



4th Annual Science Policy Awards of Excellence - Youth Category





4th Annual Science Policy Awards of Excellence - Youth Category

CSPC is proud to present its 4th Annual Science Policy Awards of Excellence—Youth Category which follows in the spirit of our 2013 Young Generation Award.

This award recognizes a young individual (student, postdoctoral fellow, researcher, entrepreneur, etc.) under the age of 35 who developed an innovative and compelling evidence-based policy that will make a positive difference to Canadians. Proposals were to be connected to one or more of the themes for the 2018 CSPC Conference. This award is designed not only to highlight innovative, evidence-driven policy ideas, but also to encourage innovative young people who may not currently be studying, or working on, public policy to develop and share their policy ideas.



2018 Winner:
Jessica Kolopenuk,
 PhD Candidate, Faculty of Native
 Studies, University of Alberta

The Selection Committee was impressed by the quality of the submissions and the dedication of the applicants so they wanted to share the best of these innovative evidence-based policy proposals with the CSPC community.

Please join us in congratulating our 2018 winner Jessica Kolopenuk for her proposal “An Indigenous Approach to Canada’s National Missing Persons DNA Program” and our runners-up, Anna Levinsson, Samuel Looper and Claire Velikonja.



We are honoured to have
The Honourable Kirsty Duncan,
 Minister of Science
 with us to present the 2018 Award
 during the CSPC Gala on
 November 8, 2018



2018 Runner-up:
Anna Levinsson
 Postdoctoral Fellow,
 Montreal Heart Institute
*“Sex, drugs & cardiovascular
 disease: cardiovascular drug
 development needs women”*



Samuel Looper
 Undergraduate Student,
 Engineering Science,
 University of Toronto



2018 Runners-Up:
Claire Velikonja
 Undergraduate Student,
 Chemical Engineering,
 University of Toronto
*“Wildfire Disaster Monitoring and
 Management Through the Canadian Space
 Agency”*

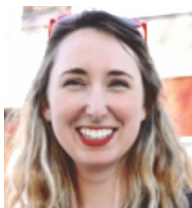


This year, the CSPC Awards Committee was happy to see that many high quality proposals.

CSPC would like to extend very warm thanks to the distinguished members of our 2018 Awards Selection Committee for their valuable time, commitment and enthusiasm for encouraging young people to consider how they might contribute to evidence-based policy. A special thank you to Charles McIvor and Sandra Noël of Innovation, Science and Economic Development Canada, Kin Kuok of Mount Sinai Hospital and Yazen Abed of the CSPC for all of their work on making this Award possible.

Proposals are reviewed blind and the Committee enjoyed learning about the incredible diversity and passion of the young people who applied to the Award once the winners had been selected and the applicants were revealed. We received applications from **5 provinces and the majority of them were from women**. To date, the youngest applicant was grade 12 student Joey Li from Vancouver in 2017.

2018 CSPC Awards Selection Committee



Sierra Clark
 PhD Candidate,
 Epidemiology,
 Imperial College
 London
 Winner 2018
 CSPC Youth
 Award



Karine Morin
 Consultant,
 Genome Canada



**Dr. Arvind
 Gupta**
 Professor,
 University of
 Toronto



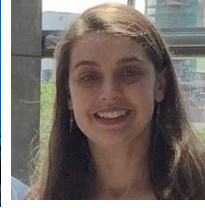
Dr. Ted Hsu
 Visiting Scholar,
 Queen's University
 Former Member of
 Parliament and
 Critic for Science
 & Technology Policy



Paul Dufour
 Principal,
 PaulicyWorks
 and Adjunct
 Professor,
 University of
 Ottawa



Kathryn Hayashi
 CEO, TRIUMF
 Innovations Inc.



Sandra Noël
 Manager,
 Innovation Canada,
 ISED



Joshua Bowie
 Chair, CSPC Awards Committee
 Senior Officer,
 Manufacturing and Life Sciences
 Branch, Innovation, Science and
 Economic Development Canada



Impact of the Award

In this, the Award's fourth year, the CSPC followed up with previous winners and runners-up to ask them about the impact that the CSPC Science Policy Awards of Excellence have had on their lives. It is inspiring to see these bright young people continue to pursue their passion for evidence-based policy.

Past Award Winners

1st CSPC Award Winner (2013)—Ari Cuperfain



Ari Cuperfain was the inaugural recipient of the CSPC Award of Excellence, Young Generation Award in 2013. He has since completed an MSc in Chemistry and is currently a medical student at the University of Toronto. His research interests are in neurogenetics with a focus on both aging and personalized medicine. With respect to science policy, Ari was one of two Canadian delegates selected to attend the Global Biotech Revolution 2016 Leaders of Tomorrow GapSummit, where young professionals from over 30 countries met to address the most pressing global challenges in biotechnology expected over the next several decades. Ari is active with the Canadian Blood Services OneMatch program where he works to recruit the most needed registrants to join the registry as potential stem cell/bone marrow donors. He is passionate about geriatric medicine, geriatric psychiatry and models of healthcare delivery for older adults.

2nd CSPC Award Winner (2016)—Amani Saini, *“Using Genetic Tests to Prevent Adverse Drug Reactions”*



“After receiving the 2016 Canadian Science Policy Award of Excellence, I started an organization called Adverse Drug Reaction Canada (ADR Canada) (www.adrcanada.org). We educate and raise awareness about the need to prevent adverse drug reactions through data collection, genetic testing, pharmacogenomics and the use of electronic medical records. Since winning the award, I've had the opportunity to share my policy idea at numerous conferences and through the media, and this has really strengthened support for the idea. In the coming years, ADR Canada will be expanding its activities to better communicate the policies we support and disseminate knowledge of how ADRs can be prevented. We will also be connecting with Canadians and organizations to build a national network of those wanting to see an end to ADRs, which are Canada's 4th leading cause of death, killing up to 22,000 Canadians annually. We are excited to meet and engage with more Canadians to involve them in creating better health outcomes for us all! “



Impact of the Award

In this, the Award's fourth year, the CSPC followed up with previous winners and runners-up to ask them about the impact that the CSPC Science Policy Awards of Excellence have had on their lives. It is inspiring to see these bright young people continue to pursue their passion for evidence-based policy.

Past Award Winners

3rd CSPC Award Winner (2017)—Sierra Clark

"Residential Woodburning in Canada: Health and Climate Effects and Intervention Strategies"



Sierra Clark is currently a doctoral candidate in Epidemiology at Imperial College London. "The award led me to apply for the Policy Analyst Recruitment and Development Program (PARDP) policy analyst role within the department of Natural Resources Canada. The policy that I proposed would have been within the jurisdiction of that department and I could have acted on it within that role. It was a very tough decision for me, though in the end, I chose to accept a PhD in London and not the PARDP position. While my actions on this policy proposal are a bit on hold for now, it is likely I will pick it up, or something similar, in the future."



Impact of the Award

Past Runners-up

2016 Runner-up—Robert Gooding-Townsend,

“Using a Modified Lottery to Select Among Meritorious Grant Applications”



“This past year, I started working at [Copperleaf](#), a Vancouver tech company that implements utilitarianism for utilities. My role as a consultant has been great for building my skills and career capital. I also realized that a PhD, particularly in America, did not make sense for me at this time. I remain interested in the same questions, but there are deep structural issues that make it difficult for young people to be involved in science policy. For now, I am continuing to write with Science Borealis and working on a fantasy novel that's about science policy among other topics.”

2016 Runner-up—Jessica Ross, “Rethinking Phosphorus: Contaminant or Commodity? Securing Food for Our Future”

2018 has seen Canada’s phosphorus policy community grow and progress, and Jessica has been thrilled to be part the effort! The year kicked off with the National Nutrient Recycle and Reuse (NNRR) Forum in March, a concerted effort across several government, academic, and industry stakeholders to develop a Canadian phosphorus roadmap and policy. This forum led to the preparation of the “NNRR Forum Report - A Roadmap for Building a Canadian Nutrient Recovery and Reuse Framework,” which includes information and recommendations from Jessica’s paper published in FACETS, “Canada: Playing Catch-Up on Phosphorus Policy.”



Jessica is also the co-founder of www.PhosphorusHub.com, an outreach effort alongside the NNRR Forum. The goal of the Phosphorus Hub is to connect Canadian and North American groups who are interested in the intersection of food, soil, fertilizer, security, water, and the circular economy - in other words, phosphorus.

The highlight of the year came in September, when Jessica and her thesis supervisor, Dr. Sidney Omelon (McGill), were selected as Top 10 finalists out of 150 applicants in the MaRS Discovery District’s Women in CleanTech challenge. Their technical proposal and vision for the role of phosphorus within a sustainable, clean technology future meant they got to speak about their vision with one of their heroes, writer and innovator Margaret Atwood.

Jessica was recognized as the Valedictorian at the University of Ottawa’s Fall 2017 Convocation (Science, Engineering, and Medicine). She continues to work full-time as a Project Manager in the Department of National Defence.

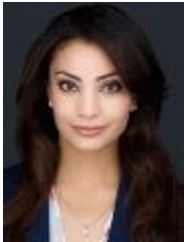


Impact of the Award

Past Runners-up

2017 Runner-up—Dr. Deena M. Hamza,

“A Proactive and Cost-Effective Approach to Reducing Mental Illnesses”



Since the success of her proposal, Deena has undertaken research into the training family medicine residents receive in mental illness. As a key collaborator with the College of Family Physicians of Canada, Deena has provided evidence of the urgent need to enhance training experiences for residents in the treatment of mental illness, as well as providing care to Indigenous peoples and marginalized, disadvantaged and vulnerable populations. In addition, Deena has been invited to speak as an “expert” on mental health in for media and other audiences and received the Audience Award at UAlberta’s Falling Walls competition (part TedTalk, part Dragon’s Den) for her pitch “Breaking the Wall of Mental Illness”. Deena is Evaluation Lead with Postgraduate Medical Education in the Faculty of Medicine & Dentistry at UAlberta where she is evaluating the curriculum change from a time-based system to one where residents are required to demonstrate competencies specific to their area of practice to improve patient care outcomes by ensuring future physicians have skills in patient-centered care, communication, professionalism, critical thinking, and teamwork alongside the attainment of medical knowledge.

2017 Runner-up—Meagan Grabowski,
“Modernizing the Yukon Scientists and Explorers Act”



Being part of the Canadian Science Policy Conference Award recipients provided a strong foundation and motivation for me to move my policy recommendations forward. After receiving a congratulatory letter from the Yukon Government Minister of Tourism and Culture, I had a meeting with the Deputy Minister about my recommendations and received news that improvements would be made. In my community, I continue to discuss and push for better relationships between researchers and northerners, particularly First Nation governments. I have also recently been promoted to Manager of Environment and Natural Resources at Champagne and Aishihik First Nations, and work towards relationship building with other levels of government, industry and researchers on behalf of the First Nations. I see a strong future for the Yukon in moving from a field site for international and national researchers, to a driver and leader in all stages of research.

We look forward to seeing the impact of the Award on this year’s winner and runners-up to following up with the 2018 winners to see where their interest and drive takes them.

**We hope that you enjoy the Awards Committee’s
2018 selection of top Awards proposals on the following pages.**

2018 WINNER - JESSICA KOLOPENUK

An Indigenous Approach to Canada's National Missing Persons DNA Program



BIOGRAPHY

Jessica Kolopenuk (Cree, Peguis First Nation) is a Ph.D. Candidate in the Department of Political Science at the University of Victoria. Her doctoral project, *The Science of Indigeneity: DNA Beyond Ancestry* is a study of how, in Canada, genomic biotechnologies are impacting definitions of Indigeneity in the fields of forensic science, biomedical research, and physical anthropology. She identifies productive spaces where Indigenous peoples may intervene to govern the genetic sciences that affect their bodies, territories, and peoples. Jessica recently took up the position of Assistant Professor at the Faculty of Native Studies, University of Alberta (UofA). Over the past two years she has been involved with co-developing the Indigenous Science, Technology, and Society Research and Training Program at the UofA, which aims to support scientific literacy and capacity among Indigenous peoples. Additionally, Jessica is a co-organizer of the Summer internship for INdigenous peoples in Genomics Canada (SING Canada).

INSPIRATION

"The legacy of gender-based violence moves through my family as it does for other Indigenous families who have endured historical and interpersonal traumas associated with colonialism. Less well known to the outside world, though, are the legacies of strength, resilience, and love that are also passed through our generations. The love that I have been given and that which I have for my mom and grandmother, my women relatives, and all those who have experienced physical and sexual violence inspires me to write this proposal. By imagining a productive solution that contributes to ending systems of violence, this proposal is a sign of endurance marking our collective refusal to be altogether defined by victimization."

OPPORTUNITY FOR ACTION

In Canada there are 1,181 confirmed cases of missing and murdered Indigenous women [1]. Compared to other Canadians, Indigenous women are more likely to experience violence in their lifetime; they are more likely to die as a result of this violence; and their homicides are more likely to go unresolved [1]. International, federal, provincial, and Indigenous research conclude that the victimization of Indigenous women, girls, and 2SLGBTQ (Two Spirit, lesbian, gay, bisexual, transgender, and queer) is systemically linked to Canada's history of race and gender-based policies of discrimination against Indigenous peoples

JESSICA KOLOPENUK

An Indigenous Approach to Canada's National Missing Persons DNA Program

against Indigenous peoples [2, 3, 4, 5, 6, 7]. Academic research has shown that especially the legal disenfranchisement of Indigenous women and their descendants from their communities via sexist Indian Act registration rules, accompanied by socio-economic marginalization is linked to physical and sexual violence against them [8, 9, 10, 11, 12, 13, 14]. For many Canadians, these are sad realities. For Indigenous peoples, these realities mark the devastating loss of our loved ones who may never come home.

Globally, the analysis and data-banking of DNA is being built into modern systems of governance. As Dr. Frederick Bieber, Advisory Committee member of Canada's National DNA Data Bank writes, "[m]ost industrialized nations now collect biological samples from crime scenes and from those convicted of serious crimes for entry into government DNA data banks" [15]. Additionally, forensic DNA profiling is used by governments for purposes of "missing persons recovery efforts, and for reunification of human remains in the aftermath of mass disaster or war" [15]. Internationally, large-scale DNA-based identification projects have been designed to, for instance, find the 8960 missing persons killed during the military dictatorship in Argentina from 1976 to 1983 [16]. Likewise, following conflict during the break-up of the former Yugoslavia, the International Commission on Missing Persons (ICMP) was established in 1996 to identify the over 30,000 persons who had gone missing. These projects have set a global precedent: massive coordinated efforts to forensically identify missing and murdered individuals are possible. An Indigenous approach to identifying Missing and Murdered Indigenous Women and Girls (MMIWG) is also possible.

In 2015 the federal government announced the launch of the National Inquiry into Missing and Murdered Indigenous Women and Girls. One year earlier on December 16th, 2014, Canada's National Missing Persons DNA Program (MPP) was legalized after Bill C-43, *The Economic Action Plan 2014 Act, No. 2.*, was passed by Parliament. Adding three new humanitarian indices to the pre-existing National DNA Data Bank, the MPP is part of a federal government effort to standardize DNA profiling and coordinate the organization of DNA-based data for all missing persons in Canada. Additionally, Canadian policy actors have framed the MPP as both a preemptive and after-the-fact response to violence against Indigenous women and girls [4, 5, 17]. To date, however, there has not been a government-to-government relationship between Indigenous peoples and Canada in the governance of the MPP. Further, the National Inquiry has not targeted forensic DNA policy as an area of research. These are missed opportunities that, if taken, could improve existing policy efforts directed at identifying MMIWG and convicting their offenders.

An Indigenous Approach to Canada's National Missing Persons DNA Program

The fields of science, politics, and law continue to be defined by power imbalances in which Indigenous peoples are not in governing control of policy areas that affect them [18, 19]. Having not designed the MPP, Indigenous organizations have been cautious about its effectiveness. In 2014, the Assembly of First Nations (AFN) warned that it is distrustful of the government's motivation for collecting and preserving Indigenous people's DNA [20]. As a question of national policy, the design, operation, and control of the MPP requires ongoing consultation, consent, and collaboration with Indigenous peoples if it is to avoid becoming a form of contemporary paternalism that has historically laced colonial policy-making.

PROPOSED ACTION

Policy solutions aimed at identifying MMIWG and convicting their offenders need to be determined with, by, and for Indigenous peoples, nations, organizations, and families. This proposal, therefore, stops short of offering a prescriptive answer. Instead, it advances a pathway toward the co-production of policy through the cooperation of multiple stakeholders. This approach to policy creation can strengthen the effectiveness of a culturally safe MPP for Indigenous peoples while also strengthening relationships between the federal government and Indigenous peoples. There are some clear initial steps that can be taken to commence this process.

1. **Meaningful Indigenous Representation on the National DNA Data Bank Advisory Committee.**

The National DNA Data Bank Advisory Committee, appointed by the Solicitor General of Canada, oversees the effectiveness and efficiency of the Data Bank. The Committee is composed of experts in legal, scientific, constabulary, and bioethical fields. There is currently no Indigenous representation on the NDDB Advisory Committee. Given that, in part, the rationale for the creation of the MPP has included consideration of MMIWG, the NDDB Advisory Committee should have Indigenous representation. The percentage of members that are Indigenous included on the Committee ought to be decided in consultation and consent with relevant Indigenous women's organizations including the Native Women's Association of Canada, Pauktuutit Inuit Women of Canada, and Les Femmes Michif Otipemisiwak / Women of the Métis Nation.

2. **Developing Culturally Relevant DNA Handling Protocols**

There are culturally distinct ways of understanding DNA [21, 22]. As late Hopi geneticist Dr. Frank Dukepoo has expressed: for many Indigenous cultures, DNA holds physical and also spiritual significance - genetic material, even when separated from the body, remains part of the whole person [23, 24]. To adapt to advances in DNA-based governance, Indigenous peoples around the world have

JESSICA KOLOPENUK

An Indigenous Approach to Canada's National Missing Persons DNA Program

person [23, 24]. To adapt to advances in DNA-based governance, Indigenous peoples around the world have been developing culturally consistent policies related to the use of DNA. In Aotearoa/ New Zealand, for example, the Guidelines for the Disposal and Retention of Samples and Specimens have been developed: culturally safe Maori protocols for the handling and destruction of DNA [25]. In collaboration with grassroots, provincial/territorial, and national Indigenous organizations, the NDDDB should develop optional protocols for Indigenous families who consent to the inclusion of their or their loved one's DNA into the MPP. This policy change would make Canada a global leader in a reconciliatory approach to forensic DNA policy.

3. **Coordinating Research and Practice Among The National Inquiry and the MPP**

The National Inquiry into Missing and Murdered Indigenous Women and Girls has been extended to April 2019 at which time it must deliver its final report. Currently, the National Inquiry has not publicly identified the governance of the MPP and the collection, profiling, and data-banking of Indigenous women, girls, 2SLGBTQ and their family members' DNA as a research priority. As government sponsored forensic policies and practices increasingly move toward the collection and profiling of DNA, Indigenous peoples should not be left behind. In consultation with the NDDDB and the National Centre for Missing Person's and Unidentified Remains (NCMPUR) as well as in its ongoing consultation with institutions, experts, and communities, the National Inquiry should include consideration of forensic DNA approaches to the identification of MMIWG. The Inquiry might consider how current forensic policy can be used or improved to convict offenders.

JESSICA KOLOPENUK

An Indigenous Approach to Canada's National Missing Persons DNA Program

REFERENCES

1. The Royal Canadian Mounted Police. 2014. Missing and Murdered Aboriginal Women: A National Operational Overview. Accessed from <http://www.rcmp-grc.gc.ca/en/missing-and-murdered-aboriginal-women-national-operational-overview#sec1>
2. Amnesty International. 2004. Stolen Sisters: A Human Rights Response to Discrimination and Violence Against Indigenous Women in Canada. Accessed from <https://www.amnesty.ca/sites/amnesty/files/amr200032004enstolensisters.pdf>
3. Amnesty International. 2009. No More Stolen Sisters: The Need For a Comprehensive Response to Discrimination and Violence Against Indigenous Women in Canada. Accessed from <https://www.amnesty.ca/sites/amnesty/files/amr200122009en.pdf>
4. Government of Canada. 2014. Action Plan to Address Family Violence and Violent Crimes Against Aboriginal Women and Girls. Retrieved from <https://www.swc-cfc.gc.ca/fun-fin/ap-pa/action-eng.pdf>
5. Oppal, Wally T. 2012. Forsaken: The Report of the Missing Women Commission of Inquiry Executive Summary. British Columbia, Canada.
6. Assembly of First Nations. 2012. Coordinated and Urgent Action to End Violence Against Indigenous Women & Girls – Towards a National Action Plan. Accessed from https://www.afn.ca/uploads/files/missing_and_murdered_indigenous_women/afnendviolencepaper-naws.pdf
7. Native Women's Association of Canada. 2009. Voices of Our Sisters in Spirit: A Report to Families and Communities, 2nd ed. Canada. Accessed from https://www.nwac.ca/wp-content/uploads/2015/05/NWAC_Voices-of-Our-Sisters-In-Spirit_2nd-Edition_March-2009.pdf
8. Barker, Joanne. 2016. Critically Sovereign: Indigenous Gender, Sexuality, and Feminist Studies. Durham: Duke University Press.
9. Hunt, Sarah. 2015/2016. "Representing Colonial Violence: Trafficking, Sex Work, and the Violence of Law." *Atlantis*, 37.2 (1), 25-39.
10. Altamirano-Jiménez, Isabel. 2013. *Indigenous Encounters with Neoliberalism: Place, Women, and the Environment in Canada and Mexico*. Vancouver, BC: University of British Columbia Press.
11. Goeman, Mishauna. 2013. *Mark My Words: Native Women Mapping Our Nations*. Minneapolis and London: University of Minnesota Press.
12. Kuokkanen, Rauna. 2008. "Globalization as Racialized, Sexualized Violence." *International Feminist Journal of Politics*, 10(2), 216-233.
13. Lawrence, Bonita and Kim Anderson. 2005. "Introduction to 'Indigenous Women: The State of Our Nations.'" *Atlantis*, 29(2), 1-10.
14. Young, Alannah Earl and Denise Nadeau. 2005. "Decolonising the Body: Restoring Scared Vitality." *Atlantis* 29(2), 1-13.
15. Bieber, Frederick R. 2006. "Turning Base Hits into Earned Runs: Improving the Effectiveness of Forensic DNA Data Bank Programs." *Journal of Law, Medicine & Ethics*, (summer), 222-233.
16. Corach, D., Sala, A., Penacino, G., Iannucci, N., Bernardi, P., Doretti, M.,...Hagelberg, E. 1997. "Additional Approaches to DNA Typing of Skeletal Remains: The Search for "Missing" Persons Killed During the Last Dictatorship in Argentina." *Electrophoresis*, 18, 1608-1612.
17. Rabson, Mia. 2014, August 28. Justice Minister Rejects Inquiry as Premiers Agree to Roundtable. *Winnipeg Free Press*. Retrieved from <https://www.winnipegfreepress.com/local/yet-another-study-not-needed-272988601.html>
18. Truth and Reconciliation Commission Canada. 2015. *Honouring the Truth, Reconciling for The Future: Summary of The Final Report of the Truth and Reconciliation Commission of Canada*. Winnipeg: Truth and Reconciliation Commission of Canada.
19. Royal Commission on Aboriginal Peoples Canada. 1996. *Bridging the Cultural Divide: A Report on Aboriginal People and Criminal Justice in Canada*. Ottawa: Royal Commission on Aboriginal Peoples.
20. Blaze Carlson, Kathryn. 2014, July 27. Canada Works to Institute a National Missing Persons DNA Databank. *The Globe and Mail*. Retrieved from <https://www.theglobeandmail.com/news/national/without-a-trace/article19800319/>
21. Claw, Katrina G., Matthew Z. Anderson, Rene L. Begay, Krystal S. Tsosie, Keolu Fox, Summer internship for Indigenous peoples in Genomics (SING) Consortium, and Nanibaa' A. Garrison. 2018. "A Framework for Enhancing Ethical Genomics Research with Indigenous Communities." *Nature Communications*, 9(2957), 1-7.
22. Sahota, P. C. 2014. "Body Fragmentation: Native American Community Members' Views on Specimen Disposition in Biomedical/genetics Research." *AJOB Empir. Bioeth.* 5, 19-30.

JESSICA KOLOPENUK

An Indigenous Approach to Canada's National Missing Persons DNA Program

REFERENCES (cont.)

23. Petit, Charles. February 19, 1998. "Trying to Study Tribes While Respecting Their Cultures / Hopi Indian geneticist can see both sides." San Francisco Chronicle accessed from <https://www.sfgate.com/news/article/Trying-to-Study-Tribes-While-Respecting-Their-3012825.php>
24. Arbour, Laura and Doris Cook. 2006. "DNA on Loan: Issues to Consider when Carrying Out Genetic Research with Aboriginal Families and Communities." *Community Genet*, 9, 153-160.
25. Cunningham, E., V. Cameron, J. Evans, V. Irvine, S. Pitama, and P. Robertson. 2007. "The Development of Guidelines for Handling Samples and Specimens Collected for Research Involving Māori." *New Zealand Medical Journal* 120(1264), 117-119.

RUNNER-UP - ANNA LEVINSSON

Sex, drugs & cardiovascular disease: cardiovascular drug development needs women



BIOGRAPHY

"Originally from Sweden, I arrived in Montreal in summer 2015. I had recently finished my PhD in medical science and came to Montreal for a summer program in cultural psychiatry at McGill University. My background is quite interdisciplinary; I have a master's degree in mathematical statistics with minors in art history and German language. The topic of my doctoral dissertation was interaction effects between genetic susceptibility and air pollution exposure on cardiovascular disease, but during my time as a PhD candidate, I also collaborated with a German research team on a study of sex differences in schizophrenia. Since I arrived in Montreal I have worked as a postdoctoral fellow at McGill University Department of Psychiatry and currently as a postdoctoral fellow at Montreal Heart Institute and Université de Montréal Département de Médecine."

INSPIRATION

"My interest in medical sex differences awoke during a psychology lecture where the professor said that women and men develop schizophrenia at different ages, with different symptoms, but receive the same treatment. I wondered if the same was true for other disease, for example heart disease. Ten years later, as a postdoctoral fellow at the Montreal Heart Institute, I was asked to focus my research on sex differences in heart failure (HF). I soon noticed that there were no sex-specific guidelines for the treatment of HF, that the clinical trials underlying the guidelines had a small percent of women participants, and that HF drugs were generally tested in men only! In addition, this was not isolated to HF but rather the overall picture for cardiovascular disease. I found this outrageous, that medication for the second most common cause of death is in fact only tested in half the patient population."

OPPORTUNITY FOR ACTION

Women are underrepresented in cardiovascular research, despite that cardiovascular disease (CVD), together with cancer, is the main killer of both women and men worldwide. In Canada alone, near 70,000 deaths in 2016 were caused by diseases of the circulatory system, close to 35,000 of which were women. [1] For both women and men, 26% of the total number of deaths were caused by CVD. As the mean age

ANNA LEVINSSON

Sex, drugs & cardiovascular disease: cardiovascular drug development needs women

of the population increases, the number of people living with chronic disease including CVD will increase as well, and the cost of healthcare will rise accordingly. The yearly cost for cardiovascular disease in Canada exceeds \$20 billion. [2]

The number of deaths due to CVD is similar in men and women, but on the other hand, there may be significant sex differences regarding safety and efficacy of treatment, and thereby differences in prognosis. Women have a higher risk of experiencing some adverse drug reactions (ADRs), and more severe ADRs, than men. [3] This could be the result of differences in drug pharmacokinetics (PK), meaning differences in absorption, distribution, metabolism or excretion of the drug. [4-6] The differences in ADRs may also be due to differences in pharmacodynamics (PD) or behaviour (such as taking the drug as prescribed, or at all). Also, women's drug response is affected by hormonal levels, which vary during a woman's life. [7] Thus, the current "one size fits all" approach puts underrepresented patient groups, including women, at increased risk due to under-investigated differences in PK and PD. [8, 9]

Since approximately half the CVD population are women, the impact of women's underrepresentation in randomized clinical trials (RCTs) is severe. The impact is enhanced by the fact that RCTs are considered the 'golden standard' for the study of drug effects. In reality, women rarely comprise more than 30% of the study population which often results in the number of women being too small to detect a drug effect. [8] Further, because women are underrepresented in the initial phases of drug development, they are also largely ignored in the phase of defining drug dosing. A research group from the Montreal Heart Institute published calculations of the probability of detecting a drug effect with the current 30%/70% sex distribution in clinical trials. [9] Consider a clinical trial sample including 30% women, where the number of women is too small for separate analysis. If the drug has an effect only in women, then it is likely that the trial results will be that the drug has no effect. If the effect only exists in men, however, the overall trial result will likely be positive as the null effect in women may be overshadowed by the effect seen in men. Data simulations showed that if the drug had an effect in women only, the data simulation detected the drug effect 55% of the time. However, if the true effect was in men only, then an overall positive effect of the drug was detected 90% of the time.

In summary, there are two patient groups, women and men, where mortality due to CVD is equally common. Both sexes are treated with the same drugs and doses of drugs, despite physical and hormonal differences, and despite the drug only having been analysed thoroughly in men.

PROPOSED ACTION

Both the US National Institute of Health (NIH) and the Canadian Institute of Health Research (CIHR) have

ANNA LEVINSSON

Sex, drugs & cardiovascular disease: cardiovascular drug development needs women

attempted to address the sex gap in medicine by adding a sex/gender requirement to all applications for funding. While this is a step in the right direction, it has no impact on the sex-sensitive testing of cardiovascular drugs in RCTs by the pharmaceutical industry, since it operates independently of such funding. Thus, the new policy will target the pharmaceutical industry directly with a demand from the Health Products and Food Branch (HPFB) of Health Canada that RCTs for CVD drugs are designed so that both sex subgroups are large enough (i.e. have enough statistical power) to detect a potential drug effect. The improved policy will require all new drugs to undergo such sex-stratified testing in the pipeline to market release and the industry may have to consider establishing pre-determined target female ratios for study recruitment.

In order for CVD drug developers to adhere to the demand for sex-specific drug testing, recruitment strategies and research methodology will have to adapt to raise women's interest in clinical trials participation. To increase the number of female participants, both sex and gender must be addressed. The two terms are often used interchangeably, when in fact sex is a biological characteristic (male or female) while gender refers to a range of socially constructed characteristics related to roles, behaviors and identity. [10, 11] By assessing recruitment strategies that are sensitive to gender roles and social structures, women will consider participation more attractive. Useful insights can be harvested from the advertisement sector, which has successfully targeted gender roles for decades. Women perceive greater risks and smaller benefits than men from participating in RCTs, and since women according to gender roles tend to be more risk-avoidant than men, this discourages participation. [12] To overcome this barrier, the benefits of participation, e.g. close monitoring of health changes, must be emphasized. Other successful strategies to increase female participation in clinical research include target advertisement of clinical trials in places frequented by women, which display female researchers working in the clinical trial [13], and to provide transportation to and from study visits. [14]

The long-term consequences of the policy change will be a better evidence base for clinical guidelines on treatment of cardiovascular disease. By basing guidelines only on RCTs that include adequately powered sex-specific analyses, guideline committees will be able to formulate evidence-based sex-specific treatment recommendations.

ANNA LEVINSSON

Sex, drugs & cardiovascular disease: cardiovascular drug development needs women

REFERENCES

1. Statistics Canada: Table 13-10-0147-01 Deaths, by cause, Chapter IX: Diseases of the circulatory system (I00 to I99). Accessed: 21 August 2018. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1310014701>
2. Public Health Agency of Canada: Economic burden of illness in Canada 2003-2008. In. Edited by Public Health Agency of Canada. Ottawa, ON; 2014.
3. Tamargo J, Rosano G, Thomas W, Duarte J, Niessner A, Kaski JC, Cecconi C, Drexel H, Kjeldsen K, Savarese G: Gender differences in the effects of cardiovascular drugs. *Eur Heart J Cardiovasc Pharmacother* 2017, 3(3):163-182.
4. Schwartz JB: The Current State of Knowledge on Age, Sex, and Their Interactions on Clinical Pharmacology. *Clinical Pharmacology & Therapeutics* 2007, 82(1):87-96.
5. Franconi F, Campesi I: Pharmacogenomics, pharmacokinetics and pharmacodynamics: interaction with biological differences between men and women. *Br J Pharmacol* 2014, 171(3):580-594.
6. Franconi F, Campesi I: Sex and gender influences on pharmacological response: an overview. *Expert review of clinical pharmacology* 2014, 7(4):469-485.
7. Lenzen MJ, Rosengren A, op Reimer WJMS, Follath F, Boersma E, Simoons ML, Cleland JGF, Komajda M: Management of patients with heart failure in clinical practice: differences between men and women. *Heart* 2008, 94(3):e10.
8. Tannenbaum C DD, Matera A: Age and sex in drug development and testing for adults. *Pharmacological Research* 2017, 121:83-93.
9. Levinsson A, Dubé MP, de Denus S, Tardif JC: Sex, Drugs and Heart Failure - A sex-sensitive review of the evidence base behind current heart failure clinical guidelines. *ESC Heart Failure* 2018. doi.org/10.1002/ehf2.12307.
10. Mayor E: Gender roles and traits in stress and health. *Frontiers in Psychology* 2015, 6:779.
11. Regitz-Zagrosek V: Sex and gender differences in health: Science & Society Series on Sex and Science. *EMBO Reports* 2012, 13(7):596-603.
12. Ding EL, Powe NR, Manson JE, Sherber NS, Braunstein JB: Sex differences in perceived risks, distrust, and willingness to participate in clinical trials: A randomized study of cardiovascular prevention trials. *Archives of Internal Medicine* 2007, 167(9):905-912.
13. Brennan B: New to marketing to women? Start here. In: *Women@Forbes*. 2017.
14. Liu KA, Mager NAD: Women's involvement in clinical trials: historical perspective and future implications. *Pharmacy Practice* 2016, 14(1):708.

RUNNERS-UP -

SAMUEL LOOPER AND CLAIRE VELIKONJA

Wildfire Disaster Monitoring and Management Through the Canadian Space Agency



BIOGRAPHIES

Samuel Looper is an undergraduate in Engineering Science at the University of Toronto, and director of the University of Toronto Aerospace Team (UTAT) Space Policy Division. Claire Velikonja is an undergraduate in Chemical Engineering at the University of Toronto and member of UTAT Space Policy. UTAT is a student design team, with over 100 members designing and building rockets, microsattellites, and UAV. UTAT has a strong commitment to STEM outreach, and education. The Space Policy Division was founded to promote innovation, and sustainability in applications of space technologies. The division is motivated by our experience building and developing rockets and satellites to find novel applications and study the potential of space based technologies to improve the lives of people on Earth. The division has begun a partnership with the United Nations Space Generation Advisory Council to study Space Technology for Disaster Management and continue our advocacy on the international stage.

INSPIRATION

“Participating in the development of a sounding rocket and microsattelite platform for science payloads and experiments has piqued the imagination of the UTAT Space Policy team. We’ve always believed that space technology should be developed with the interest of those back on Earth in mind; being part of a team designing payloads for microbiological research and volcanic ash analysis have reaffirmed our belief that this is both necessary and possible. We were also inspired by the Toronto machine learning research community, which is set on improving the way we analyze and extract insight from large data sets such as satellite imagery. Our team is focusing on how space technologies can be used for disaster management. Reminded of the wildfires in Fort McMurray, which devastated communities and the environment alike, we decided to propose improvements to our current fire prevention measures from our perspective of choice: orbital space. our perspective of choice: orbital space.”

SAMUEL LOOPER AND CLAIRE VELIKONJA

Wildfire Disaster Monitoring and Management Through the Canadian Space Agency

OPPORTUNITY FOR ACTION

Since 1990, forest fires across Canada have consumed an average of 2.5 million hectares of land per year [1]. These fires have ecological purpose, driving vegetation dynamics and increasing plant diversity; however, nearby human settlements are often at risk when these natural phenomena occur [2]. A stark example is the 2016 Fort McMurray Fire, which led to nearly \$4 billion in damages and over 2,000 displaced residents [3].

The past two years have seen significant increases in wildfires in Ontario, Manitoba [4], British Columbia [5] and the Canadian North, with studies demonstrating increases in the severity of forest fires and the length of forest fire season [6]. A consensus among scientists is that climate change is the leading cause of these worrying trends. Although the effect of climate change on wildfires is complex and poorly understood, studies suggest the human and economic impact of wildfires will increase, disproportionately affecting northern and indigenous communities [7]. Natural Resources Canada (NRCan) currently runs the Canadian Wildland Fire Information System (CWFIS), as a central information hub on wildfires. It includes daily fire risk assessments using weather data, and an archive of fire statistics across Canada [8].

The potential of space technologies for furthering the detection, monitoring, and risk assessment of wildfires is acknowledged throughout the scientific community. The two key components in forest fire risk assessment are meteorological conditions and biofuel distribution [9, 10]. The Canadian Weather Services currently relies on satellites such as NASA's Geostationary Operational Environmental Satellite (GOES) for hyperspectral imaging and atmospheric composition sensors to provide the most accurate weather maps available [11]. Biofuel distribution is critical for correctly modelling the potential spread of wildfires. The most effective and accurate methods of mapping forest fire fuels are radar and optical sensor satellites such as the Sentinel Constellation used in the European Space Agency GlobBioMass project [12].

Satellites are also employed in measuring current forest fires, and monitoring their spread. The CWFIS currently uses radiometer and spectroradiometer imagery to identify thermal anomalies corresponding to forest fires and burned forest area [13]. These spectrometer and multispectral optical sensor readings also allow for the detection of forest fire atmospheric emissions [14]. The data sets the CWFIS relies on are created using the Moderate Infrared Spectroradiometer (MODIS) aboard the EOS-Terra satellite operated by NASA and U.S. National Oceanic and Atmospheric Administration (NOAA) [15].

Wildfire Disaster Monitoring and Management Through the Canadian Space Agency

In addition, recent breakthroughs in machine learning powered data analytics can make more effective use of the information from space based imaging. Computer Vision and Machine Learning are being leveraged to create better Geographic Information Systems (GIS). Deep learning algorithms allow analysis of petabytes of satellite imaging in a GIS [16], while identifying patterns and anomalies more accurately than traditional algorithms. Currently the state of the art in such data analytics platforms is in the private sector, by commercial ventures such as Planet, Skylab, and Descartes Labs.

NRCan has recently expressed concern in the lack of data availability and decision and analysis support systems associated with the CWFIS [17]. For example, NRCan has currently been exploring the possibility of using Low-Earth satellites for aerial surveillance of high-risk areas [18]. The CWFIS receives all of its meteorological and spectroradiometer imagery data exclusively from third-party sources such as NASA and NOAA. This limits the technical capabilities of potential wildfire modelling, as well passing over expertise in the field already present in Canada. As the Canadian Space Agency (CSA) will be launching the RADARSAT-3 constellation between July and October 2018, which will monitor parameters important to the CWFIS models and includes emergency and disaster management in its mandate, there exists an opportunity to bridge the current gap in technology and information management between the two groups [19].

PROPOSED ACTION

To combat the risk posed by Canadian wildfires, we propose the creation of a natural disaster monitoring and management program within the CSA, complementing the various government agencies currently involved in natural disaster management. Modelled after the ISRO's Disaster Management Programme [19], this organization's mandate will be fourfold:

- 1) To fund and coordinate earth observation research for natural disaster management and modelling.
- 2) To develop Canadian space technologies to improve the accuracy and access to data needed for natural disaster management and modelling.
- 3) To operate and maintain Canadian space assets used for natural disaster management and modelling.
- 4) To coordinate with various federal agencies such as NRCan and local governments to provide support for natural disaster management.

SAMUEL LOOPER AND CLAIRE VELIKONJA

Wildfire Disaster Monitoring and Management Through the Canadian Space Agency

Within the CSA, this program will leverage the data acquired by the space assets of the CSA and partner space programs. Funding for this program will ensure Canada remains at the forefront of research on the effects of climate change on wildfire phenomena.

Initial steps include meeting with NRCan and identifying current gaps in the CWFIS data. Further research could be conducted under the purview of this organization through NSERC or the NRC. This collaborative research can then be fed into the Canadian Forest Fire Behavior Prediction System [8] to ensure emergency responders and local authorities have accurate models on the future spread of extreme and dangerous wildfire.

Putting research under federal jurisdiction will ensure the effects of wildfires on under served northern and indigenous communities can be studied, as they are projected to be disproportionately affected by wildfires due to climate change. Finally, such a program can serve as a platform for international cooperation and capacity building, specifically with developing nations affected by climate change. Further work will include identifying and developing new technologies in Canada to assist in natural disaster management. Having a specialized program under the jurisdiction of the Canadian Space Agency will facilitate the integration of natural disaster monitoring and management capabilities within the CSA's operations. It will also provide centralized control and administration of the various data sets required for disaster management, ensuring they are updated and accurate, while allowing for better identification of where additional technology is needed.

Such a program would put the space assets collecting data for disaster management under Canadian jurisdiction. A Canadian satellite would have an orbit maximizing the coverage of Canadian territory, and would be equipped with sensors which can generate data in the absence of light and through clouds and precipitation, which are prohibitive constraints for earth observation in the Canadian North [20]. Additional Canadian earth observation satellites could be equipped with specialized radiometer, spectrometer, and optical sensors to create the necessary data sets for wildfire monitoring and modelling. Satellites designed for Canada such as the Radarsat constellation have greatly improved the accuracy of our satellite maps in the Canadian Arctic using specialized technologies such as Synthetic Aperture Radar [21, 22]. The program could also leverage the CSA's expertise in artificial intelligence research [23] for improved image processing software and the creation of more insightful and accurate GIS.

SAMUEL LOOPER AND CLAIRE VELIKONJA

Wildfire Disaster Monitoring and Management Through the Canadian Space Agency

Working under the CSA will ensure this disaster management program can operate relevant imaging satellites to complement our current data collection methods for key natural disaster indicators. In the case of wildfires, Canada is entirely reliant on technology from the United States and Europe to build the Canadian Wildland Fire Information System [9]. By shifting responsibility for data collection and management to the CSA, the CWFIS will be able to receive coordinated information on which to base their current predictive models and leverage the CSA's own expertise to create solutions to technological gaps in the future.

REFERENCES

1. NRCan. 'Canadian Wildland Fire Information System: Canadian National Fire Database', 2018. [Online]
2. NRCan. 'Fire Ecology', 2018. Accessed at <https://www.nrcan.gc.ca/forests/fire-insects-disturbances/fire/13149>
3. Statistics Canada. 'Fort McMurray 2016 Wildfire Economic Impact', 2017. Accessed at <https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2017007-eng.htm>
4. B. Weber, Global News. 'Long, hot wildfire season forecasted by Natural Resources Canada', May 2018. Accessed at <https://globalnews.ca/news/4212625/canada-wildfire-season-2018-natural-resources/>
5. R. Flanagan, CTV News. 'Forest fires will become more widespread and destructive, expert warns', July 2018. Accessed at <https://www.ctvnews.ca/canada/forest-fires-will-become-more-widespread-and-destructive-expert-warns-1.4034546>
6. B.J. Stocks Wildfire Investigations. 'Evaluating Past, Current and Future Forest Fire Load Trends in Canada', January 2013. Accessed at <https://www.ccfm.org/pdf/2%20Fire%20Load%20Trends.pdf>
7. NRCan. 'Climate Change and Fire', 2018. Accessed at <https://www.nrcan.gc.ca/forests/fire-insects-disturbances/fire/13155>
8. NRCan. 'Canadian Forest Fire Behavior Prediction (FBP) System', 2018. Accessed at <http://cwfis.cfs.nrcan.gc.ca/background/summary/fbp>
9. NRCan. 'Canadian Forest Fire Weather Index (FWI) System', 2018. Accessed at <http://cwfis.cfs.nrcan.gc.ca/background/summary/fwi>
10. Copernicus European Commission. 'Global Wildfire Information System: Fuels'. [Online]
11. NASA. 'GOES Satellite Network'. Accessed at <https://www.nasa.gov/content/goes>
12. European Space Agency. 'Mapping the World's Forests', 2017. Accessed at <https://earth.esa.int/web/guest/content/-/article/mapping-the-world-s-forests>
13. Copernicus European Commission. 'Active Fire Detection'. [Online]
14. Monitoring Atmospheric Climate & Composition. 'FIR Global Fire Monitoring'. Accessed at http://gmes-atmosphere.eu/about/project_structure/input_data/d_fire/
15. NASA. 'MODIS Land'. [Online].
16. M. Altaeuel. 'Transforming Satellite Imagery Classification with Deep Learning', Feb. 2018. Accessed at <https://www.gislounge.com/transforming-satellite-imagery-classification-deep-learning/>
17. R. Carr et al. 'Increasing the Resiliency and Reach of National Fire Information', 2017.
18. M. Molteni, Wired. 'The Science of Fighting Wildfires Gets a Satellite Boost'. Accessed at <https://www.wired.com/story/the-science-of-fighting-wildfires-gets-a-satellite-boost/>
19. CSA. 'RADARSAT Constellation Mission', March 2018. Accessed at <http://www.asc-csa.gc.ca/eng/satellites/radarsat/default.asp>
20. Indian Space Research Organization. 'Disaster Management Support Programme'. Accessed at <https://www.isro.gov.in/applications/disaster-management-support-programme>
21. A. Lajeunesse, Canadian Global Affairs Institute. 'The Canadian Armed Forces in the Arctic', May 2015. Accessed at https://www.cgai.ca/canadian_armed_forces_in_the_arctic
22. CSA. 'Radarsat: Components and Specification', April 2013. [Online]
23. Invest in Canada. 'Canada - A Leader in Artificial Intelligence (AI)'. Accessed at http://www.international.gc.ca/investors-investisseurs/sets/pdfs/download/Niche_Sector-AI.pdf

HONOURED PARTICIPANT -

Kiffer Card

Harnessing health Systems for HIV Elimination Among Gay and Bisexual Men



BIOGRAPHY

Kiffer Card is a doctoral candidate at Simon Fraser University and a Research Fellow with the B.C. Centre for Excellence in HIV/AIDS. During his three years as a PhD student, he has co-authored 15 articles, 9 as first author with an additional 8 under various stages of review. He is also the recipient of the University-Without Walls-Engage Fellowship as well as several other scholarships from the Canadian Association for HIV/AIDS and from Simon Fraser University. His research strives to reduce health inequities experienced by vulnerable populations—particularly with regards to their mental, social, and sexual health. Here, he discusses his thesis research, which examines the intersection of social, technological, and sexual behaviour among gay and bi-men.

INSPIRATION

“Highlighted by British Columbia’s (BC) Provincial Health Officer as a priority health equity issue in 2014, gay, bisexual, and other men who have sex with men (gbMSM) are at 71 times greater risk for HIV than other men. They are also at significantly higher risk for other sexually transmitted infections, including syphilis, chlamydia, and gonorrhea. Addressing these disparities, the expansion of antiretroviral therapy (ART) beginning in 2003 and the coverage of pre-exposure prophylaxis (PrEP) in 2018 now offers a viable path towards achieving BC’s “Hope to Health” goal of eliminating HIV by 2020. However, to the present time HIV incidence has remained elevated among gbMSM despite declines in other target populations such as people who use drugs. The persistence of HIV incidence in this population highlights the need for action in addressing adherence and access in this population. As a member of the LGBT community, I am inspired to improve the health and well-being of people living with HIV and to eliminate new HIV infections in our community.”

KIFFER CARD

Harnessing health Systems for HIV Elimination Among Gay and Bisexual Men

OPPORTUNITY FOR ACTION

1. Canadian gbMSM are at disproportionate risk for HIV

Gay, bisexual, and other men who have sex with men (gbMSM) account for more than half of new HIV cases in Canada. gbMSM are approximately 71 times more likely to acquire HIV compared with other men, despite making up only 2-7% of the male population. Health inequities in this population persists despite the recent development of highly effective biomedical prevention strategies – contributing to significant costs on health care systems (between \$253,000 \$400,000 per new infection). Indeed, while declining HIV incidence has been observed among other key populations such as people who use drugs, the same cannot be said for gbMSM. Existing health systems do not adequately address the needs of gbMSM, hampering the opportunity for HIV elimination.

2. Existing Biomedical Prevention Strategies have the Potential to Eliminate HIV

Among the most effective strategies at reducing HIV incidence, “Treatment as Prevention” (TasP) involves the use of combination antiretroviral therapies to reduce the viral load and transmission potential among people living with HIV by promoting earlier diagnosis, reducing time to treatment initiation, and providing support for ongoing care and maintenance of treatment schedules. Yet, stable HIV incidence among gbMSM suggests that the benefits of have not been fully realized in this population – particularly among racialized gbMSM, those with low socioeconomic status, and those engaging in high risk sexual behaviour. In order for health systems to effectively implement TasP, individuals must be screened and diagnosed by a healthcare provider. However, according to the Public Health Agency of Canada (PHAC), 18% of gbMSM living with HIV have not received a diagnosis – perhaps due to the large number of gbMSM who either do not have a provider or do not disclose their sexual orientation to their provider. As HIV is most transmissible in the first few weeks following infection, reducing time to HIV diagnosis and initiation of treatment is critical to eliminating onward transmission. While targeted screenings and social marketing for anonymous and rapid point-of-care HIV tests have great potential among gbMSM, these have not been fully leveraged by health systems and, therefore, many gbMSM do not meet provincial recommendations for annual HIV testing. In fact, according to PHAC’s national HIV behavioural surveillance, 24.8% of gbMSM have not been tested for HIV in the past 2 years — highlighting an apparent need to improve interactions between health systems and gbMSM with regards to HIV testing. Likewise, in addition to expanding HIV testing among HIV-negative gbMSM, there is also an opportunity to promote biomedical prevention strategies that can prevent HIV acquisition.

KIFFER CARD

Harnessing health Systems for HIV Elimination Among Gay and Bisexual Men

Indeed, individuals who feel that they may be at risk for HIV-infection can utilize antiretroviral therapies as a post-exposure prophylactic (PEP) to prevent infection with 80% efficacy or, as of February 2016, antiretroviral therapies can be used as a pre-exposure prophylactic (PrEP) to reduce acquisition risk by 90% or more. Of course, as with other prevention strategies access to PEP and PrEP varies within and between provinces and territories – creating geographic and structural disparities among gbMSM.

3. Health Systems Optimization is Needed to Improve Biomedical HIV Prevention among gbMSM

Given that health systems have the potential to eliminate HIV through existing care and prevention technologies, the lack of progress among gbMSM is concerning. Levesque, Harris & Russel (2013) conceptualize five barriers to health care access and highlight them as core dimensions of patient-centered care. These include gbMSM's concerns with approachability (e.g., not everyone feels comfortable interacting with traditional health systems), acceptability (e.g., not all prevention strategies are broadly accepted), availability (e.g., not everyone has access to biomedical HIV prevention), affordability (e.g., not everyone can afford treatment), and appropriateness (e.g., not all healthcare services are appropriate for vulnerable populations). Funding programs which can improve health systems access will therefore greatly benefit gbMSM and support efforts to eliminate HIV (e.g., not everyone feels comfortable interacting with traditional health systems to prevent infection with 80% efficacy or, as of February 2016, antiretroviral therapies can be used as a pre-exposure prophylactic (PrEP) to reduce acquisition risk by 90% or more). Of course, as with other prevention strategies access to PEP and PrEP varies within and between provinces and territories – creating geographic and structural disparities among gbMSM.

3. Health Systems Optimization is Needed to Improve Biomedical HIV Prevention among gbMSM

Given that health systems have the potential to eliminate HIV through existing care and prevention technologies, the lack of progress among gbMSM is concerning. Levesque, Harris & Russel (2013) conceptualize five barriers to health care access and highlight them as core dimensions of patient-centered care. These include gbMSM's concerns with approachability), acceptability (e.g., not all prevention strategies are broadly accepted), availability (e.g., not everyone has access to biomedical HIV prevention), affordability (e.g., not everyone can afford treatment), and appropriateness (e.g., not all healthcare services are appropriate for vulnerable populations). Funding programs which can improve health systems access will therefore greatly benefit gbMSM and support efforts to eliminate HIV.

KIFFER CARD

Harnessing health Systems for HIV Elimination Among Gay and Bisexual Men

PROPOSED ACTION

Aiming to improve health systems access and care delivery among gbMSM, the Community-Based Research Centre for Gay Men's Health (CBRC) has operated in Vancouver, British Columbia since 1999. Since its incorporation as a charitable non-profit organization, the CBRC has advocated for gay men's health by promoting knowledge exchange and community-based research. With the emergence of TasP, PrEP, and PEP, the CBRC has set out to revolutionize health systems serving gbMSM across Canada by establishing partnerships with key local and/or regional gay men's health community organizations, including Vancouver's Health Initiative for Men, the AIDS Committee of Toronto, MAX in Ottawa, and RÉZO in Montreal. Together these leading organizations provide essential services to gbMSM in their perspective cities and coordinating with the CBRC have established the Community Alliance project. Funded by PHAC, the goal of the Community Alliance is to increase gbMSM's access to combination prevention services (including HIV testing and treatment, nPEP and PrEP) across the country by 50-75% before 2022.

One of the key objectives of the Alliance is to facilitate knowledge translation efforts between researchers and front-line knowledge users so that this data can be leveraged to improve health systems access. Indeed, to date the barriers to PrEP and ART access are still poorly understood and community-organizations often lack the necessary information needed to improve access to these critical prevention options. Yet, ongoing research through several CIHR funded programs has allowed researchers to amass volumes of potentially relevant data. Therefore, there is a need for policies and funding conditions which facilitate knowledge translation between researchers and knowledge users. Given this, we propose that funding be made available for and/or conditional upon the:

- 1) Support for analytic skills development and capacity-building within community-based organizations to allow them to hire, train, and retain skills-proficient individuals who can leverage existing data sources for the guidance of community-programming.
- 2) Improvement of the access to data collected by health researchers through the funding of knowledge translation activities such as the creation of data visualization dashboards that can be used either in conjunction with or in lieu of original data or open data resources.
- 3) The creation of collaborative working groups which can better integrate knowledge users and researchers into existing health systems and healthcare hierarchies.

While funding these initiatives will likely improve knowledge translation efforts, these are obviously difficult tasks. Therefore my presentation will focus on the potential barriers and strategies to improving care and executing these goals.

HONoured PARTICIPANT - DENNIS LEE

Building a Technocratic Society: promoting Accurate Scientific Communication



BIOGRAPHY

Dennis Lee is a Immunology PhD Candidate who conducts scientific research related to Multiple Sclerosis (MS) at the University of Toronto. He volunteers as a moderator on the global forum site Reddit where he helps facilitate scientific conversation for over five million subscribers. In addition, he participates in discussions with people who are affected by MS and/or interested in learning more about the technical and research perspective of the illness. Dennis is passionate about scientific communication to the public and has introduced immunology as a topic to over 300 secondary students for Immunology Day with the national organization Let's Talk Science.

INSPIRATION

"Since my 8th grade teacher used news clippings as a tool for teaching English, I have always been interested in current events. This excitement magnified with the explosion of internet resources and the freedom of sharing different opinions and joining global discussions online. However, with political turmoil occurring in recent years over effective misinformation campaigns, I became curious about how people perceive and understand information. Scientific evidence is often found behind paywalls, filled with technical jargon, and difficult for the public to interpret. Therefore, for much of the public, evidence is not accessible. I wanted to be able to present scientific information by identifying the most effective way to communicate to each particular audience. I soon realized the impact of tailored communication beyond scientific papers and the need to promote a technocratic society where the public can make well-informed decisions."

OPPORTUNITY FOR ACTION

Since 2016, largely spurred by the Brexit Referendum and the election of Donald J. Trump in the US, many have opined that the death of democracy is upon us. Some have coloured this phenomenon by comparing it to the Aldous Huxley novel, Brave New World. The problem is not that the government or some entity imposes a certain line of thinking on their respective citizens (as in Orwell's 1984), but instead that disinterest of the electorate and widespread misinformation would lead to the downfall of

Building a Technocratic Society: Promoting Accurate Scientific Communication

society. Political leaders given mandates by the electorate have taken their supposed popularity to make sweeping decisions with little thought for the consequences. While policies are often filled with cost-benefit analyses and compromises with no clear cut answer, the ability to make those decisions become hindered by political interference. The erosion of trust in expertise and ideological-based decision-making is highly disconcerting. For example, Donald Trump's puzzling claims surrounding coal energy generation runs against almost every logical and scientific piece of evidence [1].

Closer to home, the Government of Ontario is shutting down the opening of three temporary Overdose Prevention Sites (OPS) and conducting a review on the harm reduction strategy despite the due diligence already completed [2]. This announcement conflicts with dire warnings regarding an opioid epidemic in Canada [3]; calls by Medical Officers to decriminalize all drugs [4]; public health research showing the benefit of these sites [5, 6]; and public support [7]. The science and logic behind the provision of OPS are clear but politicians are beginning to tread in a direction opposite to expertise and evidence. This is partially due to the voter base that does not support the sites and elected the government [8]. In the information age, where roughly 90% of Canadians have internet access [9], reliance on expertise and research should be paramount for policy and voting priorities. However, many lack the ability to properly assess the credibility and content of research or expertise. A 2016 poll in the US indicated that fake headlines could trick Americans roughly 75% of the time [10]. As a result, politicians are no longer bound by expertise and best practices but by populist perspectives which could have been easily misled.

Facebook, which was a battleground for "fake news" during the 2016 US Presidential elections, is a social media platform that is testing methods to prevent misinformation campaigns by including the use of fact-checkers and verifying political ads [11]. Unfortunately, the impact of deception spreads beyond government policy and into all topics such as climate change, homeopathic remedies, and conspiracy theories. Many are focused on targeting the social media platforms where these falsehoods spread [11, 12], but more initiatives must be focused on educating and providing opportunities for Canadians to understand research and technical expertise.

In Canada, the public research funding agencies (CIHR, NSERC, and SSHRC) have each committed some focus into educating the next generation of Canadians and improving scientific literacy [13, 14, 15]. However, only NSERC specifically focuses on translating knowledge to the public as part of their core mission. It can also be argued that the tri-council funding agencies are not well equipped to handle science outreach and should instead, be largely focused on grants, scholarships, and fellowships [16]. Therefore, while there is some attention towards the problem of scientific literacy among the electorate, a specific unified initiative to improve Canadian scientific literacy is desperately needed.

Building a Technocratic Society: Promoting Accurate Scientific Communication

Improvement of scientific literacy leads to the foundations of a technocratic society where evidence and expertise inform policy and is not led astray by misinformation.

PROPOSED ACTION

Recommendation 1: Establish the Office of Scientific Literacy (OSL) under the Minister of Science.

In accordance with the Naylor Report [16], the creation of the National Advisory Council on Research and Innovation (NACRI) will provide oversight and improve coordination for all public research funding agencies in Canada. The need for science outreach is globally recognized and we propose that budgets for scientific outreach be reorganized by NACRI and allocated to the OSL [17, 18]. Specifically, the Government of New Zealand produced an excellent 10-year initiative to tackle some of these issues in 2014 which the OSL could use to build their own framework [18]. The primary mandate of the OSL would be to track and promote scientific literacy of Canadians. Two initiatives of the OSL are outlined in recommendations 2 and 3. Additionally, the OSL will act as an expert consultancy for other Government bodies to share scientific knowledge with the public in a meaningful way.

Recommendation 2: Promote science communication in the classroom.

Key recommendations from the New Zealand initiative [18] include building stronger links between educators, researchers, and students. To fulfill this need, we suggest the OSL to train and employ moderators that can help facilitate scientific discussion between researchers and the public. While there has been a growing push for scientists to engage in scientific outreach and communication, the results can vary depending on the abilities of the scientist to foster discussion. Utilizing a trained moderator helps ensure a high value session for all those involved [19]. We recommend meeting a mandate of having every high school student participate in at least one information session given by a scientist (Upper-year PhD Candidate, Post-doctoral fellow, Research Associate, or Professor). In addition, PhD candidates could lead a session as a compliment to their education. By implementing this program, we expect to improve public training in science and encourage scientists to build relationships with the community.

Recommendation 3: Promote scientific integrity in the media.

While not a focal point of the New Zealand initiative [18], the media heavily influences opinion and public judgement [20]. We propose that the OSL hold the media accountable for providing accurate reports on scientific concepts and facts: as such, we can prevent the spread of misinformation through

Building a Technocratic Society: Promoting Accurate Scientific Communication

widely circulated sources. Although a detailed consultation should be completed before implementing a strategy, two plausible action plans are listed below. Firstly, the Government could mandate a list of topics that would require an academic expert be consulted for the content of the article such as climate change, health and disease, and urban design. The expert will include their signage on the final article sent for print as proof of academic rigor. Alternatively, the Government could mandate all large media corporations hire a Chief Scientific Officer (CSO) who is accountable for all the claims made by the corporation. Failure to correct misinformation in a timely manner or propagation of misinformation could be subject to fines levied by the OSL. By implementing this recommendation, we hope to set a new global standard for the media to report scientific evidence.

Summary: The rate of information dissemination in the internet age has led to misinformation campaigns that have negatively affected public policy, public health, and scientific literacy. With the goal of promoting a technocratic society that values evidence-based decision-making, we recommend the establishment of a specific office responsible for the promotion of scientific literacy. Furthermore, we outline two novel initiatives that the OSL can use to improve scientific literacy for all Canadians. By promoting scientific literacy, the electorate will be better informed to support well-studied public policy and dispel misinformation.

REFERENCES

1. Qiu, L. and Schwartz, J. (2018, Aug 21). Trump's False Claims About Coal, the Environment and West Virginia. *The New York Times*. Retrieved from <https://www.nytimes.com/2018/08/21/us/politics/trump-fact-check-west-virginia-rally.html>
2. The Canadian Press. (2018, Jul 24). Ontario to review safe injection, overdose prevention sites, health minister says. *CBC News*. Retrieved from <https://www.cbc.ca/news/canada/toronto/ontario-safe-injection-sites-limbo-1.4760002>
3. Murphy, Y., et al. (2015). Prescription opioid use, harms and interventions in Canada: A review update of new developments and findings since 2010. *Pain Physician*, 18(4), E605-E614.
4. CBC News. (2018, Jul 9). Decriminalize all drugs for personal use, Toronto Public Health recommends in new report. *CBC News*. Retrieved from <https://www.cbc.ca/news/canada/toronto/toronto-public-health-recommends-decriminalizing-drugs-1.4739344>
5. Kennedy, M. C., & Kerr, T. (2017). Overdose prevention in the United States: A call for supervised injection sites. *American Journal of Public Health*, 107(1), 42-43. doi:10.2105/AJPH.2016.303523
6. Potier, C., et al. (2014). Supervised injection services: What has been demonstrated? A systematic literature review. *Drugs and Alcohol Dependence*, 145(1), 48-68. doi:10.1016/j.drugalcdep.2014.10.012
7. Cruz, M. F., et al. (2007). Public opinion towards supervised injection facilities and heroin-assisted treatment in Ontario, Canada. *International Journal of Drug Policy*, 18(1), 54-61. doi:10.1016/j.drugpo.2006.12.001
8. Selley, C. (2017, Jan 10). Chris Selley: Suddenly, safe-injection sites are mainstream politics. *National Post*. Retrieved from <https://nationalpost.com/opinion/chris-selley-suddenly-safe-injection-sites-are-mainstream-politics>
9. CIA World Factbook. (2016). Retrieved from <https://www.cia.gov/library/publications/the-world-factbook/geos/ca.html>
10. Silverman, C. and Singer-Vine, J. (2016, Dec 6) Most Americans Who See Fake News Believe It, New Survey Says. *Buzzfeed News*. Retrieved from <https://www.buzzfeednews.com/article/craigsilverman/fake-news-survey#.vk5PpamMPP>

DENNIS LEE

Building a Technocratic Society: Promoting Accurate Scientific Communication

REFERENCES (cont.)

11. Facebook. (2018, Mar 29). Hard Questions: What is Facebook Doing to Protect Election Security? *Facebook Newsroom*. Retrieved from <https://newsroom.fb.com/news/2018/03/hard-questions-election-security/>
12. Heater, B. (2018, Aug 19). Jack Dorsey admits Twitter hasn't 'figured out' approach to fake news. *TechCrunch*. Retrieved from <https://techcrunch.com/2018/08/19/jack-dorsey-admits-twitter-hasnt-figured-out-approach-to-fake-news/>
13. McLean, R. and Tucker, J. (2013) Evaluation of CIHR's Knowledge Translation Funding Program. Retrieved from http://www.cihr-irsc.gc.ca/e/documents/kt_evaluation_report-en.pdf
14. NSERC. (Modified 2018, Jan 25). NSERC 2020. Retrieved from http://www.nserc-crsng.gc.ca/NSERC-CRSNG/NSERC2020-CRSNG2020/index_eng.asp#plan1
15. The Impact Group. (2010, Nov). Knowledge Transfer Through Research Contracting. Retrieved from http://www.sshrc-crsh.gc.ca/about-au_sujet/publications/consultations/knowledge_transfer-transfer_connaissances_e.pdf
16. Advisory Panel for the Review of Federal Support for Fundamental Science. (2017). Investing in Canada's Future-Executive Summary. Retrieved from [http://www.sciencereview.ca/eic/site/059.nsf/vwapj/ExecSummary_April2017-EN.pdf/\\$file/ExecSummary_April2017-EN.pdf](http://www.sciencereview.ca/eic/site/059.nsf/vwapj/ExecSummary_April2017-EN.pdf/$file/ExecSummary_April2017-EN.pdf)
17. Science Borealis. (2016, Jul 11). Canadian Science Funding Review Should Include Science Communication. Retrieved from <http://blog.scienceborealis.ca/canadian-science-funding-review-should-include-science-communication/>
18. New Zealand Government. (2014, Jul). A Nation of Curious Minds. Retrieved from <https://www.curiousminds.nz/assets/Uploads/science-in-society-plan-PDF.pdf>
19. Cambre, J., *et al.* (2017). Escaping the echo chamber: Ideologically and geographically diverse discussions about politics. Paper presented at the Conference on Human Factors in Computing Systems - Proceedings, , Part F127655 2423-2428. doi:10.1145/3027063.3053265
20. Happer, C., & Philo, G. (2013). The role of the media in the construction of public belief and social change. *Journal of Social and Political Psychology*, 1(1), 321-336. doi:10.5964/jspp.v1i1.96

HONOURED PARTICIPANT - EMMA FINLAYSON-TRICK

Public Behaviour During Infectious Disease Outbreak: Canada's communication policy



BIOGRAPHY

Emma Finlayson-Trick is a Master of Science candidate at Dalhousie University, Department of Microbiology & Immunology. She is studying the role of a bacterial protein in Crohn's disease. Outside the lab, Emma is passionate about science communication. She created the blog "Think of the PLoSibilities," which takes open-access scientific articles and synthesizes them into lay summaries for the public. In addition, Emma is an advocate for women in STEM. She co-organized Halifax's first Soapbox Science event, a platform for female scientists to discuss their research with the public. Emma has been recognized for her dedication to research and to the community in the form of the Dalhousie Faculty of Science Undergraduate Research Prize, the Dalhousie Faculty of Medicine's Impact Award, and the Ron Carr Award, which recognizes an outstanding academic achiever committed to the betterment of colleagues and the community. She is pursuing a career as an infectious disease specialist.

INSPIRATION

"Infectious disease outbreaks tend to elicit fear and panic. I know because during the 2009 H1N1 influenza pandemic, along with many other Vancouverites, I flinched at every cough, sneeze, and sniffle I heard. Five years later during the 2014 Ebola outbreak, I behaved quite differently. I had since begun my undergraduate education in microbiology and immunology and had come to better understand these disease-causing organisms. My friends, in comparison, still feared the microscopic culprits. Moreover, compelled by fear-mongering journalism they, and 85% of polled Americans, believed Ebola was airborne.¹ I still find this statistic unacceptable. As a nation of scientists, policy-makers, and communicators, Canada has the skill to effectively engage with the public on issues pertaining to disease outbreak. For this reason, I am inspired to propose a modified outbreak communication policy that is informed by my passion for infectious disease and science communication."

EMMA FINLAYSON-TRICK

Public Behaviour During Infectious Disease Outbreak: Canada's communication policy

OPPORTUNITY FOR ACTION

Infectious disease outbreaks pose a serious threat to human health and society.[2, 3, 4, 5, 6, 7] Experts suspect that current vaccines and treatments may not be sufficient to tame the next outbreak.[8] Beyond morbidity and mortality, outbreaks have economic and social consequences.[9, 10, 11] For example, the economic impact of the 2014 Ebola outbreak was exacerbated by the suspension of global trade and travel.¹⁰ Until exposure to infectious diseases can be better predicted, prevented, and treated, the management of future outbreaks will rely on classic approaches that include community engagement, dissemination of evidence-based information, and management of detrimental behaviours.[12, 13, 14]

Communication greatly influences how people perceive risk.[15] Effective communication can guide individual behaviour and affect the overall health and wellness of a population. A study conducted by the University of Surrey observed that following a rabies public health campaign in a high-risk area of Azerbaijan, individuals vaccinated their dogs, which provided protection to both the animal and the owner.¹⁶ Poor or delayed communication enables the rapid spread of misinformation and speculation. In these situations, individuals behave based on the perception of risk rather than the risk itself.[9, 17,18] Canada witnessed this first-hand during the 2002 severe acute respiratory syndrome (SARS) outbreak. A retrospective study showed that Canadians spent unnecessary amounts of time and money trying to protect themselves against a virus they knew very little about.¹⁸ The SARS outbreak provided the impetus to improve outbreak communication with health care providers, professional organizations, and the general public.[19, 20, 21, 22, 23]

Communication falls subject to the Goldilocks principle in which the amount of information delivered has to be just right. Too little information, as observed pre-SARS, and too much information, as observed currently, both lead to confusion and panic. Far too often the first response to an outbreak is to produce messages, leaflets, posters, radio broadcasts, and television advertisements, that have no other purpose than to raise awareness. Canada's current outbreak communication policies work on the principle that providing information will enable Canadians to decide how to protect their health. The diversity of Canada, however, means that individuals will respond differently to the same information. The Canadian outbreak communication policy should instead be guided by clear behavioural objectives. In other words, the policy needs to transition from asking "how can we disseminate this information to the greatest number of Canadians?" to "what information is needed to encourage a particular behaviour in the Canadian population?" Behavioural and social communication strategies (sometimes called behaviour

EMMA FINLAYSON-TRICK

Public Behaviour During Infectious Disease Outbreak: Canada's communication policy

change communication) are not new. [24] The Communication for Behavioural Impact (COMBI) guide produced by the World Health Organization has influenced communication policies in several countries worldwide.²⁵ COMBI has been used successfully to eliminate leprosy in India and Mozambique and to prevent and control dengue in Malaysia and the Americas.[25,26] Behaviour change communication has also been used during outbreaks, most recently in 2014 with Ebola. Scientists identified that traditional burial methods were facilitating transmission, thus they educated communities to change/stop their burial practises, and disease transmission was reduced.[27] Our current policy leaves too much room for interpretation during an outbreak. Behaviour change communication, in comparison, uses human behaviour to inform communication and to control and prevent further disease transmission.

Outbreaks have substantial health, economic, and social costs. Furthermore, the risk of outbreaks is increasing, in part due to the changing dynamics of human behaviour. For this reason, effective communication guided by desired behavioural outcomes is critical to prevent and control disease. Updating Canada's outbreak communication policy should be a top priority before the next outbreak strikes.

PROPOSED ACTION

Outlined are the steps that must occur to actualize an outbreak communication policy that is guided by clear behavioural objectives and that speaks to the diverse Canadian population. As the Public Health Agency of Canada (PHAC) currently guides national communication policies through collaboration with international organizations, federal, provincial, and territorial departments, I foresee them leading the organization of this new policy.[28] Certain steps are inspired by the World Health Organization's Communication for Behavioural Impact guide.[25]

Identify Behavioural and Communication Objectives

STEP 1: Identify preliminary behavioural objectives. To begin, policy organizers, health care professionals, and infectious disease experts will assess what is already known about the disease. Next, they will determine if there are certain practices common within the population that may facilitate the disease spreading. If particularly troublesome practices are identified (i.e. Ebola example given previously), they will communicate with community/religious/nongovernmental-organization/etc. leaders to understand the beliefs, values, and norms related to the practices.

EMMA FINLAYSON-TRICK

Public Behaviour During Infectious Disease Outbreak: Canada's communication policy

STEP 2: Conduct a rapid situational market analysis. Policy organizers will determine whether the objectives outlined in STEP 1 are feasible, practical, and appropriate for the population. Situational market analysis will identify factors that will facilitate and restrict the behavioural objectives. This step necessitates research using semi-structured interviews, observation, focus group discussions, community meetings, structured interviews and questionnaires, and interviews with stakeholders.[25]

STEP 3: Refine behavioural objectives and define communication objectives. Policy organizers will modify the preliminary behavioural objectives to reflect the information learned during STEP 2. Furthermore, they will identify what information needs to be communicated to the public in order to achieve the behavioural objectives.

STEP 4: Design a strategy to achieve objectives. Policy organizers will next determine what avenues are available to disseminate information to the population. Communication experts will be able to help identify the best combination of media to reach specific target groups.[29,30] In addition, special attention will be focused on reaching vulnerable populations in Canada. Vulnerable populations include Aboriginal peoples, homeless peoples, refugees, seniors, those with limited internet and phone access, those who have visual and auditory disabilities, and those who are illiterate.[31,32] Representatives from each vulnerable population will be consulted to determine how they best receive information (i.e. word of mouth, schools, community centers, etc.). This step should not take long as routes of communication should be identified and constantly updated pre-outbreak.

Implement and monitor objective-based strategy. Implementing the policy will require a coordinated effort by community leaders, government, and public officials. Once implemented, ongoing monitoring will indicate if there are components of the strategy that need to be adjusted. Implementation monitoring will compare what is happening to what should be happening and behavioral monitoring will measure the completion of behavioural objectives. Monitoring information will be acquired through meetings with community outreach leaders, public health workers, and online surveillance. Other nations have had success monitoring online health discourse. For example, the Taiwanese government decided to implement daily review of public opinion on mass and social media during disease outbreak.³³ This allowed the government to determine if their communication strategy was working and if there were disease rumours that needed to be disproven.[33]

EMMA FINLAYSON-TRICK

Public Behaviour During Infectious Disease Outbreak: Canada's communication policy

Evaluate effectiveness of communication policy

Following an outbreak, the overall impact of the strategy will be evaluated using similar methods outlined during the situational market analysis. This ensures input from a variety of groups including, but not limited to, community members, stakeholders, and government officials. Two forms of evaluation will occur: outcome (were the behavioural objectives achieved?) and impact (how will the outcomes contribute to future outbreak preparedness?). The evaluation results will be shared using the same avenues used to disseminate information during the outbreak.

REFERENCES

1. Dwyer M. Poll: Most believe Ebola likely spread by multiple routes, including sneezing, coughing. Harvard School of Public Health. <https://www.hsph.harvard.edu/news/pressreleases/poll-finds-most-believe-ebola-spread-by-multiple-routes/>. Published 2014.
2. Liao Y, Xu B, Wang J, Liu X. A new method for assessing the risk of infectious disease outbreak. *Sci Rep.* 2017;7. doi:10.1038/srep40084.
3. World Health Organisation (WHO). WHO | Emerging diseases. WHO.
4. Ogden NH, AbdelMalik P, Pulliam J. Emerging infectious diseases: prediction and detection. *Can Commun Dis Rep.* 2017;43(10):206-211. doi:10.14745/ccdr.v43i10a03.
5. *Surveillance of Zika.*; 2018.
6. Walensky RP, del Rio C, Armstrong WS. Charting the Future of Infectious Disease: Anticipating and Addressing the Supply and Demand Mismatch. *Clin Infect Dis.* 2017;64(10):1299-1301. doi:10.1093/cid/cix173.
7. National Institutes of Health (US). Understanding Emerging and Re-emerging Infectious Diseases. In: *NIH Curriculum Supplement Series, Biological Sciences Curriculum Study.* ; 2007. doi:10.1056/NEJMra1108296.
8. Walsh B. The World Is Not Ready for the Next Pandemic. *Time Mag.* 2017.
9. Science I, Henry B. Canadian Pandemic Influenza Preparedness : Communications strategy. 2018;44:106-109.
10. World B, The World Bank. *World Development Report 2015: Mind, Society, and Behavior.*; 2015. doi:10.1596/978-1-4648-0342-0.
11. Chen F, Griffith A, Cottrell A, Wong Y-L. Behavioral responses to epidemics in an online experiment: using virtual diseases to study human behavior. *PLoS One.* 2013;8(1):e52814. doi:10.1371/journal.pone.0052814.
12. Agua-Agum J, Allegranzi B, Ariyaratnam A, et al. After Ebola in West Africa — Unpredictable Risks, Preventable Epidemics. *N Engl J Med.* 2016;375(6):587-596. doi:10.1056/NEJMs1513109.
13. Woolhouse MEJ, Rambaut A, Kellam P. Lessons from Ebola: Improving infectious disease surveillance to inform outbreak management. *Sci Transl Med.* 2015;7(307). doi:10.1126/scitranslmed.aab0191.
14. Hagan JE, Smith W, Pillai SK, et al. Implementation of Ebola case-finding using a village chieftaincy taskforce in a remote outbreak - Liberia, 2014. *MMWR Morb Mortal Wkly Rep.* 2015;64(7):183-185. doi:10.1111/ajtm.13333.
15. Canada H. Strategic Risk Communications Framework. *Heal (San Fr.)* 2006.
16. Hasanov E, Zeynalova S, Geleishvili M, et al. Assessing the impact of public education on a preventable zoonotic disease: Rabies. *Epidemiol Infect.* 2018;146(2):227-235. doi:10.1017/S0950268817002850.
17. Smith RD. Responding to global infectious disease outbreaks: lessons from SARS on the role of risk perception, communication and management. *Soc Sci Med.* 2006;63(12):3113-3123. doi:10.1016/j.socscimed.2006.08.004.
18. Blendon RJ, Benson JM, DesRoches CM, Raleigh E, Taylor-Clark K. The public's response to severe acute respiratory syndrome in Toronto and the United States. *Clin Infect Dis.* 2004;38(7):925-931. doi:10.1086/382355.
19. Hawryluck L, Gold WL, Robinson S, Pogorski S, Galea S, Styrar R. SARS control and psychological effects of quarantine, Toronto, Canada. *Emerg Infect Dis.* 2004;10(7):1206-1212. doi:10.3201/eid1007.030703.

EMMA FINLAYSON-TRICK

Public Behaviour During Infectious Disease Outbreak: Canada's communication policy

REFERENCES (Cont.)

20. Skowronski DM, Petric M, Daly P, et al. Coordinated response to SARS, Vancouver, Canada. *Emerg Infect Dis*. 2006;12(1):155-158. doi:10.3201/eid1201.050327.
21. Nelson S, Byng A. The SARS pandemic in Toronto, Canada, 2003. *Nurses disasters Glob Hist case Stud*. 2015:229-255.
22. Zuberi D. SARS Unmasked: Risk Communication of Pandemics and Influenza in Canada. *Labour*. 2011;(67):234-237.
23. Politi B, Chai C. SARS 10 years later: How has the health care system changed? *Global News*. March 5, 2013.
24. Koenker H, Keating J, Alilio M, Acosta A, Lynch M, Nafo-Traore F. Strategic roles for behaviour change communication in a changing malaria landscape. *Malar J*. 2014;13(1). doi:10.1186/1475-2875-13-1.
25. World Health Organization, UNICEF, FAO. Communication for Behavioural Impact (Combi). *Commun Behav Impact*. 2012:3-14. doi:WHO/HSE/GCR/2012.13.
26. Suhaili MR, Hosein E, Mokhtar Z, Ali N, Palmer K, Isa MM. Applying communication for-behavioural-impact (COMBI) in the prevention and control of dengue in Johor Bahru, Johore, Malaysia. *Dengue Bull*. 2004;28(SUPPL.):39-43.
27. Jacobsen KH, Alonso Aguirre A, Bailey CL, et al. Lessons from the ebola outbreak: Action items for emerging infectious disease preparedness and response. *Ecohealth*. 2016;13(1):200-212. doi:10.1007/s10393-016-1100-5.
28. Canada and the World Health Organization. Government of Canada. http://international.gc.ca/world-monde/international_relationsrelations_internationales/multilateral-multilateraux/who-fao.aspx?lang=eng. Published 2017. Accessed August 23, 2018.
29. PHAC. Communications and Stakeholder Liaison Annex.
30. Mitchell A, Simmons K, Matsa KE, Silver L. Publics Globally Want Unbiased News Coverage but are Divided on Whether Their News Media Delivers. 2018:55.
31. Leung CS, Ho MM, Kiss A, Gundlapalli A V., Hwang SW. Homelessness and the response to emerging infectious disease outbreaks: Lessons from SARS. *J Urban Heal*. 2008;85(3):402-410. doi:10.1007/s11524-008-9270-2.
32. Health Disparities Task Group. *Reducing Health Disparities – Roles of the Health Sector.*; 2004. doi:0-662-69313-2.
33. Hsu Y-C, Chen Y-L, Wei H-N, Yang Y-W, Chen Y-H. Risk and Outbreak Communication: Lessons from Taiwan's Experiences in the Post-SARS Era. *Heal Secur*. 2017;15(2):165-169. doi:10.1089/hs.2016.0111.

HONOURED PARTICIPANT - JAMES MCCOY

Discharge the Large! Making smaller labs for greater reward



BIOGRAPHY

Originally from Melbourne (Australia), I came to Vancouver as a postdoc at the University of British Columbia in 2016. Here, I have been developing novel methods to study the complicated ways that bacterial pathogens manipulate human bodies in order to cause disease. In 2017, I was a founding member of the Vancouver chapter of Future of Research, an international organisation that advocates for better training and funding structures for early career researchers (ECRs). In February 2017, we held our first symposium aimed at stoking discussion with local ECRs regarding their concerns and ideas on how to sustain the future of Canadian research. More than 200 ECRs, and representatives from industry and academia attended. Now an author on a manuscript presenting our findings from the symposium, I am passionate about questioning how Canadian science could become an example for developing young talent.

INSPIRATION

“When I began my postdoc I, along with many of my colleagues, found that large “mega-labs” are extremely challenging places to work. Following my work with Future of Research, I began to ask whether large labs might directly inhibit the careers of ECR, by not only depriving ECRs of proper career training, but also reducing the opportunities for funding of a more diverse and enigmatic research climate in Canada. I soon learned through my research the larger the lab, the less efficient it often worked, wasting public funding and squandering the talents of talented ECRs. Meanwhile, I saw scientists around me attempting to pursue bold research in interdisciplinary areas, but failing to find funding. I wondered whether funding devoted to maintaining monolithic mega-labs could be better put toward the development of highly collaborative interdisciplinary research projects, which may be best pursued by many smaller labs working in partnership.”

OPPORTUNITY FOR ACTION

After more than a decade of cuts and stalls, and spurred by recent events like the Fundamental Science Review [1], Canadian research is in a resurgence. Canada now must ask how it can most efficiently use public funds to re-build a research environment that can meet the challenges of the 21st century.

Discharge the Large! Making smaller labs for greater reward

One of the key findings from the Fundamental Science Review was increasing concern that a significant portion of research funds are ending up in the labs of already-established scientists [1]. While this concern has been partly met with recent initiatives (for example, ensuring successful funding for early-career Principal Investigators (PIs) in Canada Institutes for Health Research (CIHR) Project Grants in proportion to their application rate [2]), thinking of this issue as one purely of sequestered funding misses its worst implications: large labs are bad for science.

As PIs establish careers, they steadily grow their research groups. This may allow “mega-labs” (research groups with more than 15 people) to develop. This is seen worldwide, and the Canadian funding system actively allows this: PIs may apply for hold multiple Project, and Foundation Grants at the same time. Mega-labs are often those which earn the biggest grants and require the most funding to maintain. Our research institutions often directly encourage the growth of these labs, celebrating them as pinnacles of what can be achieved in research science.

However, we now know that every metric for productivity decreases as lab size increases. Publications per year shows a dramatic plateau once lab size reaches above roughly 10 people [3]. Considering the question in terms of funding amounts shows a similar plateau; labs do not spend more money better [4]. This is particularly concerning when we consider the common assumption that labs which earn more public funding will be able to do more ambitious work, therefore publishing higher impact publications, despite evidence directly to the contrary [5]. Furthermore, higher ranked grants in funding competitions show no correlation with increased impact factor of publications [6].

The reasons for these trends are likely many and varied, but most hypotheses continually come back to the involvement of the PI with their PhD and postdocs [4]. As labs grow, PIs are less directly involved in individual projects. Despite being the most experienced researcher in the lab, they become more committed to spending time writing and administering grants required to run such large groups. This also means that PIs provide less mentorship and training for trainees (typically early career researchers (ECRs); PhD students and postdocs). This is a significant problem in Canada, as many ECRs report significant dissatisfaction with their level of mentorship and training [7]. Currently, Canadian funding agencies take no account of effectiveness of mentorship or training in awarding grants. ECRs also lose out when they attempt to transition to faculty positions, as mega-labs accumulate more and more public funding and lab space. Combined, these effects on ECR training risk causing stagnating Canadian science.

There is some evidence that mega-labs also do not participate in as much multidisciplinary work as smaller groups [8]. Reasons for this are poorly understood, but as stated above are likely a consequence

Discharge the Large! Making smaller labs for greater reward

of lower engagement of PIs of mega-labs in individual research projects. The lower success rate of multidisciplinary grant applications has also been well documented [1]. Some progress has been made to ameliorate this such as multidisciplinary grant panels [9]. Multidisciplinary science is commonly cited as the next frontier for answering the challenges of the 21st century [1, 9, 10]. While monolithic mega-labs are antithetical to highly multidisciplinary research, a network of highly collaborative smaller labs might be ideally suited to these dynamic and creative projects.

PROPOSED ACTION

In this proposal, I aim to address the issues which lead to key inefficiencies in mega-labs, without stymying “big science” projects. These points aim to incentivise more modest lab sizes through indirect means, rather than through rough metrics like directly mandated lab sizes or ideal publication number per lab member. With these combined aims, I hope to will create a more diverse, dynamic and creative research environment in Canada, with more smaller labs engaged in ground-breaking collaborations.

P.1 Cap labs at a maximum level of funding

Data demonstrate that increased funding does not lead to additional gains in publications [4], or publication impact factor [5]. In addition, the number of publications per year does not increase with lab size [3]. Interestingly, this effect is seen only after grants grow above the average CIHR Project Grant size for 2018 (roughly \$800K) [5, 11].

Therefore, funding for an individual lab should be capped at a maximum value, of roughly \$1million. “Top-up” funding could be received by labs showing exceptional return value per dollar and per lab member (see P.2 and P.3 below).

P.2 Consider lab size when reviewing grants

Currently, none of the tri-agency bodies take productivity per lab member into account when reviewing grants. This is remarkable, given data demonstrating negative correlation between increasing lab size and almost all metrics of productivity [3, 12].

All grant review should consider lab size when reviewing publication record, in terms of number of publications, impact factor, and patents. Labs which show exceptional productivity per lab member should be weighted significantly higher than “mega-labs” in related fields which consistently publish less, lower-quality work. “Mega-labs” which show good productivity here and in P.3 should be considered for “top-up” funding as in P.1.

Discharge the Large! Making smaller labs for greater reward

P.3 Consider project management and ECR mentorship in grant review

There is significant concern that one of the chief reasons “mega-labs” underperform is due to PIs committing more time to applying for and administering grants, and less to actual mentorship and professional training of ECRs who perform the vast bulk of research [13]. This is a growing trend in ECR advocacy [7]. Not addressing this issue means risking wasting public funded investment in the next generation of scientists.

All grant review should consider whether the PI has undertaken project and team management training, and is actively involved in practicing this with their lab. PIs should report number of hours per week devoted to individual and group-oriented project planning meetings. Demonstrating this would make labs eligible for top-up funding as per P.1.

P.4 Establish a pool of devoted multidisciplinary grants

Smaller labs engage in more multidisciplinary research [8]. This is therefore a unique area where smaller labs could excel, and create a network of dynamically collaborative projects. However, multidisciplinary studies are notoriously difficult to fund under current structures [1].

A pool of tri-council funds should be set aside exclusively for multidisciplinary research (roughly 10% every year). These would be reviewed a multidisciplinary panel of members from all councils. Labs would have to show exceptionally high standards in project and team management as per P.2 and P.3 to be eligible. However, these funds would not count toward the lab funding cap as per P.1, thereby providing a potential top-up and still allowing “big-science” to flourish in Canada.

P.5 Mandate project management and mentorship training

While some Canadian institutions mandate project management or mentorship training for PIs (e.g. Université Laval), it is still uncommon. Research institutions should be brought into the dialogue of how mega-labs can inhibit productivity and trainee development. Following this, nation-wide programs for project management and mentorship training for PIs should be developed and instituted.

Discharge the Large! Making smaller labs for greater reward

REFERENCES

1. Naylor, C. David, Robert J. Birgeneau, Martha Crago, Mike Lazaridis, Claudia Malacrida, Arthur B. McDonald, Martha C. Piper, Remi Quirion, and Anne Wilson. 2017. "Investing in Canada's Future: Strengthening the Foundations of Canadian Research," 243. [http://www.sciencereview.ca/eic/site/059.nsf/vwapi/ScienceReview_April2017-rv.pdf/\\$file/ScienceReview_April2017-rv.pdf](http://www.sciencereview.ca/eic/site/059.nsf/vwapi/ScienceReview_April2017-rv.pdf/$file/ScienceReview_April2017-rv.pdf).
2. McInnes, Roderick R. 2017. "Update on the Foundation Grant Program." Canadian Institutes of Health Research. <http://www.cihr-irsc.gc.ca/e/50459.html>.
3. Cook, Isabelle, Sam Grange, and Adam Eyre-Walker. 2015. "Research Groups: How Big Should They Be?" PeerJ 3: e989. doi:10.7717/peerj.989.
4. Lorsch, J. R. 2015. "Maximizing the Return on Taxpayers' Investments in Fundamental Biomedical Research." *Molecular Biology of the Cell* 26 (9): 1578–82. doi:10.1091/mbc.E14-06-1163.
5. Doyle, J. M., K. Quinn, Y. A. Bodenstein, C. O. Wu, N. Danthi, and M. S. Lauer. 2015. "Association of Percentile Ranking with Citation Impact and Productivity in a Large Cohort of de Novo NIMH-Funded R01 Grants." *Molecular Psychiatry* 20 (9): 1030–36. doi:10.1038/mp.2015.71.
6. Lauer, Michael S., Narasimhan S. Danthi, Jonathan Kaltman, and Colin Wu. 2015. "Predicting Productivity Returns on Investment: Thirty Years of Peer Review, Grant Funding, and Publication of Highly Cited Papers at the National Heart, Lung, and Blood Institute." *Circulation Research*. doi:10.1161/CIRCRESAHA.115.306830.
7. Jadavji, Navisa M, Mohamad Nadim Adi, Chris Corkery, Jiro Inoue, and Kathleen Van Benthem. 2016. "The 2016 Canadian National Postdoctoral Survey Report." National Postdoctoral Survey.
8. Carayol, Nicolas, Thuc Uyen, and Nguyen Thi. 2005. "Economics of Science" 14 (1): 70–79. doi:10.3917/redp.224.0471.
9. Alyass, Akram, Michelle Turcotte, and David Meyre. 2015. "From Big Data Analysis to Personalized Medicine for All: Challenges and Opportunities." *BMC Medical Genomics*. doi:10.1186/s12920-015-0108-y.
10. Ledford, Heidi. 2015. "How to Solve the World's Biggest Problems." *Nature*. doi:10.1038/525308a.
11. CIHR. "Project Grants: Spring 2018 Results." 2018. Canadian Institutes of Health Research.
12. Carayol, Nicolas, and Mireille Matt. 2004. "The Exploitation of Complementarities in Scientific Production Process at the Laboratory Level." *Technovation* 24 (6): 455–65. doi:10.1016/j.technovation.2004.03.007.
13. Lorsch, Jon. 2014. "Larger Labs: Is Bigger Better?" *IBiology*.

HONoured PARTICIPANT - SEJAL DAVLA

Bridging the gap between animal and human health policies



BIOGRAPHY

I am a postdoctoral researcher at McGill University and I am trying to understand how the brain develops. I came to Montreal from India to pursue my Ph.D. in neuroscience. I use fruit flies as a model organism to understand i) how a particular cell type in the brain, astrocytes develop and ii) how astrocytes control sleep. I am passionate about writing and mentoring. Outside of the lab, I teach, volunteer and mentor young adults and write science stories to lay audiences on my blog. I am an avid reader and I enjoy dancing and reading about history, politics, and philosophy.

INSPIRATION

"I recently read a fascinating blog post about zombie vultures and their plight with some of our favorite painkiller drugs. I successively found more stories where the common drugs we use is responsible for the mass killing of several animal species. It was frustrating to read these stories because, in many instances, we already have a replacement drug that is non-toxic to the species in question. I am inspired to write this proposal because the drugs we dump in the environment is acutely declining animal species, and the stakes are much higher than just losing a species."

OPPORTUNITY FOR ACTION

Animals are undeniably important stakeholders in human evolution and contribute to our economies, food supply and, social and cultural narratives globally. The interrelationship between humans, animals and the environment is constantly changing with globalization and changes in climate conditions. The increase in human activity has unleashed unprecedented dangers to both human and animal health [1, 2]. Our global health policies pivot around our own species. As we begin to understand the animal-human-environment interface, it is imminent to go beyond one species-based health policy and devise new strategies based on multiple animal species health.

The Council of Canadian Academics surveyed evidence-based risk assessment approaches of animal health emphasizing global environmental challenges such as the emergence of new pathogens, toxicant release, species extinction due to loss of habitat, zoonotic diseases. As evident from this document,

Bridging the gap between animal and human health policies

economic burdens of animal health episodes decrease trade flows, lost farming income and jobs in Canadian domestic ecosystems. A decline in wildlife population will directly affect food and source of income for First Nations people [3]. Among these challenges, there is one particular problem that is quite spectacular when it comes to animal mortality and it needs an immediate attention from scientists and policy-makers. The chemicals we use in the form of drugs, pesticides, medicines have a detrimental effect on several animal species. This proposal seeks to highlight a growing issue of adverse effects of medicines/drugs used for human use on the ecology using the following examples:

i) The deleterious effects of neonicotinoids on bees and bird species worldwide remain to be one of the most alarming stories of ecological disaster. A commonly used nicotine-based pesticide to kill pests like aphids, stink bugs, spider etc. causing mass death of honeybees [4]. Honeybees bring billions of dollars of revenues in the agriculture sector by simply pollinating farm crops [5]. In Canada, neonicotinoids are responsible for killing honeybees in the regions where corn is grown [6]. In addition, neonicotinoids also kill other insects and invertebrates that improve soil quality and fertility.

ii) Synthetic estrogen found in birth control pills wiped out fathead minnows in lakes in Ontario and disrupted the ecosystem. The minnow decline caused 23-42% decline in the predator trout population and the number of insects grew substantially [7].

iii) A stark decline in the 95% population of vulture species in the Indian subcontinent is caused by a popular painkiller drug diclofenac that belongs to a class of non-steroidal anti-inflammatory drugs (NSAIDs). Further studies identified more NSAIDs such as carprofen, ibuprofen, phenylbutazone causing toxicity not just in vultures but also in raptors, storks, cranes and owls [8, 9]. Similar diclofenac toxicity was reported in vultures in Spain and Africa [10, 11] but there are no such reports on the effect of NSAIDs for turkey and black vulture species in Canada. Vultures are a huge boon for humans as they reduce the risk of diseases carried by carrion such as rabies, anthrax, botulism etc. They also contain disease outbreaks from animals to humans by consuming carrions [12].

Together, these studies provide a solid evidence for drug toxicity causing wildlife decline that directly affects human health, economy and environment not just in Canada but globally.

SEJAL DAVLA

Bridging the gap between animal and human health policies

PROPOSED ACTION

The number of studies that unravel the causative effects of human interference on wildlife species and ecosystem remains to be very low. As we begin to learn hitherto undescribed effects of human activities on animal health and its repercussions on human health, we are forced to change policies around current and future challenges in the animal and human health. Beyond the health benefits, it is also our moral responsibility to save other species.

- 1. Research:** Implement Animal Health Risk Analysis (AHRA) for drugs that are known to affect animal species from both national and international reviews and fund Canada-wide research programs in collaboration with conservation groups. Rapid testing of drugs on wildlife species based on existing data will promptly identify drugs that need to be controlled. e.g. There are no studies that have tested effects of NSAIDS on Canadian bird species.
- 2. Evidence-based policy change:** Ban the drugs that are already proven to harm animal and environment or limit their usage in the regions where they cause toxicity. e.g. Meloxicam is an NSAID which is not toxic to vultures and other bird species [8]. Because there is an availability of an efficient alternative drug, diclofenac ban should be an immediate action plan.
- 3. Collaboration:** Be part of International efforts that are already in place to tackle drug toxicity in animals. e.g. Given the universal linkage of NSAIDS usage to vulture mortality, Canada should use policy solutions from the 'International Plan to tackle African-Eurasian crisis' and the 'European Medicines Agency' to prevent further decline in the vulture population [13, 14]. Further, extend provincial policy changes to the national level. e.g. Neonicotinoid regulations in Ontario, Montreal, and Vancouver should be implemented as a Health Canada policy nation-wide.
- 4. Drug discovery:** Drug discovery is an expensive process with stringent regulatory check-points. Increased investment is critical in drug discovery programs from both pharma companies and government to accelerate discoveries of a new class of drugs. New drug policy should include clinical testing for toxicity not just on humans but on multiple animal species.
- 5. Interdisciplinary approaches:** Animal and Health researches are two separate avenues and interprofessional collaborations between animal and human healthcare professionals funded by tri-council will be fruitful to develop interventions for both animal and human health.

SEJAL DAVLA

Bridging the gap between animal and human health policies

REFERENCES

1. Rabinowitz, P. and L. Conti, *Links among human health, animal health, and ecosystem health*. Annu Rev Public Health, 2013. 34: p. 189-204.
2. Taylor, L.H., S.M. Latham, and M.E. Woolhouse, *Risk factors for human disease emergence*. PhilosTrans R Soc Lond B Biol Sci, 2001. 356(1411): p. 983-9.
3. <http://www.scienceadvice.ca/en/assessments/completed/animal-health.aspx>.
4. Woodcock, B.A., et al., *Country-specific effects of neonicotinoid pesticides on honey bees and wild bees*. Science, 2017. 356(6345): p. 1393-1395.
5. <http://www.agr.gc.ca/eng/industry-markets-and-trade/canadian-agri-food-sector-intelligence/horticulture/horticulture-sector-reports/statistical-overview-of-the-canadian-honey-and-bee-industry-and-the-economic-contribution-of-honey-bee-pollination-2013-2014/?id=1453219857143>.
6. Tsvetkov, N., et al., *Chronic exposure to neonicotinoids reduces honey bee health near corn crops*. Science, 2017. 356(6345): p. 1395-1397.
7. Kidd, K.A., et al., *Direct and indirect responses of a freshwater food web to a potent synthetic oestrogen*. Philos Trans R Soc Lond B Biol Sci, 2014. 369(1656).
8. Swan, G.E., et al., *Toxicity of diclofenac to Gyps vultures*. Biol Lett, 2006. 2(2): p. 279-82.
9. Oaks, J.L., et al., *Diclofenac residues as the cause of vulture population decline in Pakistan*. Nature, 2004. 427(6975): p. 630-3.
10. Zorrilla, I., et al., *Suspected flunixin poisoning of a wild Eurasian Griffon Vulture from Spain*. Conserv Biol, 2015. 29(2): p. 587-92.
11. Naidoo, V., et al., *Veterinary diclofenac threatens Africa's endangered vulture species*. Regul Toxicol Pharmacol, 2009. 53(3): p. 205-8.
12. <https://blog.nationalgeographic.org/2018/02/02/endangered-vultures-critical-to-diseasecontrol-in-africa/>.
13. <https://www.cms.int/raptors/en/news/international-action-plan-tackle-african-eurasianvulture-crisis>.
14. <https://www.nature.com/news/poisoned-vulture-could-herald-european-bird-crisis-1.16161>.