest-ranking Karen of all time. Following suit, like a tsunami of lockdowns in response to a microscopic enemy, online campaigns were organized against the top Karens on the list. Initially, these were the most serious offenders, those that were hosting parties of 100 people or more at secluded houses, or those demanding to remove their masks once on-board flights to the Caribbean. Public outcry led governments and firms to evolve yet again, to take this platform extremely seriously. Offenders were cancelled, quite literally, from the real and virtual world. They lost their careers, while also alienated by family and friends.

A movement, starting from good intentions like most justice movements, was created. Uploaders on the platform weren't just users, they were warriors, they were vigilantes out surveilling the world when authorities couldn't cast their eye in that particular direction, at that particular time. Users wanted to help, navigating the frightening and confusing world that gave most people such high anxiety. Positively speaking, protests against mask-wearing guidelines grew thinner and less often, as top MASKaren warriors flew drones above the mask-less crowds identifying hundreds of offenders in one video. No more will a modern, civilized society toler

ate flagrant abuse of freedom that consequences in potentially spreading a deadly pathogen.

Cancel campaigns, as they became known, were even more efficiently coordinated. Despite these campaigns affecting mainly those in the middle and lower class, high-ranking government, business and cultural elites were also taken down. A provincial minister going on vacation when advised to stay home? Cancelled. A popstar complaining about the cancellation of a popular music festival, while reducing the severity of the disease? Ironically, cancelled. There were no grey zones, no exceptions, when the current objective of the human civilization was to "flatten the curve".

Ambitious updates to the platform changed the way warriors became known and popular. Before, warriors with videos averaging the highest Karen Score would gain celebrity stardom. Now, warriors who identified the most offenders to populate the global ranking list rose to fame. The purpose of this monumental change, by the anonymous creators, was a way to deter those not taking the pandemic seriously by accelerating the cancellation of COVID-19 restriction offenders. With this, there were three other questionable updates to the artificial intelligence software: 1) the identification of offenders against other social justice movements, 2) the seamless incorporation of all videos about an offender on warrior accounts from other platforms, and 3) the automatic notification of an offender's social network upon identification based on their online footprint.

The first update occurred less than 24 hours ago. The final three changes were implemented less and 8 hours ago. The moment they did, it changed everything. Names were just populating the MASKaren global ranking list at an alarming rate. Millions of people's phones, of warriors and those just lurking on the platform, received notifications of family and friends breaking COVID-19 guidelines, involved in potential racial or gender discrimination, and perpetuating radical ideals. It was pandemonium. Government officials and activists were too late to heed warnings. You see, everyone, every single one of us, was cancelled overnight.

It is now December 31st, 2020. In other words, it is the last day of a year that destroyed and ended an enormous number of lives around the world. Since organizations were swift in implementing automatic resignations for verified MASKaren offenders, unemployment rate in many countries skyrocketed. People forced into their homes due to not only because of the upcoming holiday, but because of the lockdowns and just having nowhere else to go.

But perhaps there's a silver lining, albeit quite a thin one at that. On this New Year's Eve, as I gaze at my family in the living room, and a Zoom screen of some of our neighbours and extended friends, I can't help but think about how much closer I am to these cancelled people. To my mother, who I now talk to on a regular basis about family finances. To my little brother, who I now encourage when he's having trouble in his online homework. To our next-door tenant, who I now purchase hand-knitted sweaters from their local business. To my best friend, who I comfort when they talk about their grandparent passing away. You see, despite the cancellations of those who deserved or didn't deserve it, those that really mattered in life opened up to me in ways that I could never have imagined.

Will the end of this pandemic tear up or thicken that lining? Only time will tell.

Happy 2021.

Sincerely,

- Me

The Wandering Heart

Story by Melody J.Y. Kang, Queen's University

Photo credit Andreas Wohlfahrt

The disease, Wander, also known as the Wandering Heart, affects approximately 7.5 billion people worldwide. The gold standard therapy for this disease is either the end of a relationship, cheating, or allowing enough time for the disease to pass, but these therapies are not effective enough, can be very invasive, or take too long to provide relief. For these reasons, patients suffering from Wandering Heart are in desperate need for an innovative treatment.

Psychiatrists, best friends, or mentors usually like to prescribe certain advice for the patients to follow, yet patients are usually non-compliant – making it the biggest source of inner turmoil. This disease has been prevalent since the beginning of time, yet a factor called social media has exacerbated symptoms in recent years. Social media allows for easy access to a short-term treatment called "sliding into DMs". Many turn to this method for immediate relief; however, this approach is extremely temporary and long-term effects are dire, usually resulting in decreased quality of life. There is also one extremely difficult treatment option for patients with disease, called "polyamory".

Polyamory is curative of this disorder and may have a positive outcome. However, some have reported the side effects of this remedy as unbearable, so most patients do not voluntarily make this choice. Little is known about the primary cause of the Wandering Heart. Many have found that it is caused by other external factors, such as a new environment, new friends, new job, old flings, mid-life crises, drunken mistake, etc. Others have speculated that this disease is completely unavoidable to many. This highlights the importance of further researching this disorder and developing effective treatment options for those that want to build healthy, loving, long-term, passionate relationships.

VIRUS

Poetry by Harjasmin Mander

It is amazing how a single virus changed life on earth
Caused great chaos and shut the doors to a lively society
It makes you think how we humans are so fragile
That something so small can have such great power over us

We are now all home, not moving at record speed and are able to reflect
Spend time with loved ones that can finally breathe, a break from the bustling society

Even our planet can finally take in a breath of fresh air
And into the eerie quiet cities
New plants emerging from the cracks in the pavement,
Taking in the warm light from the sun

Makes you realize what harm we have caused
How to disconnected we became from our surroundings
We forgot what matters, how we need each other to survive
How much we need human touch, and that this materialistic world had consumed us

And all it took was a virus to show all that was wrong

PHOTO ESSAY

Quilt: A Material Representation of Pandemic Communication

Kristie Serota, University of Toronto

I constructed this quilt to mark the one-year anniversary of the COVID-19 pandemic. The bright spring colours represent this transitional season when the snow begins to disappear, and the vibrant flowers of spring pierce their tight petals through the earth, looking for the sun. This quilt marks one year of social distancing. A year spent working remotely, muting and unmuting, waiving at our computers. A year of communicating with one another through screens, each encased in our individual black, pixelated boxes. One year without hugs and kisses from our loved ones. Thankfully, digital communication platforms such as Zoom have allowed us to stay connected. Zoom allows us to spend time safely together; however, physically distant, untouching, and intangible we are to one another.

Quilts are the antithesis of the digital world. These material objects are meant to be held, touched, and wrapped around our bodies, keeping us warm and comforted. In this project, I sought to create a material representation of our digital meeting spaces. A cozy material object that could bring physical contact and comfort to our new and potentially alienating mode of communication. To create the quilt, I used Debra Grogan's (2018) pattern titled Hugs and Kisses. Each

of 32 half square triangles arranged to create two contrasting shapes, one representing hugs and the second kisses. The total effect of the pattern does not become apparent until all of the blocks are arranged. The cheerful patchwork top is surrounded by two borders, one black and the second a silvery grey. Once I completed Grogan's pattern, I overlayed the patchwork top with black sashing. In quilting, sashing refers to strips of fabric that are sewn between blocks on the quilt top. These four lines of sashing obscure the design, interrupting the interlocking hugs and kisses. The sashing represents the interruption of physical touch required to flatten the pandemic's curve and simultaneously recreates Zoom's recognizable grid pattern. The black strips of sashing are superficial, sewn with wide basting stitches on the quilt top's surface; they are not embedded into the patchwork design. Thus, they can be easily removed. However, once removed, evidence of this sashing will persist over time as the individual puncture marks and traces of black thread will leave a lasting record of their existence.

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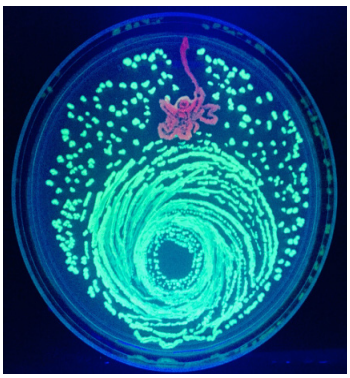
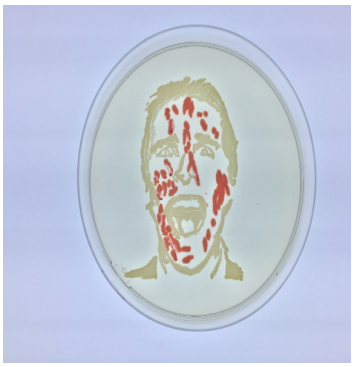
Kristie Serota is a PhD candidate in Social and Behavioural Health Sciences at the Dalla Lana School of Public Health, University of Toronto, Canada. She earned a master's degree in Applied Social Psychology from the University of Guelph where she studied the use of public deliberation as a tool for engaging citizens in democratic decision making. Her current research uses narrative approaches to explore the social, legal, and ethical aspects of medical assistance in dying (MAiD) bereavement. Her research interests include critical qualitative methods, creative analytic practices, and feminist bioethics.

A Refreshing New Medium: Agar Plate Art

Dongyun Jung, McGill Univeristy

Pseudomonas fluorescens is Gram-negative bacteria found in soil and water along with other Pseudomonas species. P. fluorescens is known to be resistant to multiple antibiotics, although it is less commonly associated with the disease than P. aeruginosa, a major cause of pneumonia in humans. The unique metabolic strategies of P. fluorescens to acquire nutrients make the organism survive in diverse environments. One of the examples is iron uptake which is driven by pyoverdine, a fluorescent siderophore whose production in low iron conditions makes the organism fluorescent. This particular P. fluorescens, isolated from imported frozen vegetables (okra), is depicting a bull on Mueller-Hinton agar.



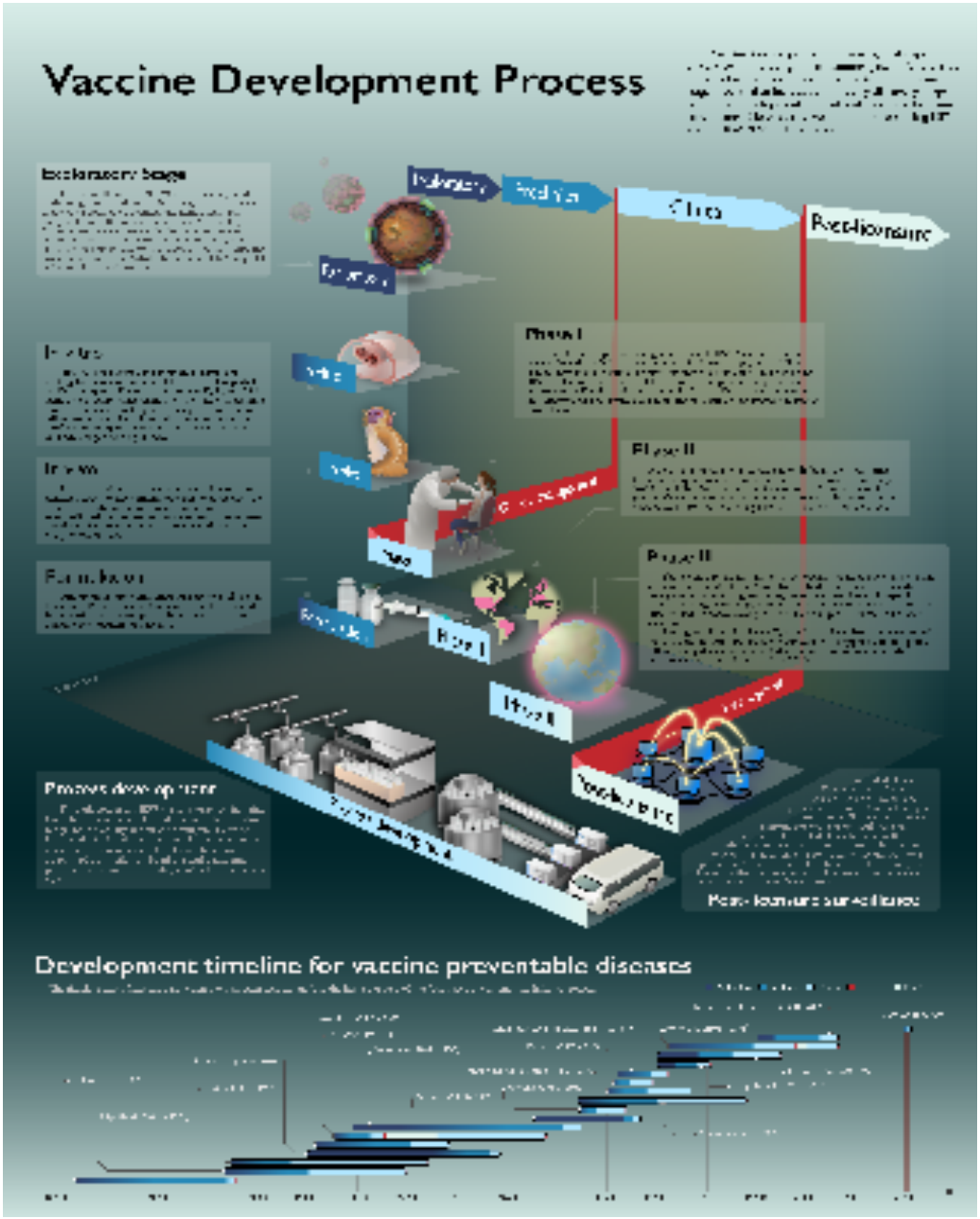


Jung Dongyun is a Ph.D. candidate in the Department of Food Science and Agricultural Chemistry at McGill University. He is working on genomics of Escherichia coli from bovine mastitis and bovine udder microbiome as his Ph.D. research project. While research is his main work, agar art is his side work in the lab. Each art piece is unique as different bacteria with different colors and shapes of colonies are used, and it is a creative way to learn about the phenotypes of bacteria. He wishes to promote the public to get interested in microbiology through his agar art.

INFOGRAPHIC

Vaccine Development Process

Mimi Guo, University of Toronto



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FEATURED ARTWORK

The Rivers of Change

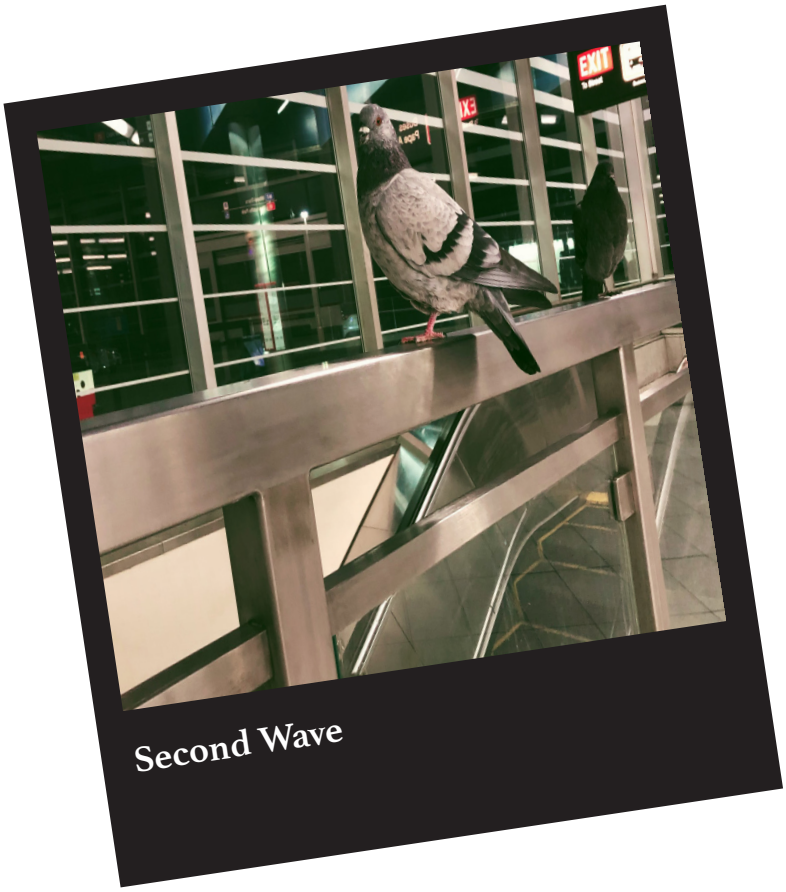
Artwork by Anne-Laurie Morin

Anne-Laure is a part-time student in the e-Health Masters program and working full time in mental health. For the past three years she has been studying soft pastels, and drawing inspiration from nature and the sciences. Other interests that help her grow as an artist include meditation, connection with others, and spiritual texts. Anne-Laure is also an avid hiker. When she is not drawing, working, or studying, she can usually can be found in a forest exploring new trails. “There are things we will never see, unless we walk to them.”- T.A. Clark

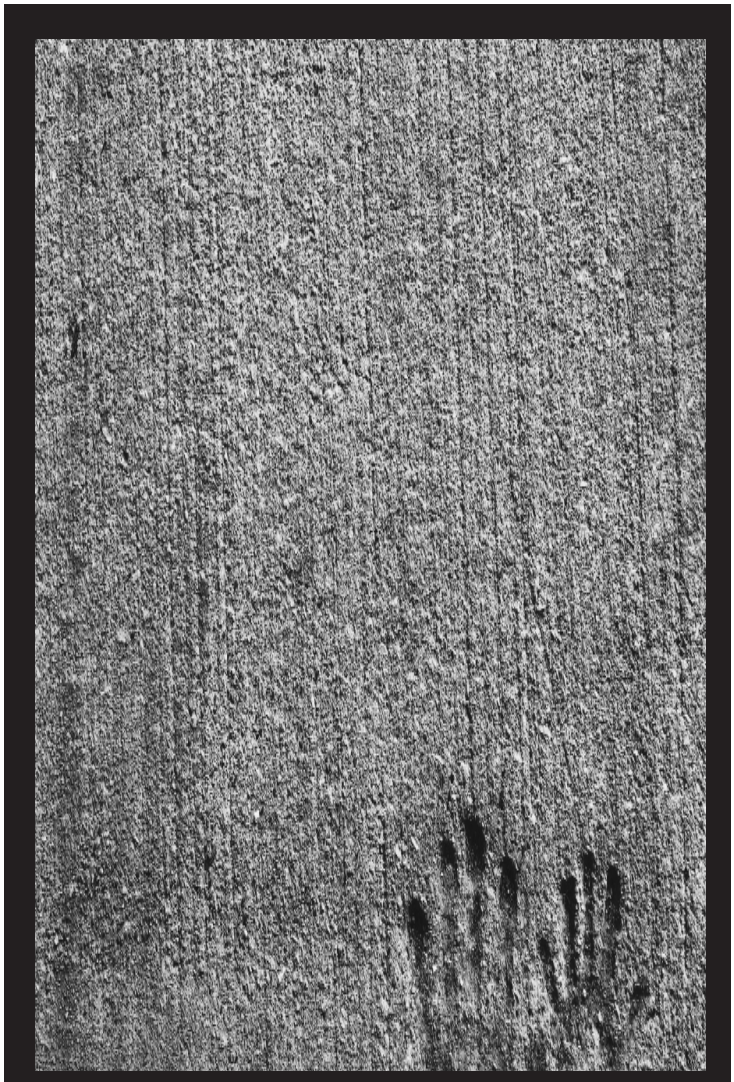
The Isolation Paradigm

Sculpted by Jared Trask

This representation began after contemplating the new reality we live in. The barriers placed between us in our world, and the distance COVID-19 has forced us to keep from those we hold dear. While we protect and maintain our health and safety, we also generate a degree of separation. We isolate COVID-19 at the cost of also isolating ourselves. This piece steps outside my traditional, more natural mediums and materials utilizing glass, clay, and paint to form this unique sculpture, The Isolation Paradigm



Second Wave



Social Distance

COVID Commute

Photography by
Raha Mahmoudi

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