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# How Flexible OR&A Teams Provided Decision Advantage through Pandemic Uncertainty

S. Guillouzic, M. R. MacLeod, D. Waller, S. Bourdon

Defence Research and Development Canada

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Canada

# Outline

- DRDC CORA background

- Pandemic-related OR&A questions

- Nature of analytical response

- Examples of OR&A support

- Future OR&A work with Canadian Forces Health Services

# DRDC CORA background

- Researchers from a variety of fields: mathematics and natural sciences, social sciences, humanities, etc.

- A distributed 'centre' of ~20 small teams of OR&A scientists embedded with military and civilian clients across 4 time zones and 2 countries (CAN and US)

- Follow quasi-military posting cycle of rotations every 3 to 5 years

- Scientists with varied skills positioned across the organization to respond to short- and long-term quantitative and qualitative analysis needs

- Rotation amongst teams and prior collaborations build informal ties enabling access to expertise outside current team

# Origin of pandemic-related questions

- As the crisis developed, questions arose directly or indirectly in teams with:
  - NORAD (North American Aerospace Defense Command)
  - CFINTCOM (Intelligence Command)
  - CJOC (Canadian Joint Operations Command)
  - MARLANT (Maritime Component Commander for CJOC)
  - ADM(DIA) (Data, Innovation & Analytics organization)
  - Aerospace Force Development

- Over time, formed an increasingly direct relationship with Canadian Forces Health Services (CFHS) and the network of command/regional surgeons

- Also linked into scientists in the other DRDC Centres, medical intelligence, and the personnel research and analysis organization

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# Situation in March 2020

- Plans were changing quickly

- Focus on mission continuity
  - Little thought to long-term, mission sustainability, impact on service members and their families

- Ability to test for COVID-19 was very limited

- Impact of testing was not clear

- Decision-making lacked rigourous decision-support

- **COVID-19 risk was *not* quantified**



Jasmin Sessler
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# How did we do it?

- Scientist-to-scientist networks
  - CORA scientists in NORAD, MARLANT quickly reached out to colleagues old and new
- Scientist-to-military networks
  - Rotational models in both CORA and the military have built up informal networks that built up latent trust
- Ability to address novel problems
  - CORA's model meant scientists were used to "leaping" into new areas
- Quick wins
  - Part of OR&A is doing simple things well and quickly
- Collaboration beyond CORA
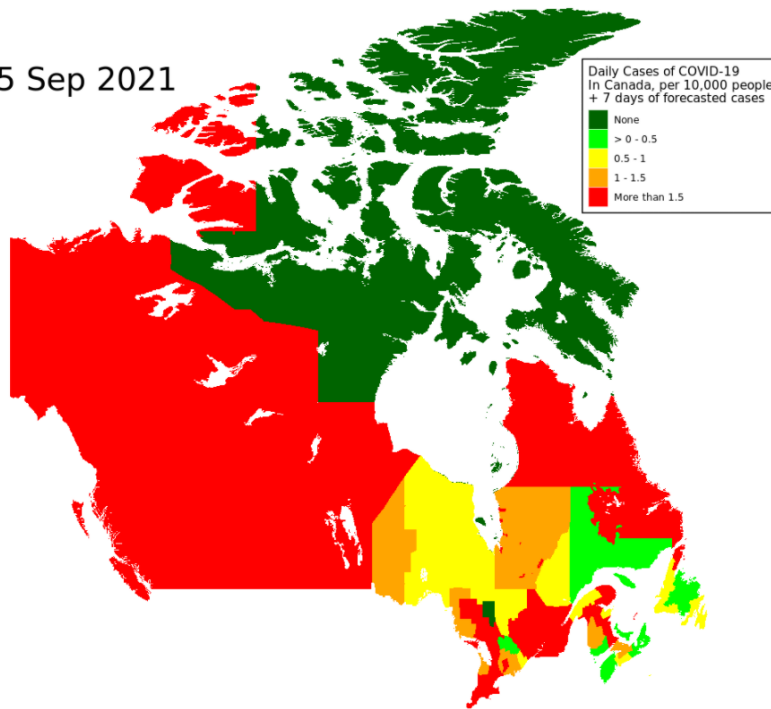  - Networks extended into other Centres, other gov't departments, and allies



Blake Wheeler
https://unsplash.com/photos/itt1jPISHLo

# Example 1: situational awareness

- Dynamically map reported cases and hotspots for CFINTCOM and CJOC [1]
  - See right…

- The crucial building block for many studies is now the COVID-19 Point Prevalence Map [4], which uses the reported case rate to estimate the current and predicted percentage of SARS-CoV-2 infections in a region
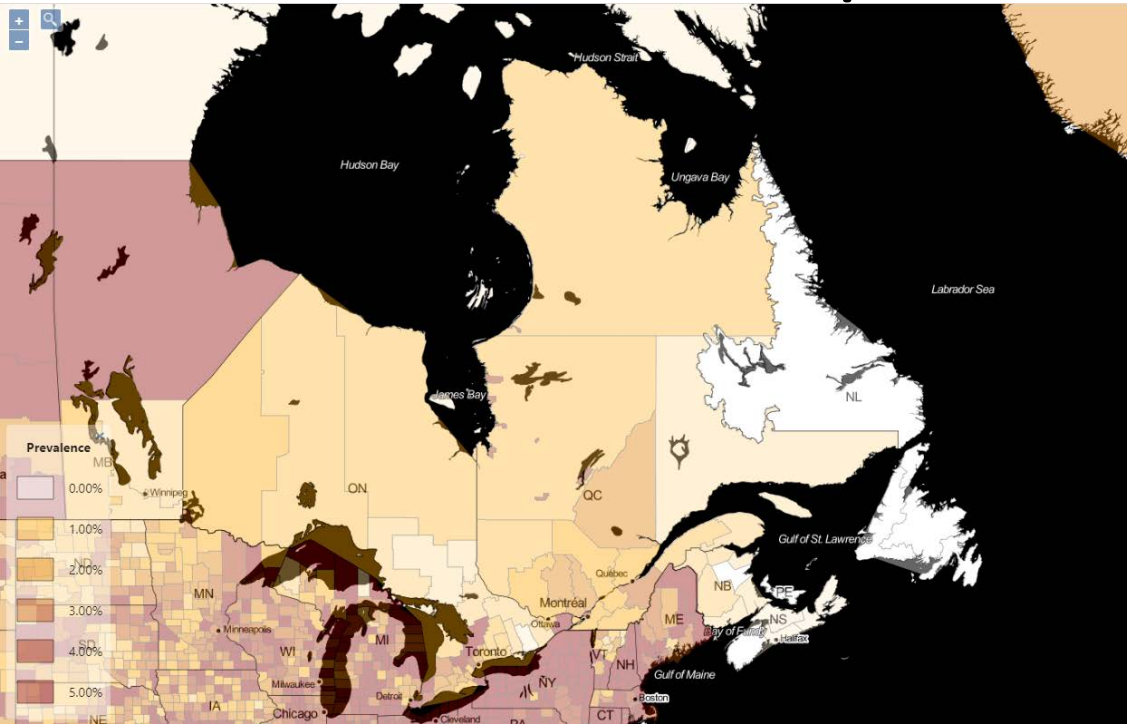  - See next slide



http://dia-dasi.cloud.forces.gc.ca/analytics/DynamicMappingCovid19.html

# Point-Prevalence Map

https://decision-support-tools.com/map

# Ex 2: probability of missed infection

- Operations can't and didn't stop, so questions came from multiple organizations for the likelihood that an infection would be brought into a building, unit, ship, air crew…., e.g.:
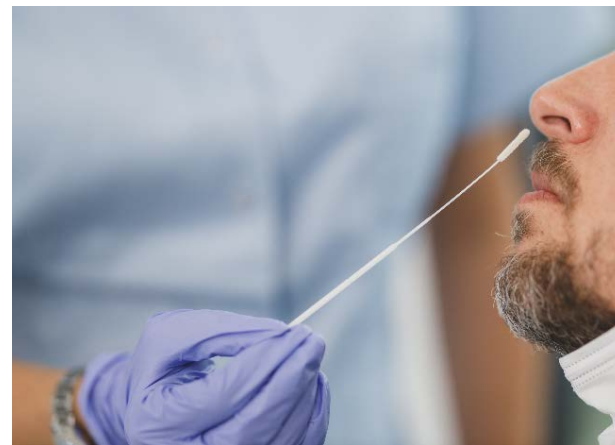
  - The probability of a non-symptomatic individual bringing infection into a group – the NORAD/USNORTHCOM Command Center [5]

  - NORAD interest in applying sentinel testing to check for changes in relative prevalence to the background [6]
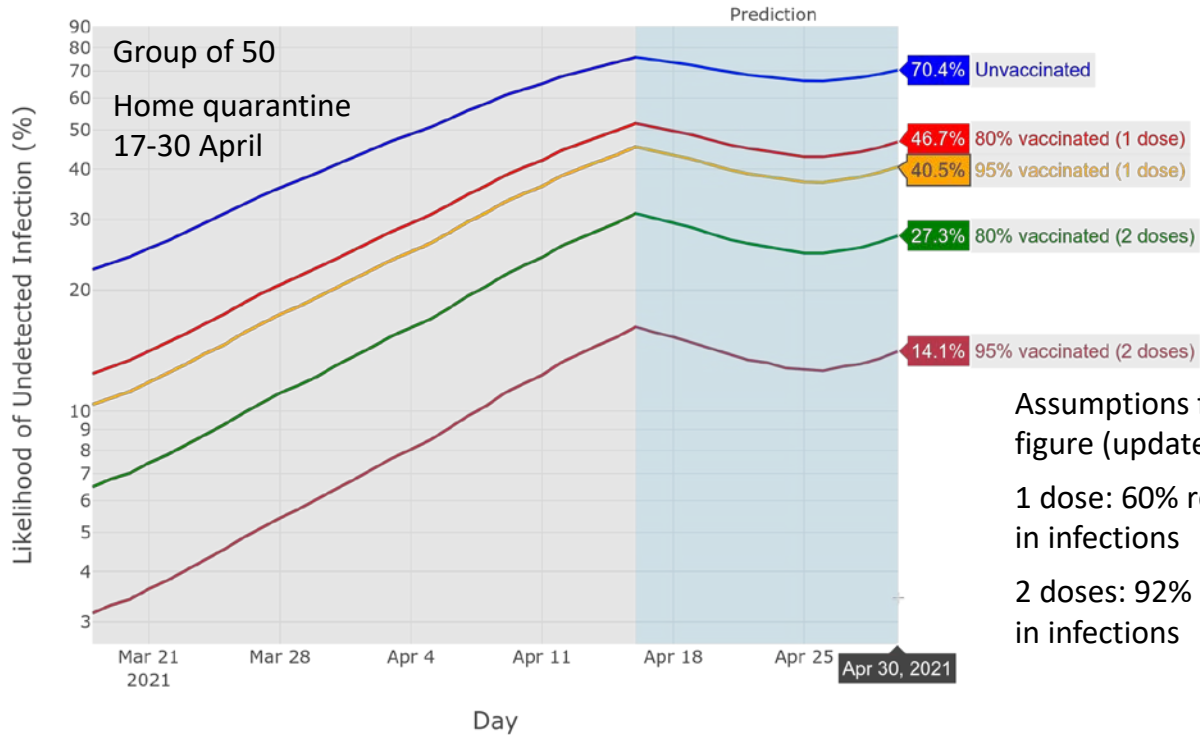
- Missed Infection Calculator



https://stocksnap.io/photo/coronavirus-disease-IMQ3PNZFAY

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# Missed infection calculator

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- Multiple locations

- Full or imperfect quarantining

- Time-dependent test sensitivity

- Correlation between tests

- PCR or antigen tests

- Vaccination



Prediction

Group of 50

Home quarantine
17-30 April

Likelihood of Undetected Infection (%)

70.4% Unvaccinated
46.7% 80% vaccinated (1 dose)
40.5% 95% vaccinated (1 dose)
27.3% 80% vaccinated (2 doses)
14.1% 95% vaccinated (2 doses)

Mar 21 2021   Mar 28   Apr 4   Apr 11   Apr 18   Apr 25   Apr 30, 2021

Day

Assumptions for this figure (updated since)

1 dose: 60% reduction in infections

2 doses: 92% reduction in infections

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# Ex 3: outbreak modelling and analysis

- Multiple epidemiological outbreak models developed for different applications

- Spread within a Mission Capability Preservation Team [7]

- Leadership and Recruit School [8]

- Pre-vaccination Spread on Naval ships [9,10]

- Deployed settings [11]

- Contact tracing burden [12]

- Maple Resolve, the Canadian Army's primary high readiness exercise (presented in Modelling & Simulation #1 tomorrow)

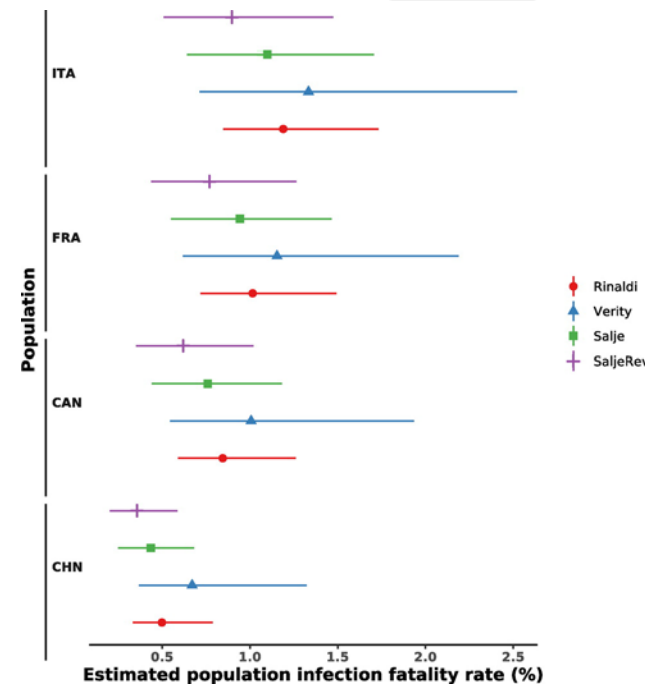- Adjustments to pre-embarkation protocols for Naval vessels post-vaccination [13]

Cumulative infected cohorts

scenario 3 - 0% PPE - no instructor isolation
scenario 3 - 50% PPE - no instructor isolation
scenario 3 - 90% PPE - no instructor isolation

van den Hoogen & Okazawa

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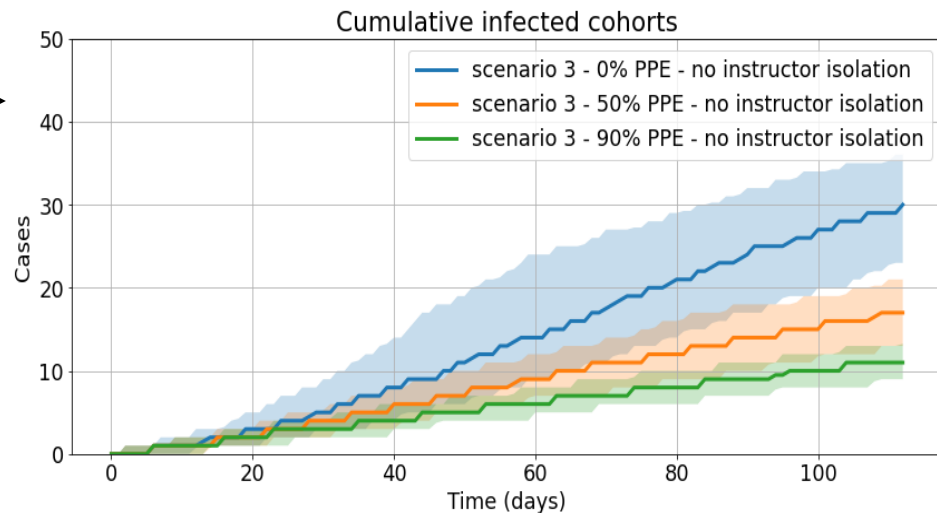
# Ex 4: consequence estimation

- Risk of severe outcomes always a primary concern

- Reviewed infection fatality rate with CFHS [2], and extended to quantify estimate for younger military population [14]

- Given low fatality risk, refocused on risk of hospitalization as primary outcome

  - Used as a proxy for understanding the likelihood of medical evacuation from a ship [13]

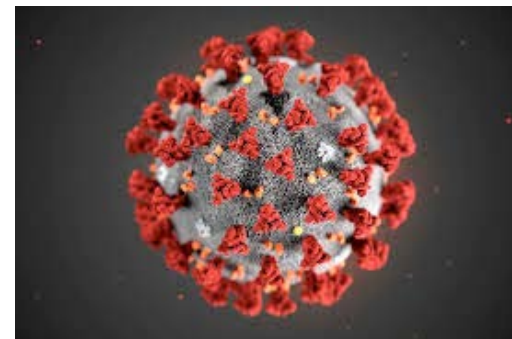  - As pandemic evolved, reviewed impact of variants of concern [15] on this outcome



MacLeod & Hunter, INFORMS Journal on Applied Analytics

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# Ex 5: other analyses

- Early review of likelihood of provincial medical systems being overwhelmed, potential requests for assistance [16]

- Investigation of natural language processing for classifying flood of new publications [17]

- Prototype Partial Observable Markov Decision Process model of community spread [18]

- Calibrating SEIR models to infection rates experienced by military deployed to long-term care facilities [19]

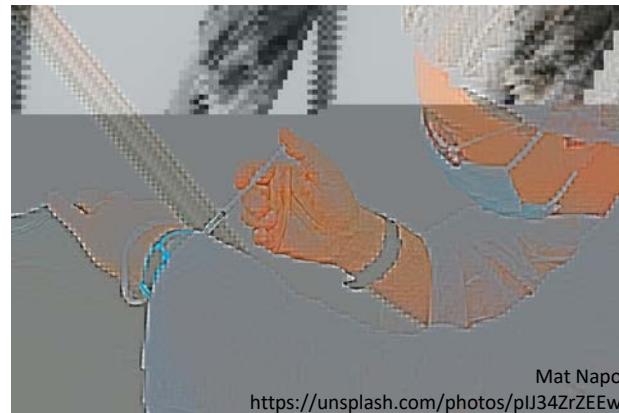- Simulating the potential load on contact tracing capacity [20]



https://www.cdc.gov/dotw/covid-19/index.html

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# Future work

- Pandemic not over yet: variants upended assumptions about the path out of the pandemic, even at relatively high vaccination levels…

- Health care is a major area of study for operational research, plenty of scope:

  - Risk/benefit analysis

  - Statistical analysis of electronic medical data

  - Efficiency and effectiveness of operations

  - Data-driven policy/committee work

  - The unknown



Mat Napo
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# Summary

- Conditions existed for successful DRDC CORA response to COVID-19

  - Strong scientist-to-scientist networks

  - Trusted military-to-scientist networks

  - Scientists were used to moving into new areas

  - Ability to address novel problems

  - Do simple things well and quickly

  - Collaborate beyond DRDC CORA (other DRDC centres, Health Services)

- Numerous models and tools developed for operational use – still in use

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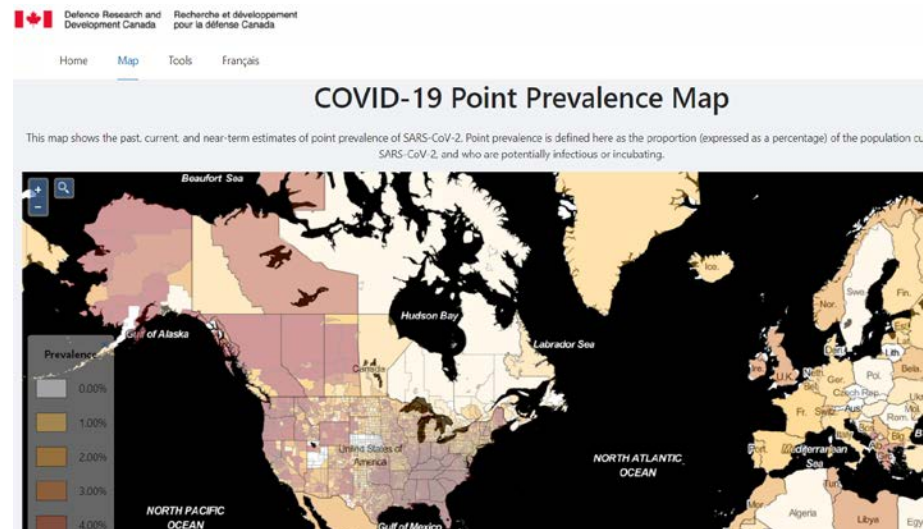
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