



COVID-19
IMMUNITY
TASK FORCE

GRUPE DE TRAVAIL
SUR L'IMMUNITÉ
FACE À LA COVID-19



in collaboration with
CoVaRR+Net

.....

Seminar Series | Research Results & Implications

The Eighth Wave

*Challenges and predictions for an
uncertain future*

.....



September 19, 2022 | 1 p.m. to 2:30 p.m. EDT

Moderator

Tim Evans, MD, PhD

Executive Director, COVID-19 Immunity Task Force

Professor, Director and Associate Dean of the School of Population and Global Health,
Faculty of Medicine, McGill University



Land Acknowledgement

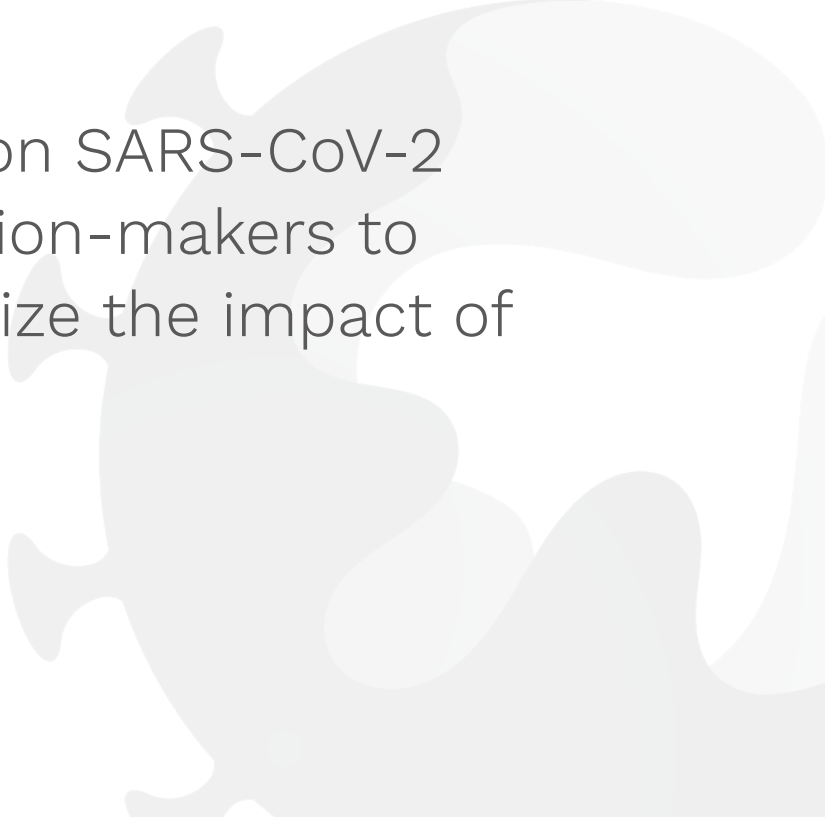
I am speaking to you from my place of work at McGill University, which is on land which has long served as a site of meeting and exchange amongst Indigenous Peoples, including the Haudenosaunee and Anishinabeg nations. I'd like to acknowledge and thank the diverse Indigenous Peoples whose presence marks this territory on which peoples of the world now gather.

COVID-19 Immunity Task Force mandate

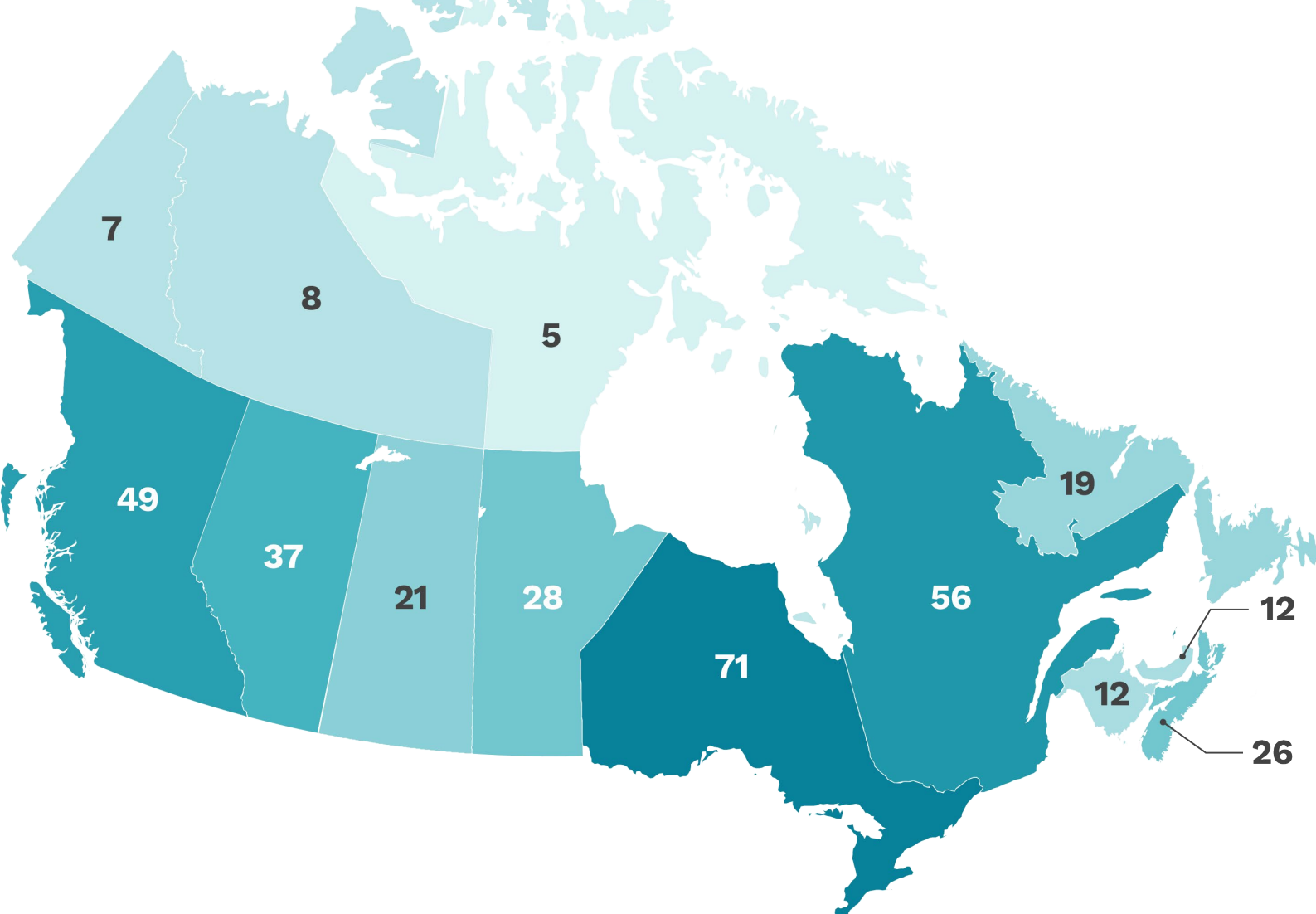
Established by the Government of Canada in April 2020

Mandate:

Catalyze, support, fund, and harmonize knowledge on SARS-CoV-2 immunity for federal, provincial, and territorial decision-makers to inform their efforts to protect Canadians and minimize the impact of the COVID-19 pandemic.



CITF supports studies active across Canada



119 studies

Panelists

David Buckeridge, MD, PhD, FRCPC, Professor in the School of Population and Global Health at McGill University; Scientific Lead, CITF Data Management & Analysis

Sarah (Sally) Otto, PhD, Killam University Professor and Canada Research Chair, University of British Columbia; Co-Lead of CoVaRR-Net's Computational Biology and Modelling Pillar 6

Charu Kaushic, PhD, Scientific Director, CIHR-Institute of Infection and Immunity; Professor, Department of Pathology and Molecular Medicine, McMaster University; CITF Leadership Group member

Shelly Bolotin MSc, PhD, MScPH, Director, Centre for Vaccine Preventable Diseases, and Associate Professor, Dalla Lana School of Public Health and the Department of Laboratory Medicine and Pathobiology, University of Toronto; Scientist, Public Health Ontario; Co-lead, CITF Vaccine Surveillance Working Party

Mel Krajden, O.B.C., MD, FRCPC, Professor, Pathology and Laboratory Medicine, University of British Columbia; former Medical Director of the British Columbia Centre for Disease Control Public Health Laboratory; CITF Leadership Group member

How many Canadians have been infected with SARS-CoV-2 so far?

As answered by **David Buckeridge**, MD, PhD, FRCPC

Scientific Lead, Data Management and Analysis

CITF Secretariat

Professor, School of Population and Global Health, McGill University



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Disclaimer

I have no COIs to declare related to this study.



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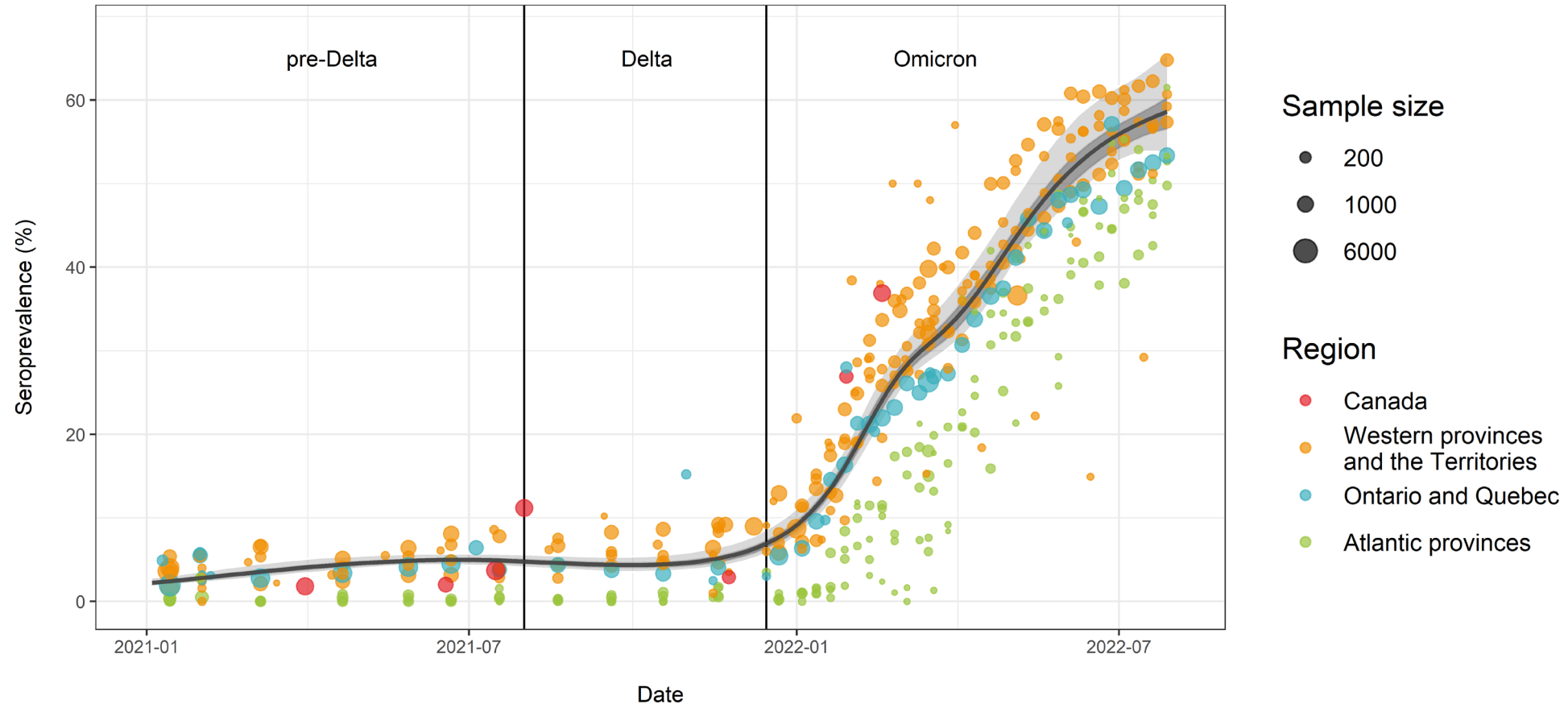
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Serology provides a window on the wave

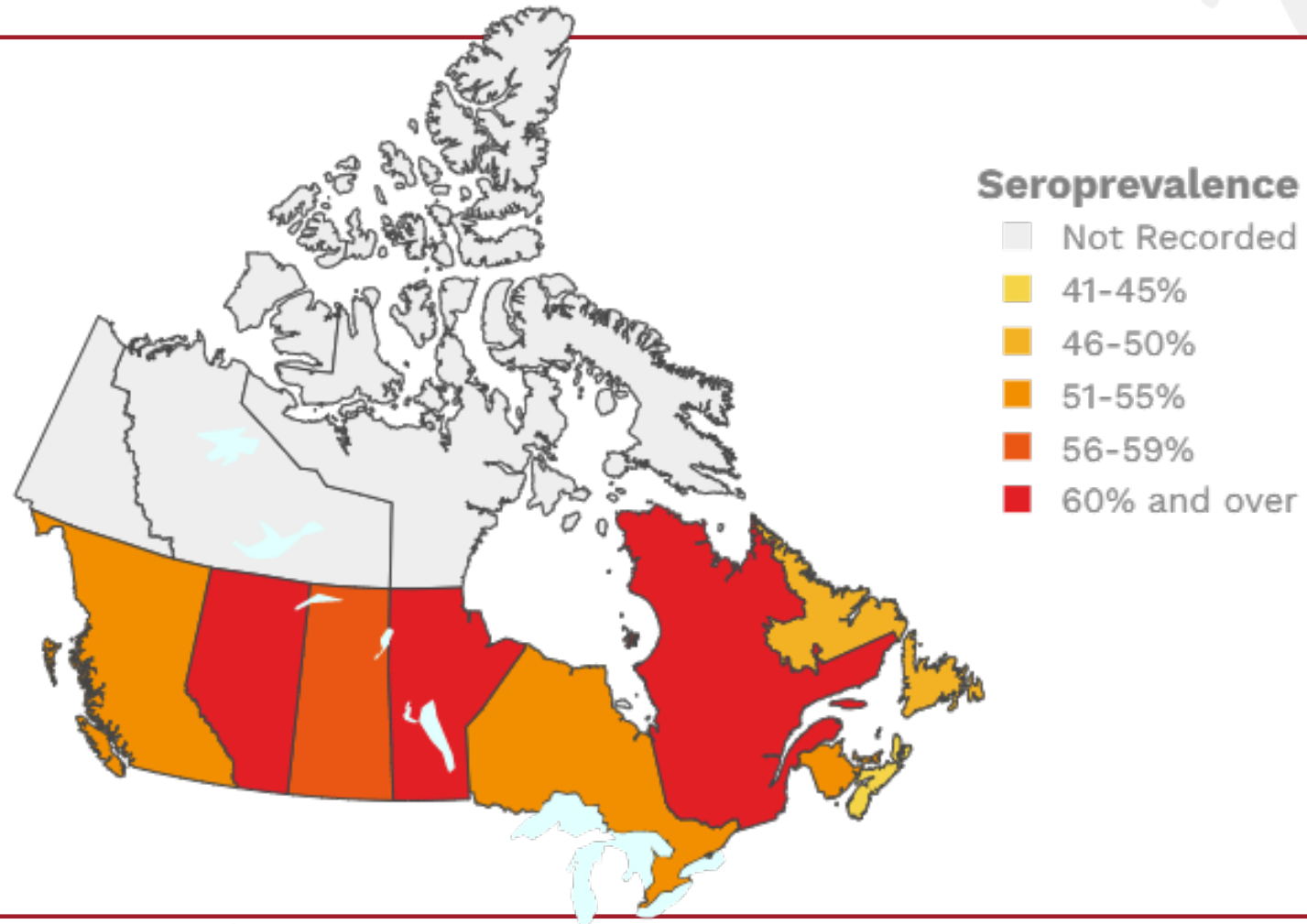
- Laboratory testing was not able to keep pace with the number of new infections, so the number of tests no longer tracked with new infections
- Other data used to track infections were affected by Omicron variant
- Serology data continue to provide a window on new infections
 - ▶ Infection (nucleocapsid) and vaccination (spike) evoke different serology
 - ▶ Change in anti-nucleocapsid serology reflects new infections over short periods
 - ▶ Estimates of serology collected from CITEF partners, harmonized, and analyzed



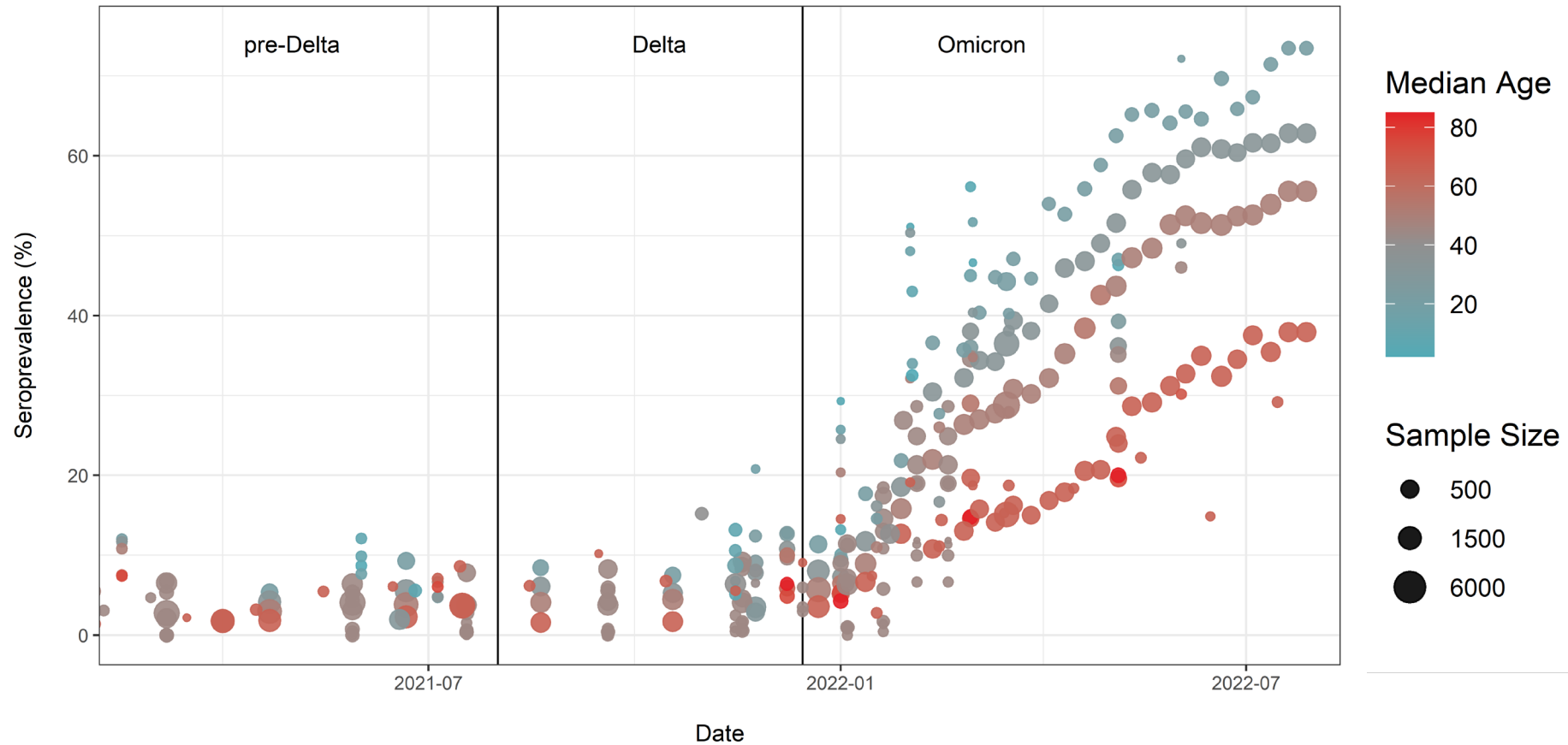
Over 60% of people in Canada – or roughly 18.2 million people – have infection-acquired antibodies




People in every province have been affected



More infections in younger age groups





How have variants been evolving?
What are the risks of a future wave over time?
How much could hybrid immunity and a bivalent booster help?

As answered by **Sarah (Sally) Otto**, PhD

Department of Zoology
University of British Columbia

Coronavirus Variants
Rapid Response
Network



Réseau de réponse
rapide aux variants
du coronavirus





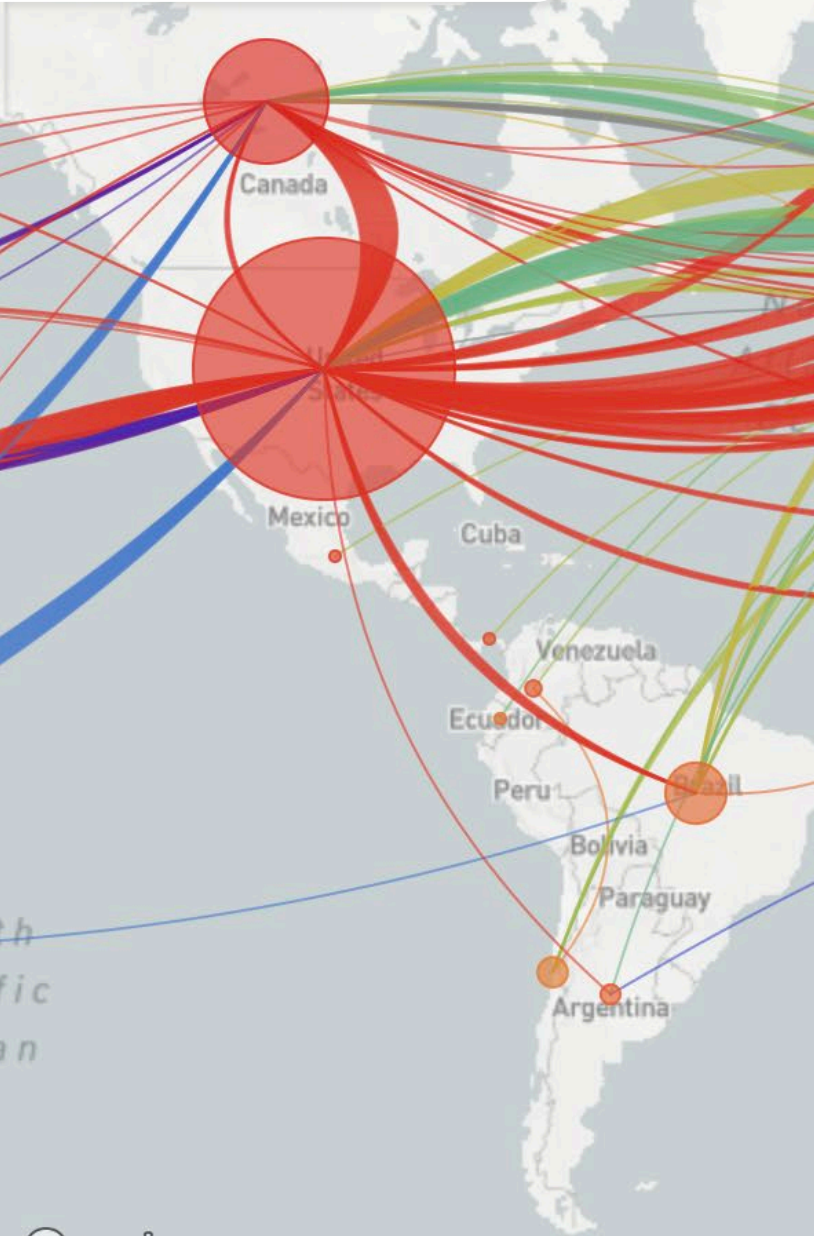
Disclaimer

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Land Acknowledgement

I would like to acknowledge that I join you from the traditional, ancestral, and unceded territory of the xwməθkwəy' əm (Musqueam) People.



Within weeks after the initial reports emerging from Wuhan, China, of a new respiratory illness in December 2019, scientists had started searching for signatures of adaptation to humans within the genomes of SARS-CoV-2.



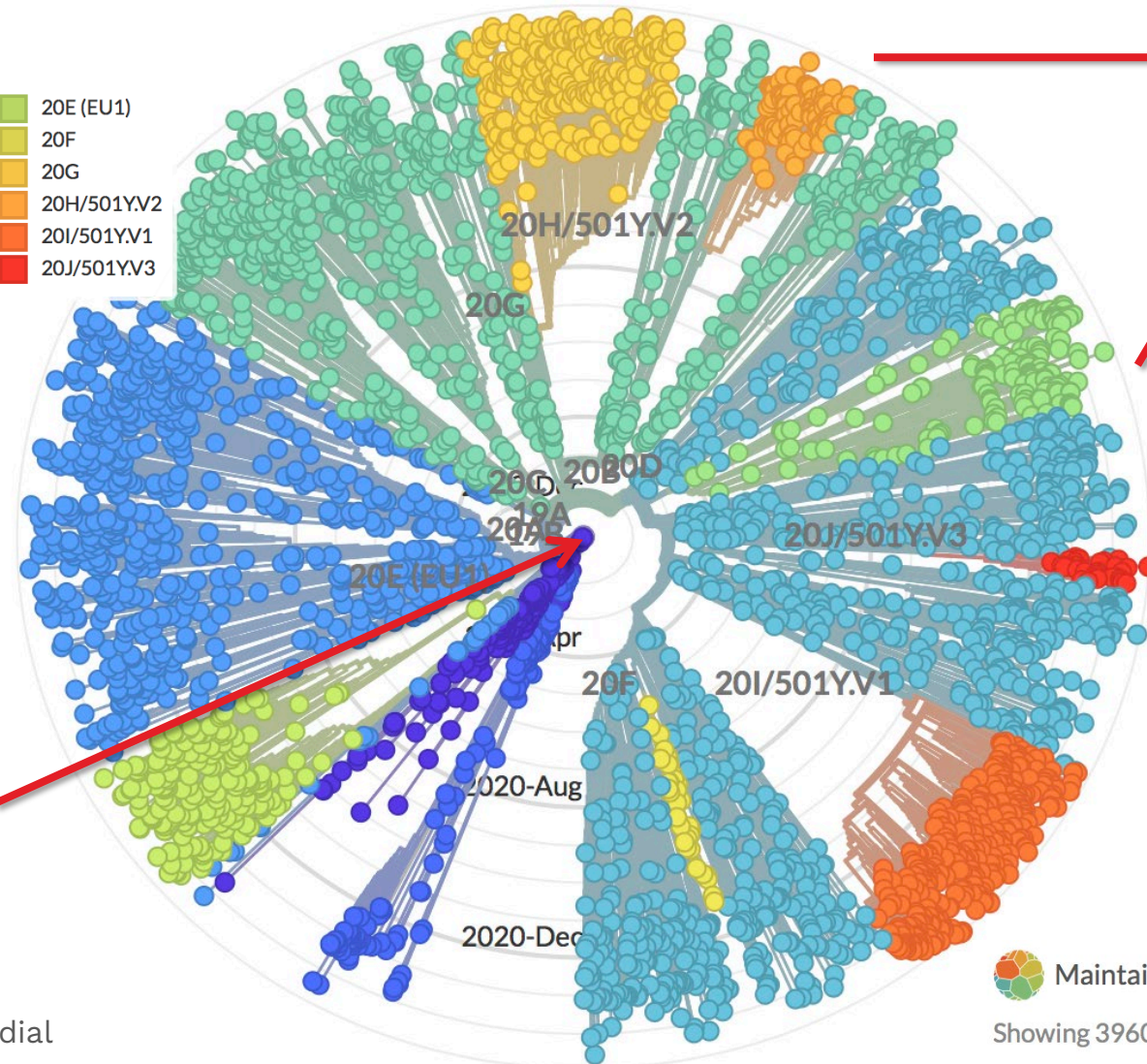
No strong signs of selection in the first year

Phylogeny

Clade ^

- 19A
- 19B
- 20A
- 20B
- 20C
- 20D

- 20E (EU1)
- 20F
- 20G
- 20H/501Y.V2
- 20I/501Y.V1
- 20J/501Y.V3



>12,000,000 genomes!!

Rate of substitution:
= 0.0008/bp/year
(about once per genome every two weeks)

Common ancestor
in Nov/Dec 2019

<https://nextstrain.org/ncov?l=radial>

Maintained by the Nextstrain team. Enabled by data from **GISAID**

Showing 3960 of 3960 genomes sampled between Dec 2019 and Mar 2021.

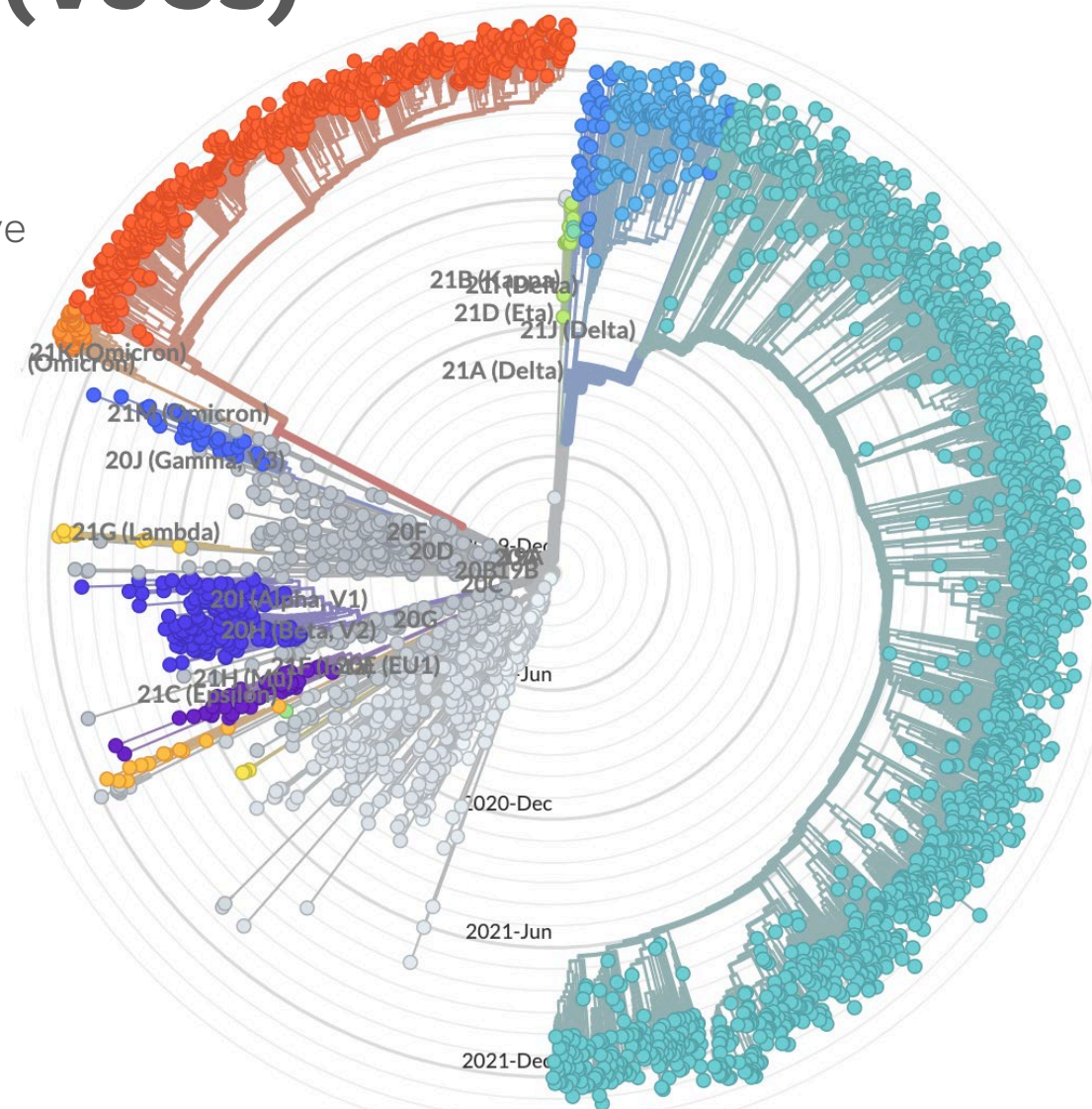
Second year characterized by waves of variants of concern (VoCs)

Omicron:

More transmissible
More immune evasive
Less virulent

Alpha:

More transmissible
More virulent



Most VOCs have emerged from earlier lineages, not currently common strains. This “leap-frogging” is thought to be due to emergence of major new variants from persistent infections.

Delta:

More transmissible
More virulent

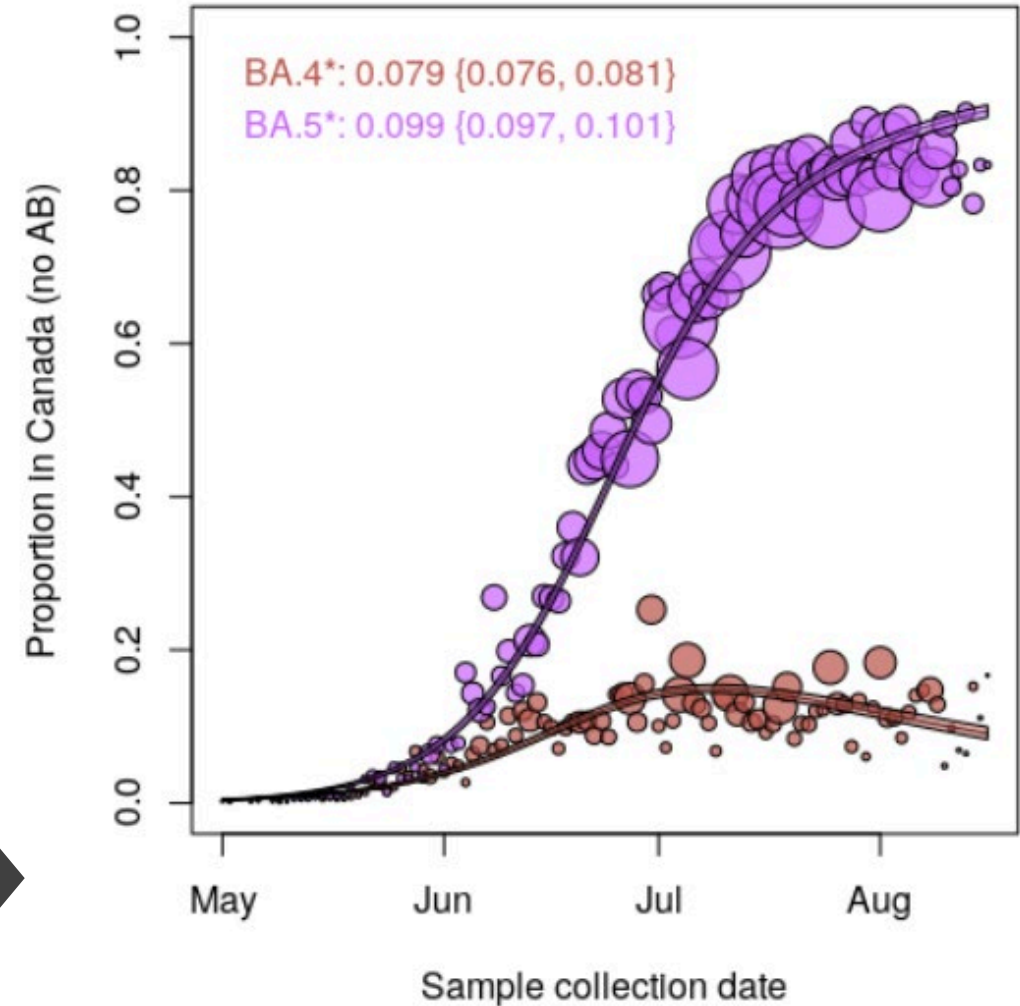


A network of interdisciplinary researchers from institutions across the country created to assist in the Government of Canada's overall strategy to address the potential threat of emerging SARS-CoV-2 variants.

Monitor growth of variants

In Canada:

- BA.5 now dominating
- Some sub-variants show a minor growth advantage (e.g., BA.5.2 and BF.5 over BA.5.1)

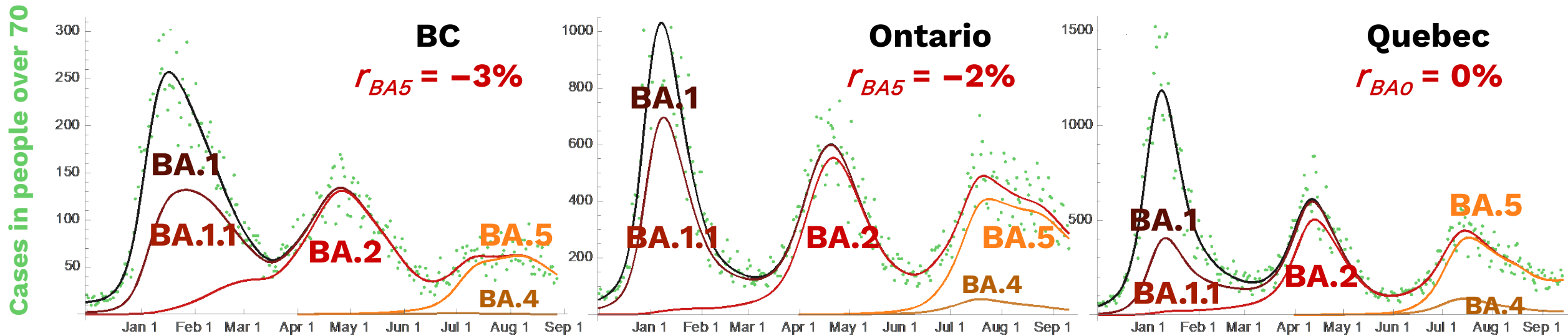


<https://covarnet.ca/modelling-resources/>



Variant-driven waves: Omicron 2022

We can combine evolutionary changes with case data (here **cases among those over 70, a more reliably tested age group**) to understand how new variants drive waves.

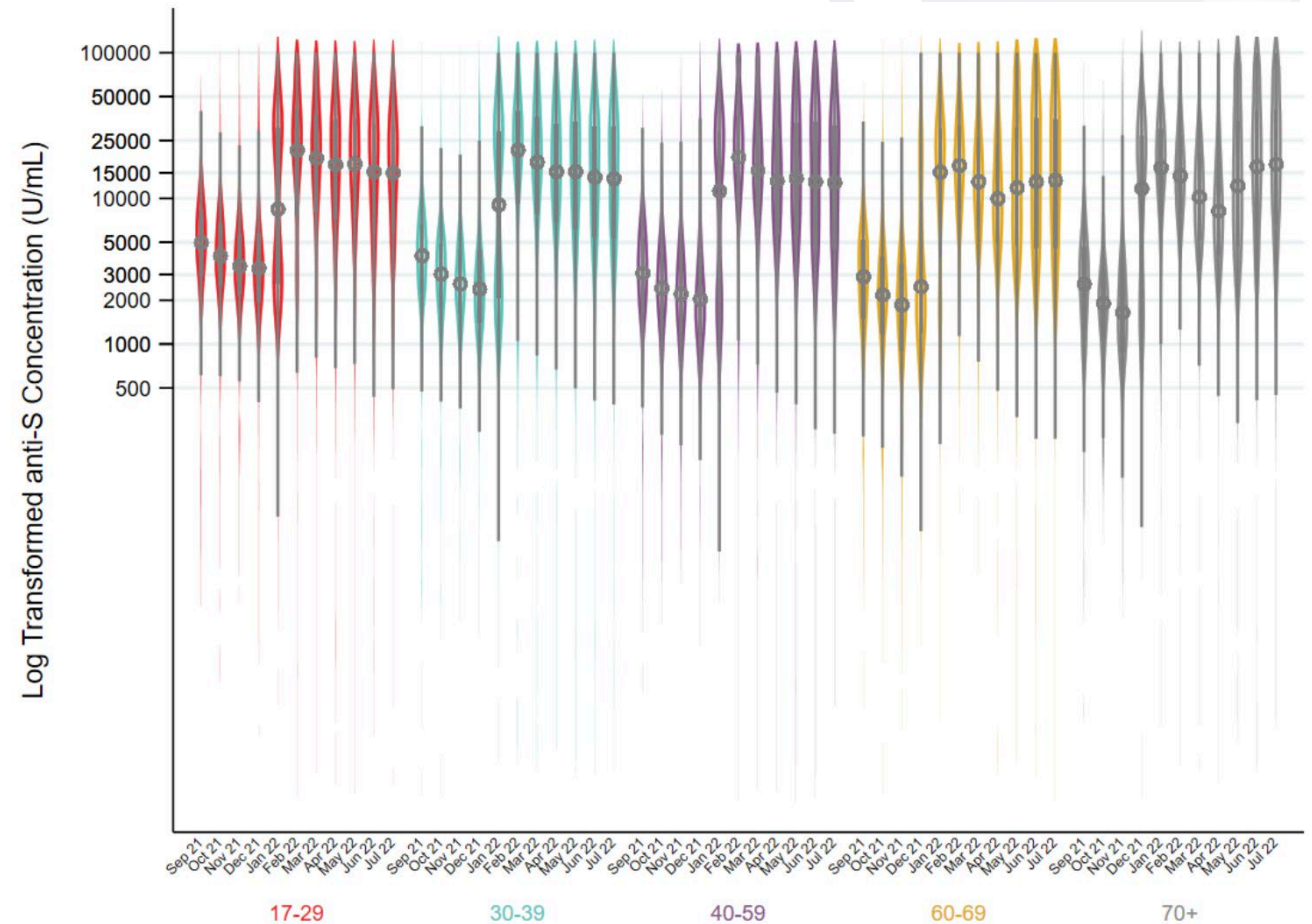


Estimates of growth rate, r , for BA.5 are estimated on the last day and change with changing immunity and with protective health measures, both mandated and voluntary (e.g., wearing effective masks, increasing ventilation, and avoiding crowded indoor spaces)

Predicting population-level susceptibility with serology data

COVID-19 cases will be driven by the drop in immune protection over time.

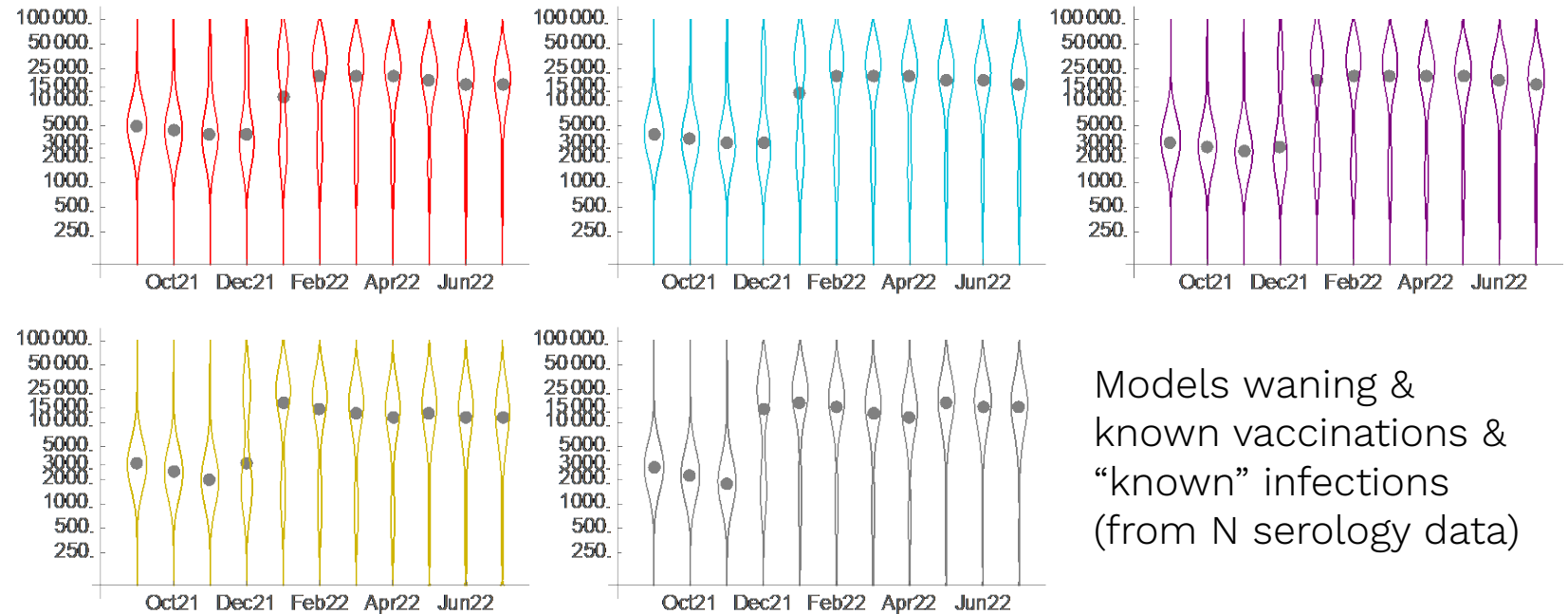
We can predict population-level susceptibility by modelling spike antibody distributions over time, matching Canadian Blood Services data from blood donations.



Canadian Blood Services data by age group, through mid-July 2022

Modelling immune dynamics and the protection from infection

- 1) Describe initial distribution
- 2) Estimate waning rate
- 3) Estimate boosting from vaccinations and/or infection
- 4) Propagate the distribution forward



Models waning & known vaccinations & “known” infections (from N serology data)

What are the risks of a future wave over time?

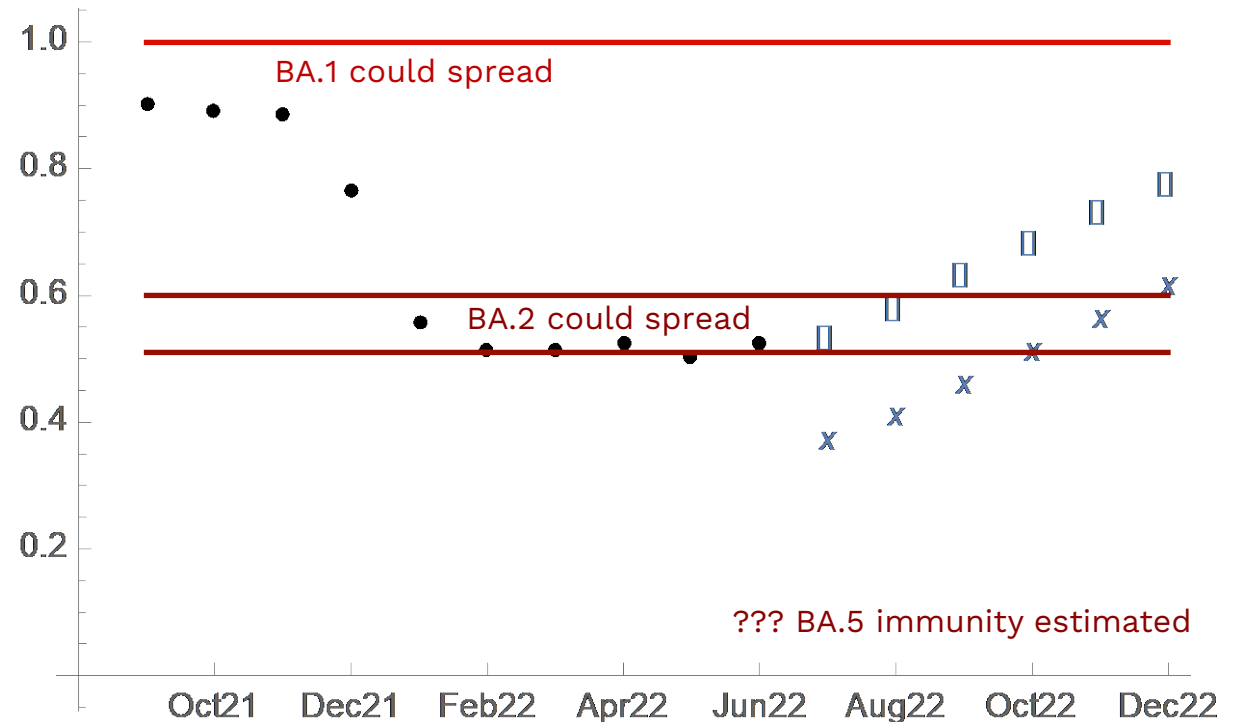
Modelling immune dynamics and the protection from infection

Waning is too rapid and immunity too old to protect against waves, even without new variants.

How much could hybrid immunity and a bivalent booster help?

Could extend protection despite waning immunity for 3-4 months.

Susceptibility



Why is it so difficult to define immunity?

As answered by **Charu Kaushic**, PhD

Scientific Director, CIHR Institute of Infection and Immunity

Professor, Department of Pathology and Molecular Medicine, McMaster University

CITF Leadership Group member



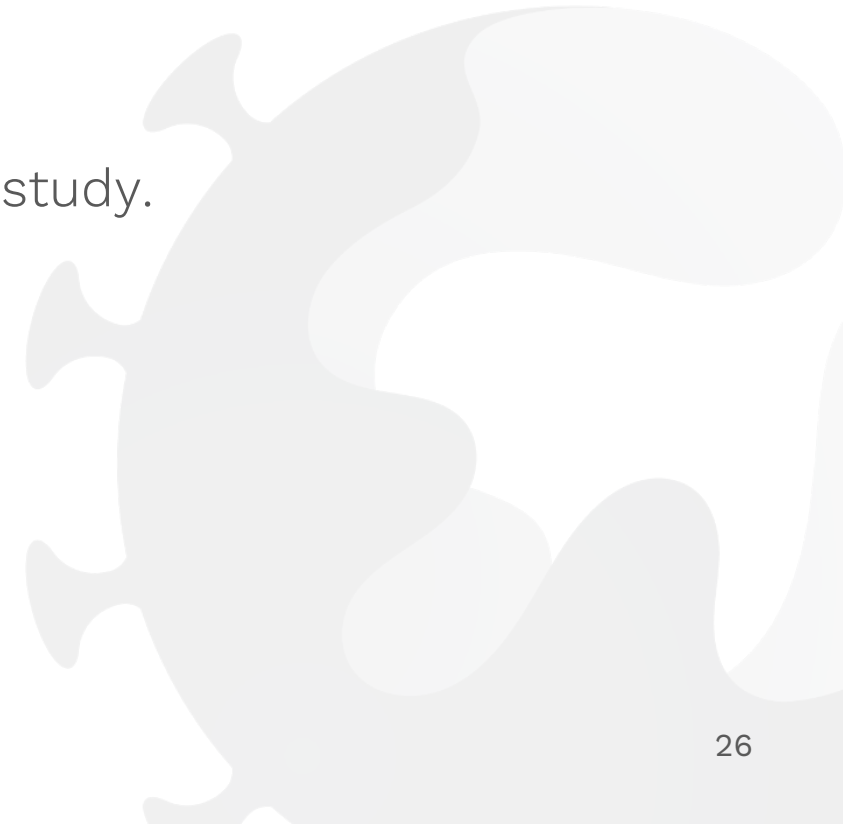
Canadian Institutes
of Health Research

Instituts de recherche
en santé du Canada



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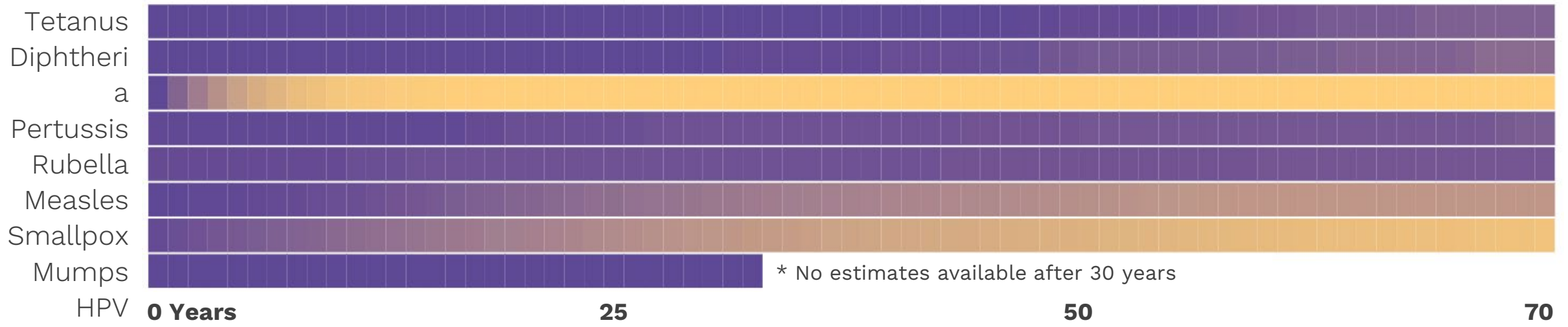


Land Acknowledgement

We take this time to recognize that we are speaking to you from the traditional territory shared between the Haudenosaunee confederacy and the Anishinabe nations, which was acknowledged in the Dish with One Spoon Wampum belt. That wampum uses the symbolism of a dish to represent the territory, and one spoon to represent that the people are to share the resources of the land and only take what they need. We take this time to recognize the land that each of you are on as well.

VARIABILITY IN IMMUNITY:

Some viruses/vaccines generate longer-lasting immunity than others



Legend:

100% [Dark Purple] [Medium Purple] [Light Purple] [Yellow] 0% Estimated protection after vaccination

(Graphic) N. Desai / [Science](#)

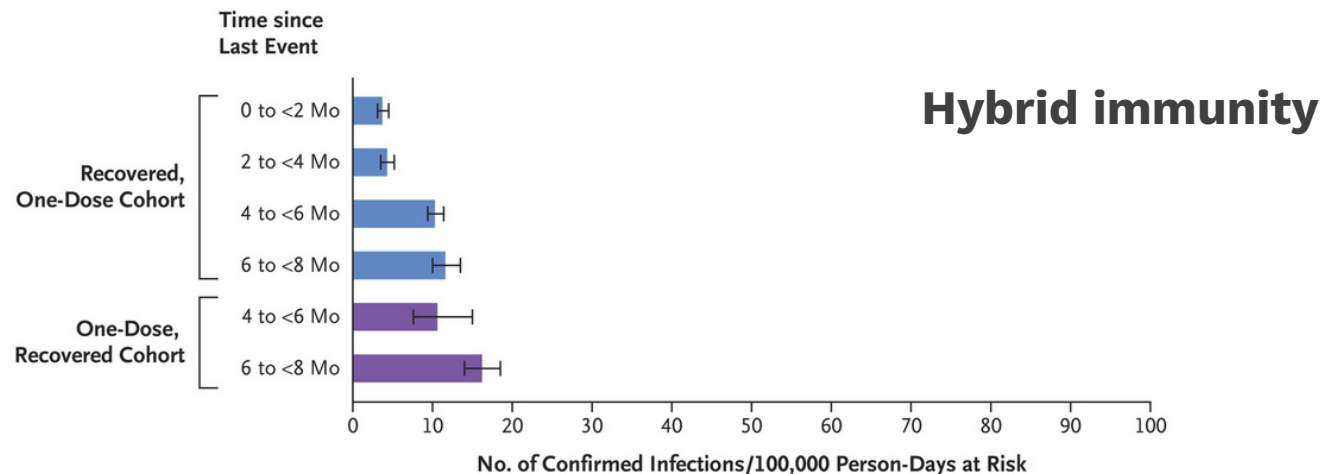
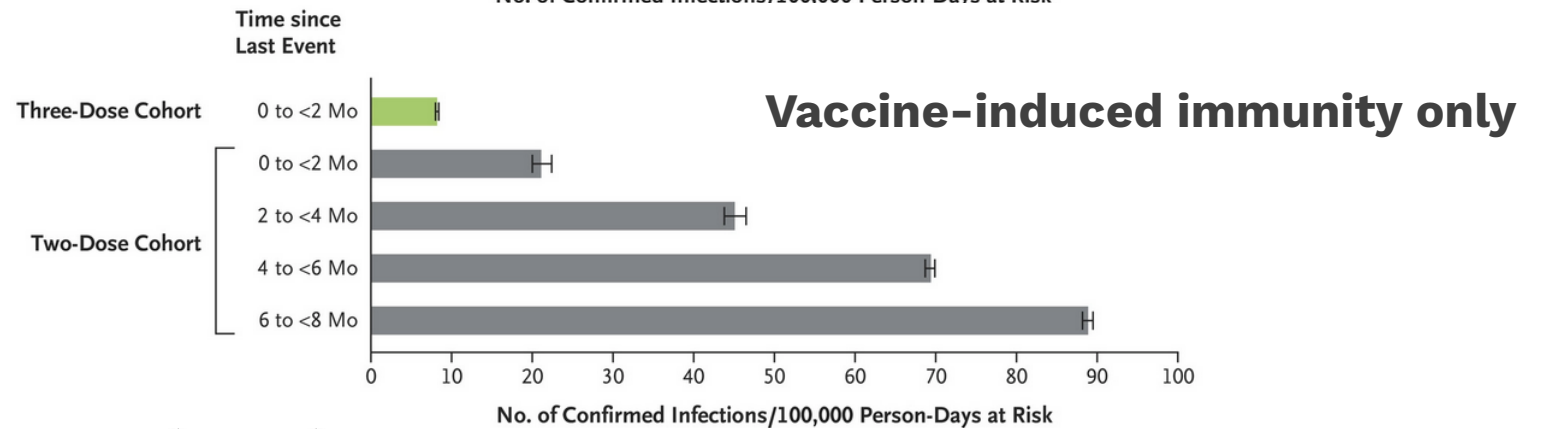
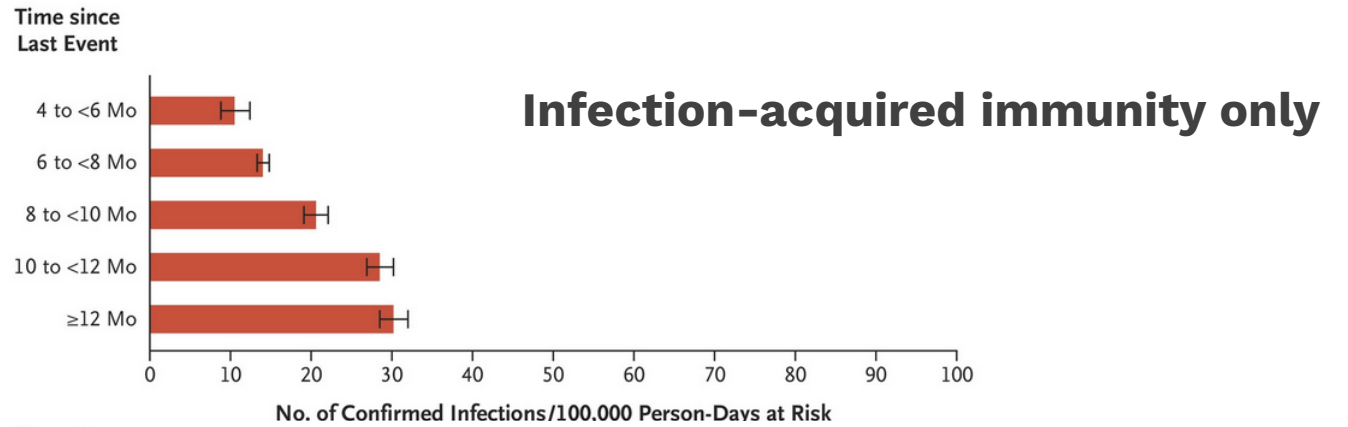
(Data) Joseph Lewnard/UC Berkeley; Hiroshi Nishiura/Hokkaido University; T.F. Schwarz et al., *Cancer Med.*, 11, 2723, 2017; N. Klein et al., *Vaccine*, 35, 3395, 2017

VARIABILITY IN IMMUNITY:

Immune responses strongest after both infection and vaccination (hybrid immunity)

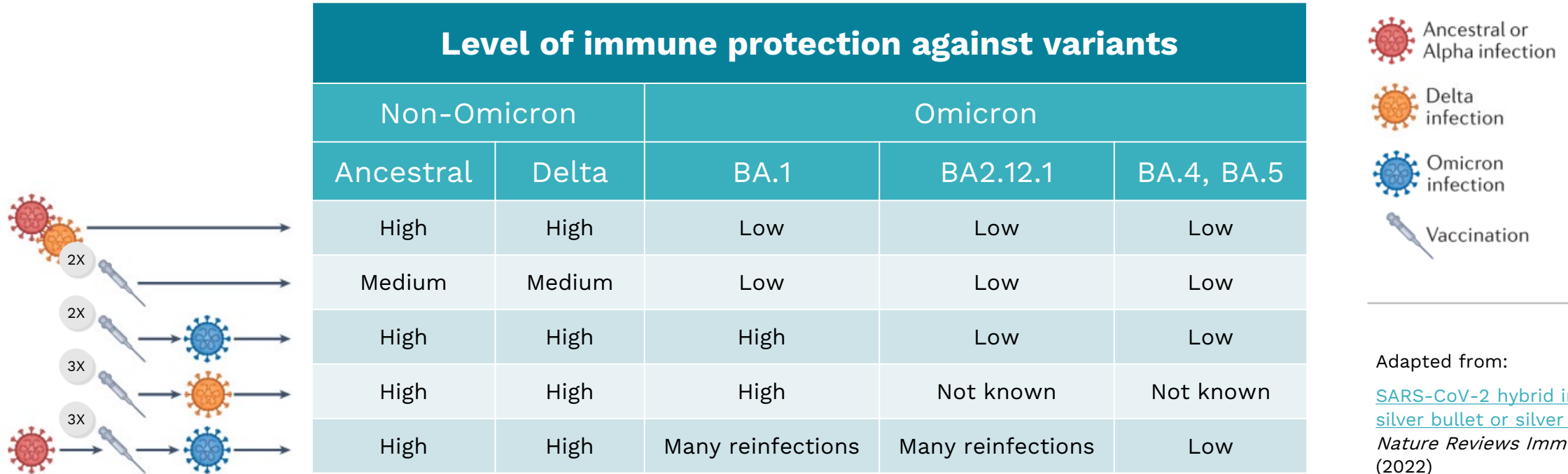
However, inflammatory responses can be exacerbated with infection. Many can have symptoms that last for months (Long-COVID) following recovery from acute infection

[Protection and Waning of Natural and Hybrid Immunity to SARS-CoV-2. NEJM 386:2201-2212](#)



VARIABILITY OF IMMUNITY:

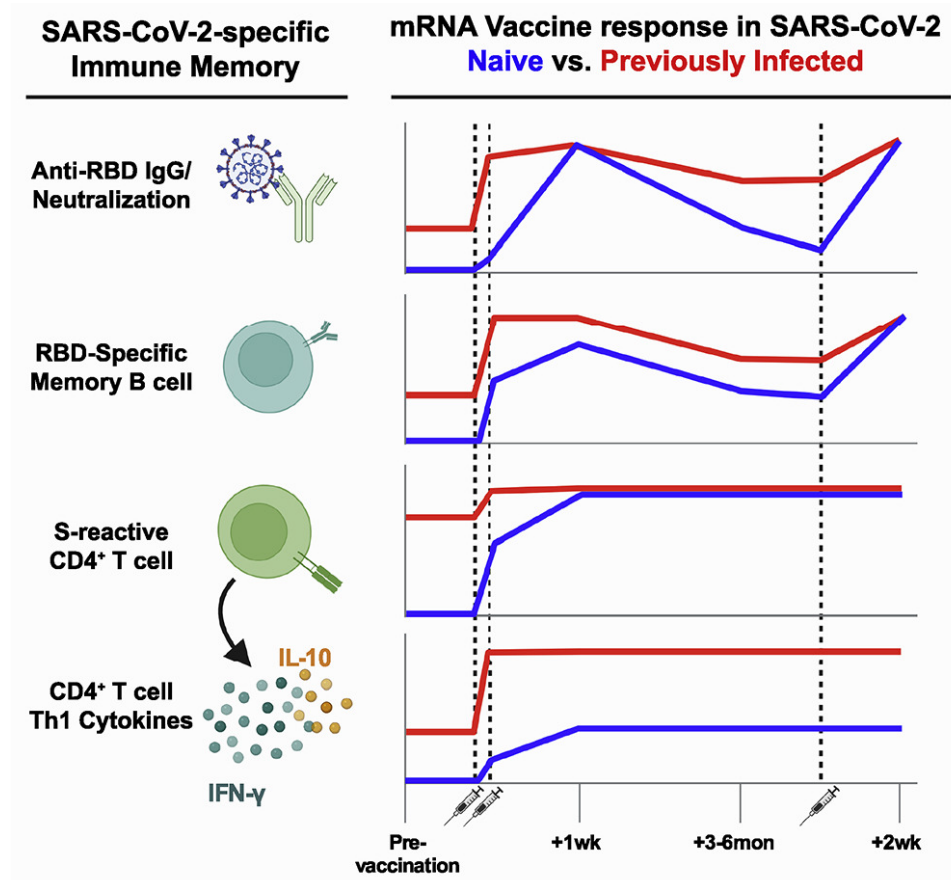
Vaccine timing, previous infections, variants & individual factors contribute to a complex immunity landscape



This makes it difficult to predict how future waves will unfold; **Is there a better way to determine protective immunity to SARS-CoV-2?**

Adapted from:
[SARS-CoV-2 hybrid immunity: silver bullet or silver lining?](#)
Nature Reviews Immunology (2022)
[BA.2.12.1, BA.4 and BA.5 escape antibodies elicited by Omicron infection](#), *Nature* (2022)

Hybrid immunity confers a more comprehensive immunity

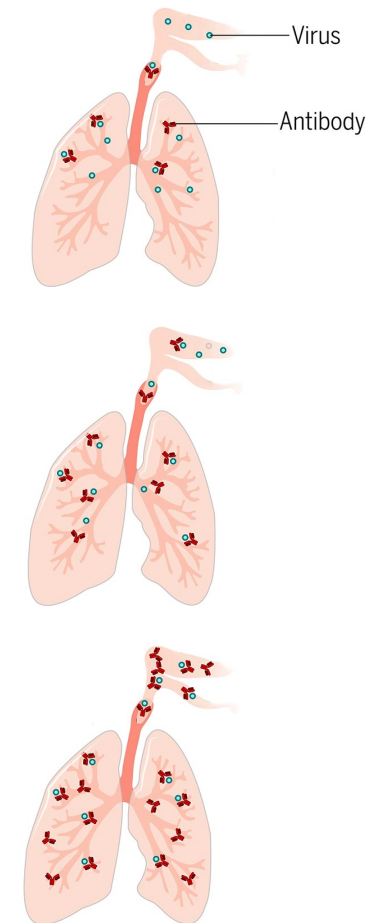


[Imprinted SARS-CoV-2-specific memory lymphocytes define hybrid immunity, *Cell* \(2022\)](#)

Why is it so important to define immunity?

The immune system has many different and important parts:

- ▶ Innate immunity (the body's first line of defence) must be considered. Ex: do natural killer cells work against SARS-CoV-2?
- ▶ Antibody-mediated immunity is not one-size-fits-all: neutralizing antibodies are more “powerful” than non-neutralizing antibodies
- ▶ The difference between the protection conferred via blood (IgG) and via mucosal (IgA) (nose and mouth) entry points plays a role
- ▶ The contribution of T cells in the lungs offers important protection against severe disease
- ▶ Vaccines and boosters confer robust protection from serious illness and death
- ▶ Waning immunity is an important consideration



[Immune correlates of protection by mRNA-1273 vaccine against SARS-CoV-2 in nonhuman primates.](#) *Science* (2021) 373

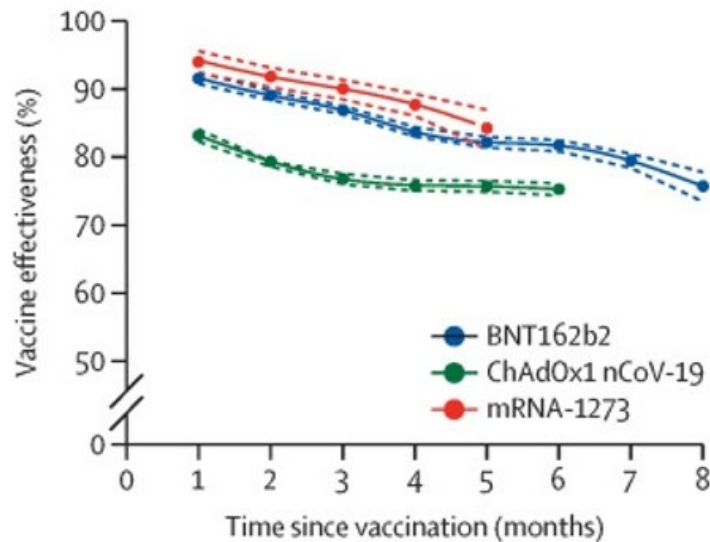
[Neutralizing antibody levels are highly predictive of immune protection from symptomatic SARS-CoV-2 infection.](#) *Nature Medicine* (2021) 27:1205-1211

SARS-CoV-2 immunity: Why have we been so surprised?

We made really good vaccines that exceeded most expectations...

...But vaccines are not providing long-term protection...

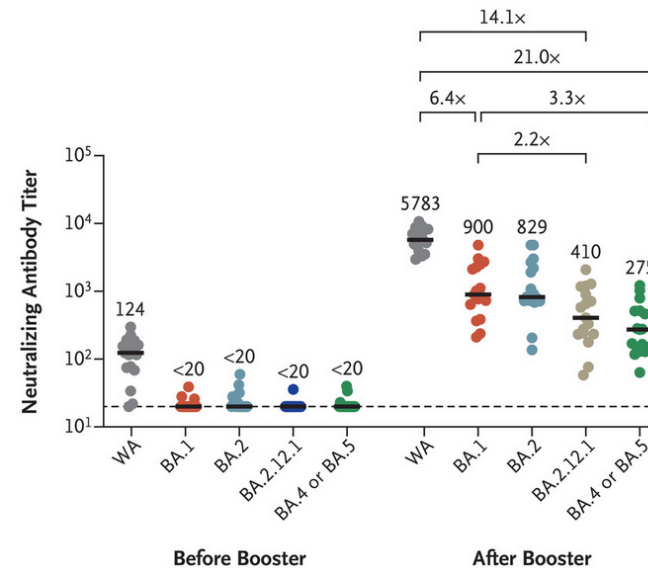
Primary immunization series effectiveness against infection over time, overall



[COVID-19 vaccine waning and effectiveness and side-effects of boosters: a prospective community study from the ZOE COVID Study](#). The Lancet Infectious Diseases 22:1002-1010

and variants are further eroding their effectiveness

Neutralizing antibody titers 6 months after 2nd Pfizer dose, and 2 weeks after Pfizer booster



[Neutralization Escape by SARS-CoV-2 Omicron Subvariants BA.2.12.1, BA.4, and BA.5](#). The New England Journal of Medicine 387:86-88

What is the picture of hybrid immunity in Canada?

Added to the conversation by **Tim Evans**, MD, PhD

Executive Director, Executive Director, COVID-19 Immunity Task Force

Professor, Director and Associate Dean of the School of Population and Global Health, Faculty of Medicine, McGill University



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SARS-COV-2 infection-induced seroprevalence by age in Canada (July 15, 2022)

Seroprevalence estimates from multiple sources including blood donors, residual blood & provincial sources

Age group (y)	Seroprevalence* (%)
< 5	65
5 – 11	65
12 – 18	65
Adults (18 – 70)	60
Elderly (70+)	35

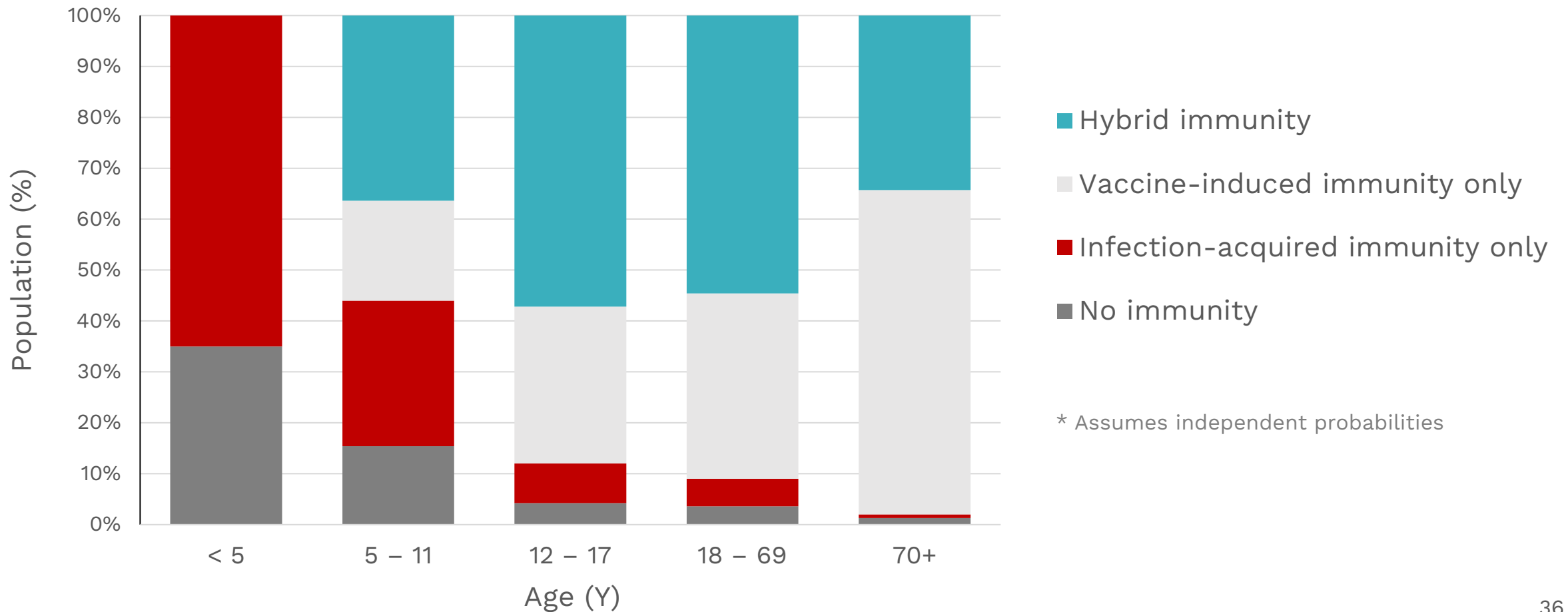
* Mid-point of range from various cohort estimates

18.2 million newly (or freshly) infected Canadians between Dec 15, 2021, and July 15, 2022**

** Estimated from seroprevalence change in Omicron wave. 95% CI: 16.5 – 20.5 million

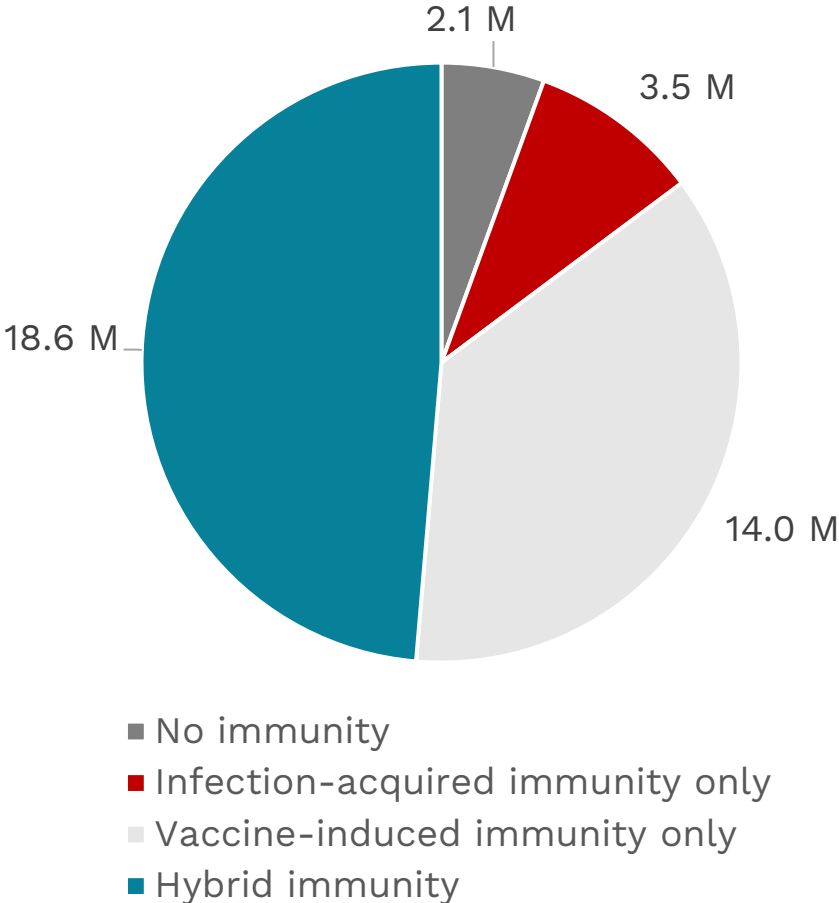
Mixed picture of COVID-19 immunity in Canada

Breakdown of SARS-CoV-2 immunity by age*



Distribution of COVID-19 immunity status for the Canadian population (July 15, 2022)

Age group (y)	Census estimates*	No immunity	Infection-acquired immunity only	Vaccine-induced immunity only	Hybrid immunity
<5	1.9 M	0.7 M	1.2 M	0.0 M	0.0 M
5 to 11	2.0 M	0.3 M	0.6 M	0.4 M	0.7 M
12 to 17	4.1 M	0.2 M	0.3 M	1.3 M	2.4 M
18 to 69	25.3 M	0.9 M	1.4 M	9.2 M	13.8 M
70	4.8 M	0.1 M	0.0 M	3.1 M	1.7 M
	38.2 M	2.1 M	3.5 M	14.0 M	18.6 M



* Statistics Canada: Population estimates July, 2021

What does it mean to be “up-to-date” with vaccinations?

What are the prospects for next generation vaccines?

As answered by **Shelly Bolotin**, MSc, PhD, MSCPH

Director, Centre for Vaccine Preventable Diseases, University of Toronto

Associate Professor, Dalla Lana School of Public Health and the Department of
Laboratory Medicine and Pathobiology, University of Toronto

Scientist, Public Health Ontario

Disclaimer

The Centre for Vaccine Preventable Diseases at the University of Toronto is supported by operational funding from the Dalla Lana School of Public Health as well as private sector donations, including from vaccine manufacturers. A set of governance processes are in place at the DLSPH to ensure independent operation of the Centre.

Land Acknowledgement

I wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

COVID-19 vaccine milestones in Canada

First Canadian case confirmed
January 25, 2020

Pediatric vaccines approved in Canada
November 19, 2021

2020

2021

2022

First report of atypical pneumonia
December 30, 2019

First vaccines administered in Canada
December 19, 2020

Bivalent vaccines approved in Canada
September 1, 2022



Published Date: 2019-12-30 18:59:00 EST
Subject: PRO/AH/EDR- Undiagnosed pneumonia - China (HU): RFI
Archive Number: 20191230.6864153

UNDIAGNOSED PNEUMONIA - CHINA (HUBEI): REQUEST FOR INFORMATION

A ProMED-mail post
<http://www.promedmail.org>
ProMED-mail is a program of the
International Society for Infectious Diseases
<http://www.isid.org>

[1]
Date: 30 Dec 2019
Source: Finance Sina [machine translation]
<https://finance.sina.cn/2019-12-31/detail-ihvzqhk1074832d.htm?fromwap>



In the first year, 310,400 lives were estimated to be saved by COVID-19 vaccine in Canada

Sources: ProMED Mail. [Undiagnosed Pneumonia - China \(Hubei\): Request for Information](#). *International Society for Infectious Diseases*. December 30, 2019. | Jones, RP. [1st doses of Pfizer-BioNTech's COVID-19 vaccine arrive in Canada](#). *CBC News*, December 13, 2020. | Boyd, A. [Health Canada has approved the Pfizer COVID vaccine for kids. Here's what you need to know](#). *The Toronto Star*, November 18, 2021. | Watson O. et al. [Global impact of the first year of COVID-19 vaccination: a mathematical modelling study](#).



What does it mean to be “up to date” with vaccination?

Being “up to date” means that an individual has received all recommended COVID-19 doses

- ▶ This could mean a different number of doses, depending on the individual
- ▶ This definition will be modified over time, as new doses or vaccine types become available

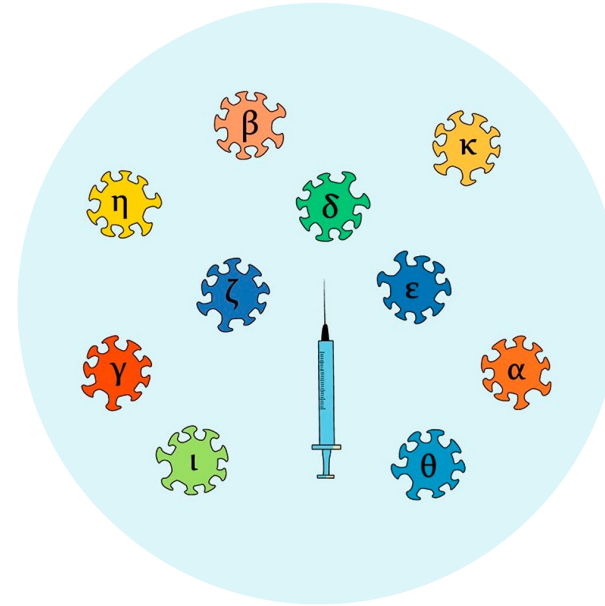
New and future COVID-19 vaccines



Variant vaccines
(i.e., bivalent booster)



Intranasal vaccines



Pan-COVID vaccines
(i.e., pan-sarbecovirus,
pan-betacoronavirus)

Images

<https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-09-01/06-covid-miller-508.pdf>;

<https://familydoctor.org/nasal-sprays-how-to-use-them-correctly/>;

<https://www.nature.com/articles/d41573-022-00074-6>

Are we expecting an early flu season and what are the impacts of this?

What are the challenges other seasonal respiratory viruses pose?

As answered by **Mel Krajden**, O.B.C., MD, FRCPC

BCCDC Public Health Laboratory

Professor, Pathology and Laboratory Medicine, UBC



Disclosures

I have received grant/contracts paid to my institution from:

Roche

Hologic

Siemens

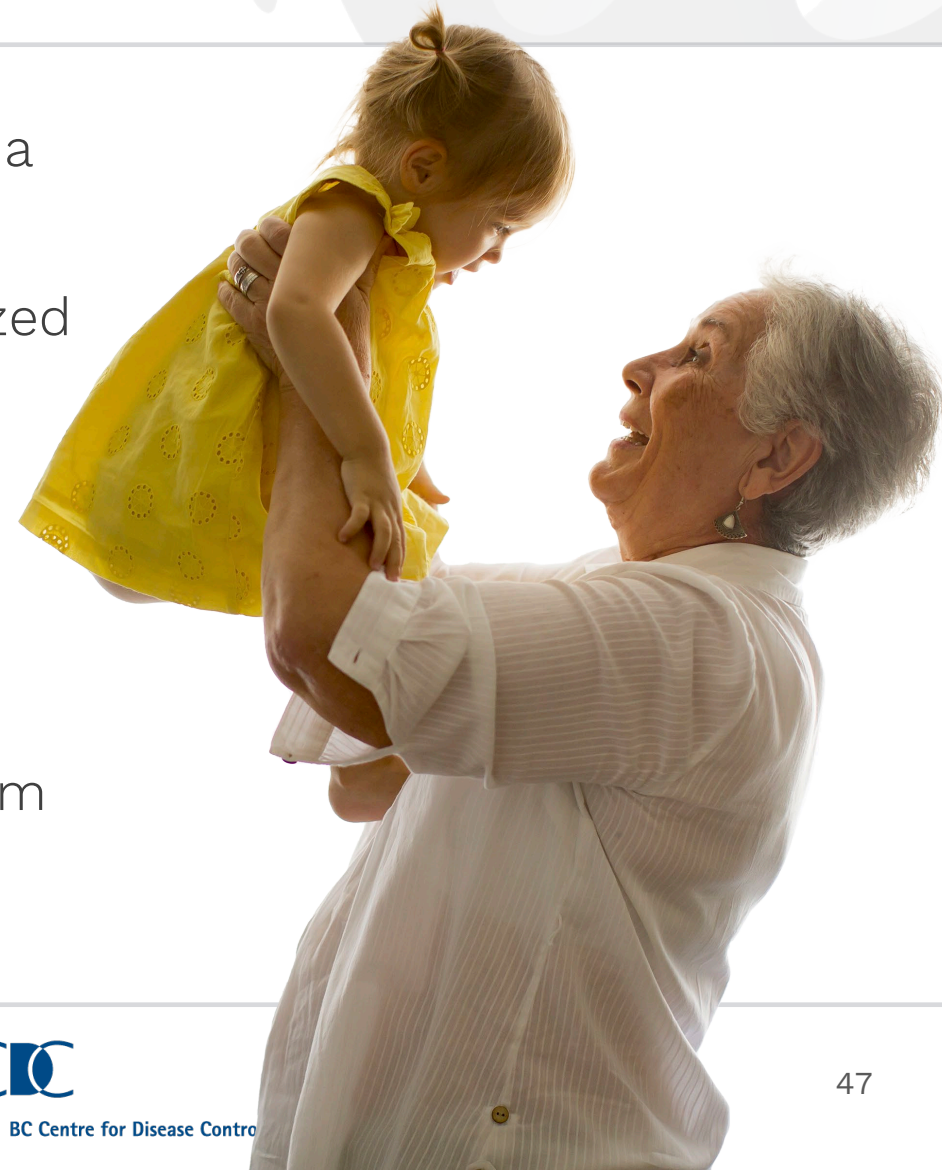
As these grants/contracts are unrelated, mitigation is not required.

Land Acknowledgement

I respectfully acknowledge that I live and work on the unceded territory of the x^wməθkwəy' əm, Skwxwú7mesh, Stó:lō and Səl'ílwətaʔ/Selilwítlh Nations.

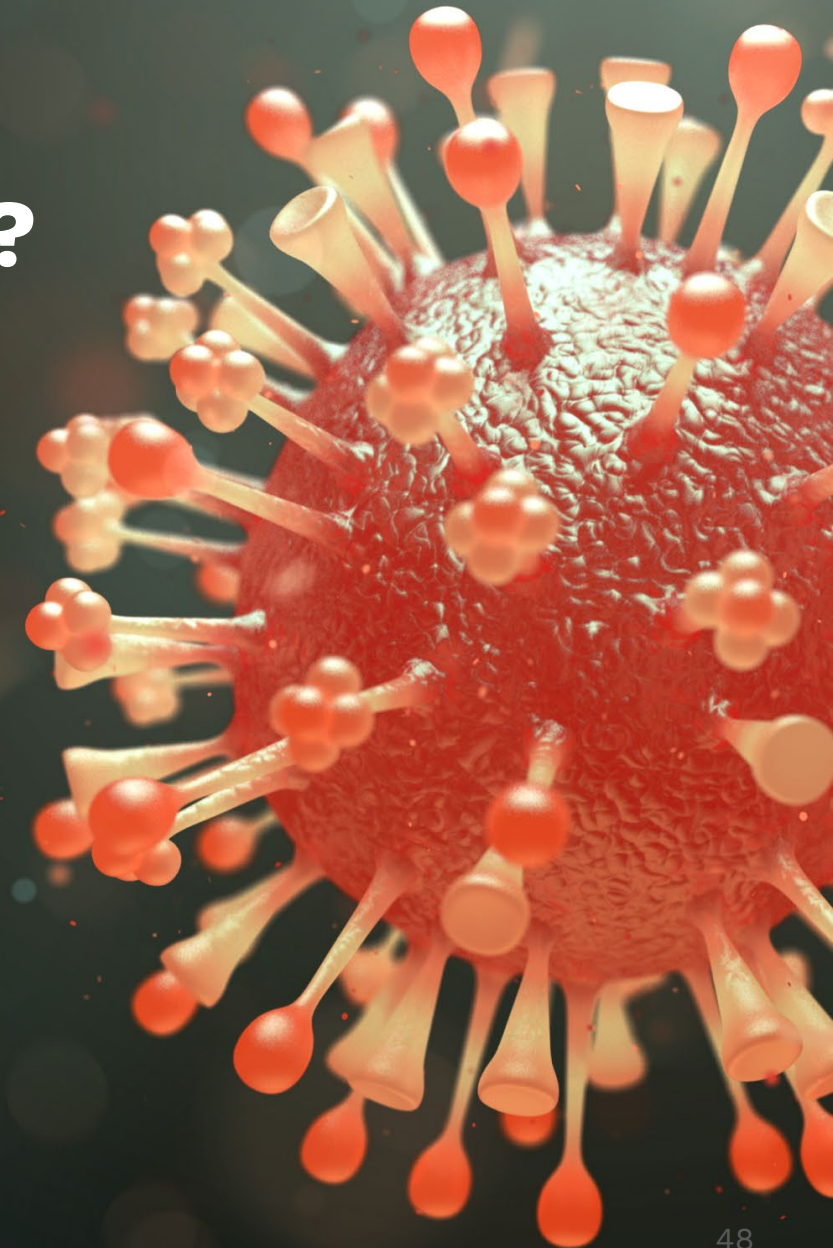
How should we think about COVID-19 at this point?

- Vaccines & infection are transforming SARS-CoV-2 into a manageable “endemic” respiratory virus
- It is time to return to normalcy for our COVID traumatized population & health system – normalcy is not zero risk!
- Focusing only on COVID morbidity & mortality is bad because our response to protect older Canadians has come at a very high cost to our youth
- It is not about preventing every infection; it is about preventing severe disease & protecting our health system – one that was already fragile pre-COVID



What are the challenges other seasonal respiratory viruses pose?

- As a result of COVID control measures, the normal seasonal activity of influenza, respiratory syncytial virus (RSV) and other respiratory viruses, have been perturbed.
- With the opening up of society these viruses *will* return with less predictability, not that they were ever totally predictable!
- Human existence in “microbial-free” bubbles creates other unknown risks!
- Lessons from the Southern Hemisphere demonstrate that influenza, RSV & other viral respiratory agents will return



Are we expecting an early flu season and what are the impacts, if so?



- We have had an extraordinarily large SARS-CoV-2 wave over the summer!
- This wave has created massive levels of hybrid immunity in the general population, less so in the elderly who are being targeted for additional immunization, including with bivalent vaccines
- This suggests that the Canadian fall will likely be quiet from a COVID perspective... but early winter may be different
- The immediate challenge is to plan for, and mitigate against, a severe influenza season with vaccination

What actions should we take?

- Continue to use caution (distancing, masking, avoiding confined spaces...)
- These tools could be combined with broader health measures like lockdowns, closures, curfews (that also work for influenza, RSV, etc.) - but at a price!
- Even if the intensity are not particularly severe... or the seasonal timing is different, the impact needs to be considered in the context of our fragile health system!
- We need contextualized public health surveillance & planning beyond COVID to identify sensible interventions to protect the various at-risk populations
- Rational plans are needed for the co-existence of SARS-CoV-2 variants & other respiratory agents, including ongoing surveillance & other preventative measures

Questions?





Summary report #9

The Eighth Wave
Challenges and predictions for
an uncertain future

You'll find our
summary of this
seminar at


covid19immunitytaskforce.ca

Discover us!

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 COVID-19 Immunity Task Force |
Groupe de travail sur l'immunité
face à la COVID-19

covid19immunitytaskforce.ca