COVID-19 Epidemiology: the knowns and unknowns
Presented by Dr. Dominik Mertz

All attendees will enter the meeting with their mic muted and will be unable to turn on their video.
Moderator:

Sarah Forgie MD, MEd, FRCPC
President
Association of Medical Microbiology and Infectious Disease (AMMI) Canada
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If you have a question for our speaker or panelists, please use the Q&A feature. Questions will be answered live following the presentation. (please note we cannot guarantee that all questions will be answered)

If you are experiencing technical difficulties, please use the chat feature or email krystal@ammi.ca.
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Co - Moderator:

James Brooks MD, FRCPC
Infectious Disease Consultant and Lecturer
Department of Medicine
University of Ottawa
Director, AMR Division
Centre for Communicable Diseases and Infection Control
Public Health Agency of Canada (PHAC)
Member of the COVID-19 Clinical Issues and Treatments Group
Dr. Mertz attended medical school and completed his training in Internal Medicine and Infectious Diseases in Switzerland prior to moving to Canada to complete a Master’s Degree in Health Research Methodology at McMaster University. He is currently an Associate Professor in the Department of Medicine and is affiliated with the Departments for Health Research Methods, Evidence and Impact, the Department of Pathology and Molecular Medicine, the Population Health Research Institute (PHRI), and the Michael G. DeGroote Institute for Infectious Diseases Research. He is also serving as the Medical Director Infection Prevention and Control at Hamilton Health Sciences.
COVID-19 EPIDEMIOLOGY: THE KNOWNS AND UNKNOWNS

Dominik Mertz, MD, MSc
Associate Professor McMaster University
Medical Director Infection Prevention and Control,
Hamilton Health Sciences, Hamilton, ON
Disclosures

– No conflict of interests in relation to the topics of this talk
Objectives

– Recap of the timelines and extent of global spread of COVID-19
  • Including reports of potential earlier export from China

– Selected settings of COVID-19 transmission: knowns and unknowns
  • Superspreader events
  • Children versus adults
  • Travel: airplane and train
  • Asymptomatic carriage
  • Serology and IFR
Coronaviruses

- From Latin “corona” = “crown”
- Discovered 1960 in chickens
- Enveloped viruses, single-stranded RNA
- Four genera:
  - Relevant for humans: alpha and beta, source: bats
  - gamma and delta, source: birds
- From bats to intermediate hosts, further recombination and mutation events, then to human
## Coronaviruses

<table>
<thead>
<tr>
<th></th>
<th>Common Coronavirus</th>
<th>SARS</th>
<th>MERS-CoV</th>
<th>COVID-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin (suspected)</td>
<td>Bats to ???</td>
<td>Bats to civet cats</td>
<td>Bats to dromedary camels</td>
<td>Bat to pangolin (?)</td>
</tr>
<tr>
<td>Transmission</td>
<td>Human-to-human through droplet/contact</td>
<td>Human-to-human through droplet/contact</td>
<td>From camels, small clusters of human-to-human transmission</td>
<td>Human-to-human through droplet/contact</td>
</tr>
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<td>Cases</td>
<td>Millions each year</td>
<td>8,098 cases</td>
<td>2,499 cases</td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>Unknown</td>
<td>774 deaths ~10%</td>
<td>861 deaths ~34%</td>
<td></td>
</tr>
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<td>Current situation</td>
<td>Year-round, peaks in Fall/Winter</td>
<td>Disappeared 2003. 87% of cases in China and Hong Kong.</td>
<td>Number of cases declining since 2016. 80% of cases in Saudi Arabia</td>
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Source: WHO and CDC websites

[https://www.merlijnvanveen.nl/en/study-hall/161-moving-target]
## Coronaviruses

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</tr>
</thead>
<tbody>
<tr>
<td><strong>Circulation</strong></td>
<td>4 strains (229E, NL63, OC43, HKU1). Thousand of years(?). Worldwide.</td>
<td>11/2002 in Guangdong Province, Southern China</td>
<td>2012 in Saudi Arabia</td>
<td>2019 in Wuhan, Wubei Province, China</td>
</tr>
<tr>
<td><strong>Origin (suspected)</strong></td>
<td>Bats to ???</td>
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Source: WHO and CDC websites

Back in time

Wuhan:
- >11 Mio population
- most populous City in central China (7th in China)
- Capital of Hubei Province (population 58.5 Mio)

Impact of COVID-19 (to date):
- 68,135 cases / 4,512 deaths (6.6%)

From: https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6
A novel coronavirus was officially announced as the causal pathogen of the outbreak by China CDC.

China CDC Level 2 emergency response activated.

Emergency monitoring, case investigation, close contact management, and market investigation initiated, technical protocols for Wuhan released: NHC notified WHO and relevant countries and regions; gene sequencing completed by China CDC.

Huanan Seafood Wholesale Market closed.

Outbreak announced by WHC. NHC and China CDC involved in investigation and response.

Case-finding activated.

Pneumonia cases linked to the Huanan Seafood Wholesale Market.

China CDC publicly shared the gene sequence of the novel coronavirus; completed PCR diagnostic reagent development and testing.

PCR diagnostic reagents provided to Wuhan.

First confirmed case from Wuhan reported outside China (in Thailand).

China CDC emergency response level upgraded to Level 1 (the highest level); national technical protocols for 2019-nCoV released by NHC.

Strict exit screening measures activated in Wuhan, people with body temperature ≥37.3°C were restricted from leaving.

First confirmed case reported in another province in China (in a person who had traveled from Wuhan); China CDC issued test reagent to all provinces in China.

NCIP incorporated as a notifiable disease in the Infectious Disease Law and Health and Quarantine Law in China.

Reagent probes and primers shared with the public by China CDC.

Qul Li et al. NEJM; 2020: DOI: 10.1056/NEJMoa2001316
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Back in time

- PCR testing of archived waste water
- Tested positive in Milan and Turin on December 18
- Tested positive in Bologna on January 29
- All controls prior to December 18 tested negative
- First confirmed cases in Italy: mid-February
SARS-CoV-2 was already spreading in France in late December 2019

A. Deslandes\textsuperscript{a}, V. Berti\textsuperscript{a}, Y. Tandjaoui-Lambotte\textsuperscript{b,c}, Chakib Alloui\textsuperscript{a}, E. Carbonnelle\textsuperscript{a,d}, J.R. Zahar\textsuperscript{a,d,e}, S. Brichler\textsuperscript{b}, Yves Cohen\textsuperscript{a,e}

\textsuperscript{a}Université Paris 13, Sorbonne Paris Cité, France, and Service de Microbiologie Clinique et Unité de Contrôle et de Prévention du Risque Infectieux, Groupe Hospitalier Paris Seine-Saint-Denis, AP-HP, Bobigny, France
\textsuperscript{b}Étude hospitalière et suivi maladies infectieuses et parasitaires, Complexe Hospitalier Paris Seine Saint-Denis, AP-HP, Bobigny, France
\textsuperscript{c}Unité de Microbiologie Pédiatrique, Centre Hospitalier Régional et Universitaire de Reims, France
\textsuperscript{d}INSERM U1272, Hospital de Retiro, Madrid, Spain
\textsuperscript{e}INSERM, U1042, F-75010, Paris, France

- 43 y/o admitted Dec 27 2019 for pneumonia in hospital near Paris
- No travel history, but wife worked at airport shop
- Swab later tested for SARS-CoV-2, resulting positive (repeatedly, all targets)

Sentinel surveillance of SARS-CoV-2 in wastewater anticipates the occurrence of COVID-19 cases

Gemma Chavarría-Miró, Eduard Anfruns-Estrada, Susana Guix, Miquel Paraira, Belén Galofré, Gloria Sánchez, Rosa M. Pintó¹, Albert Bosch¹

- PCR of concentrated waste water from April 13- May 25
- Using frozen archived samples prior to 4/2020
- Good correlation of # copies in waste water and known cases
- First positive sample: January 15, 41 days prior to first known local case

PS: One single positive in March 2019 → 2/5 targets positive (false pos? contamination?)
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Waste water Italy. Waste water Spain.
Epidemiology: Worldwide

Global Deaths

702,045

157,186 deaths
US

95,819 deaths
Brazil

48,869 deaths
Mexico

44,295 deaths
United Kingdom

39,795 deaths
India

35,181 deaths
Italy

30,297 deaths
France

28,499 deaths
Spain

https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6
# Epidemiology: Worldwide

## Total Confirmed

18,601,795

## Confirmed Cases by Country/Region/Sovereignty

<table>
<thead>
<tr>
<th>Country/Region/Sovereignty</th>
<th>Cases</th>
</tr>
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<tbody>
<tr>
<td>US</td>
<td>4,785,528</td>
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<tr>
<td>Brazil</td>
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<td>India</td>
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<tr>
<td>Russia</td>
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<tr>
<td>South Africa</td>
<td>521,318</td>
</tr>
<tr>
<td>Mexico</td>
<td>449,961</td>
</tr>
<tr>
<td>Peru</td>
<td>439,890</td>
</tr>
<tr>
<td>Chile</td>
<td>364,723</td>
</tr>
<tr>
<td>Colombia</td>
<td>334,979</td>
</tr>
<tr>
<td>Iran</td>
<td>317,483</td>
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<tr>
<td>United Kingdom</td>
<td>307,258</td>
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<tr>
<td>Spain</td>
<td>305,767</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>282,824</td>
</tr>
<tr>
<td>Pakistan</td>
<td>281,136</td>
</tr>
<tr>
<td>Italy</td>
<td>248,803</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>246,674</td>
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[https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6](https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6)
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- 246,674 Bangladesh
- 234,934 Turkey
- 228,576 France

Case Fatality Rate (Canada: 7.6%):
- 702,045 Global Deaths
- 157,186 deaths in US: 3.3%
- 95,819 deaths in Brazil: 3.4%
- 48,869 deaths in Mexico: 10.9%
- 44,295 deaths in United Kingdom: 15.1%
- 39,795 deaths in India: 2.1%
- 35,181 deaths in Italy: 14.1%
- 30,297 deaths in France: 13.3%
- 28,499 deaths in Spain: 9.3%

Source: [https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6](https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6)
Epidemiology: Canada

Canada 117,792

Count of total cases of COVID-19
50,001 and higher
30,001 to 50,000
10,001 to 30,000
5,001 to 10,000
1,001 to 5,000
1 to 1,000
0

Note: The total number includes publicly reported confirmed and probable cases.

Epidemiology: Canada

Epidemiology: US and Brazil

Daily confirmed COVID-19 cases, rolling 3-day average

The number of confirmed cases is lower than the number of total cases. The main reason for this is limited testing.

Source: European CDC – Situation Update Worldwide – Last updated 5 August, 10:04 (London time)  OurWorldInData.org/coronavirus • CC BY
Note: The rolling average is the average across three days – the confirmed cases on the particular date, and the previous two days. For example, the value for 27th March is the average over the 25th, 26th and 27th March.

https://ourworldindata.org/grapher/daily-covid-cases-3-day-average?country=BRA~USA
Epidemiology: South Africa

https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6
Epidemiology: Italy

https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6
Epidemiology: Spain

https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6
Epidemiology: UK

https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6
**Superspreader events**

- Events with 1 or more index cases resulting in a large number of secondary cases
- Contributing factors (in theory):
  1) Super shedders – high viral load
  2) Mostly young and asymptomatic (or paucisymptomatic)
  3) Large number of close contacts (“social”)
  4) Setting: indoors, crowded, insufficient ventilation

Hunan Seefood market not source, but first super spreader event?
Superspreader events

185 coronavirus (COVID-19) cases now linked to outbreak at East Lansing bar

143 of 185 infected people were customers at Harper’s Restaurant and Brew Pub
Superspreader events

185 coronavirus (COVID-19) cases now linked to outbreak at East Lansing bar

143 of 185 infected people were customers at Harper’s Restaurant and Brew Pub

- College bar in Michigan, linked to June 8
- 143 primary cases, at least 42 secondary cases
- Many contributing factors (3 Cs)

Harper’s Restaurant and Brew Pub outbreak

Health officials say a coronavirus cluster has left at least 187 people infected.

Source: Ingham County Health Department

THE WASHINGTON POST
Superspreader events – College bar in Michigan, June 8–14

13 primary cases, at least 42 secondary cases

Many contributing factors (3 Cs)
Superspreader events – College bar in Michigan, June 8–14: 131 primary cases, at least 42 secondary cases.

Many contributing factors (3 Cs):

Pre-print: https://wellcomeopenresearch.org/articles/5-67

### Estimating the overdispersion in COVID-19 transmission using outbreak sizes outside China [version 3; peer review: 2 approved]

**Akira Endo**, Centre for the Mathematical Modelling of Infectious Diseases COVID-19 Working Group, Sam Abbott, Adam J. Kucharski, Sebastian Funk

**Results:** Our model suggested a high degree of individual-level variation in the transmission of COVID-19. Within the current consensus range of $R_0$ (2–3), the overdispersion parameter $k$ of a negative-binomial distribution was estimated to be around 0.1 (median estimate 0.1; 95% CrI: 0.05–0.2 for $R_0 = 2.5$), suggesting that 80% of secondary transmissions may have been caused by a small fraction of infectious individuals (~10%). A joint estimation yielded likely ranges for $R_0$ and $k$ (95% CrIs: $R_0$: 1.4–12; $k$: 0.04–0.2); however, the upper bound of $R_0$ was not well informed by the model and data, which did not notably differ from that of the prior distribution.

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**High SARS-CoV-2 Skagit County, Washington, USA:**

On May 13, 2020, a report was published on the investigation of a small outbreak of COVID-19 in Skagit County, Washington, USA, associated with a plant-related SARS-CoV-2 outbreak in Germany.

Investigation of plant-related SARS-CoV-2 outbreak in Germany:


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Source: Ingham County Health Department

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**COVID-19 outbreak: Cases tied to bar continue to rise**

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**June 18**

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**June 28**

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**July 7**

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**July 17**

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**CUPAtea**

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**CCAAeee**

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**Tech. Engage. Apply.**

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**Emergy. Engage. Application.**

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**THE WASHINGTON POST**
Superspreader events: Kelowna

Officials sound alarm over ‘Kelowna cluster,’ now over half of all active B.C. COVID-19 cases

- Around Canada Day: several private parties in vacation rentals, resorts and houseboats
- Following week, dozens of infected party-goers
- Secondary cases then occurred resulting in community transmission, and largest cluster in B.C. → 130 cases by July 31, and >1000 in self-isolation
- not one single super spreader event, but major impact on local epidemiology
Superspreader events: Switzerland
«Superspreader»: 300 visiteurs d'un club zurichois en quarantaine

Le canton de Zurich a détaillé dimanche en fin de journée les difficultés de traçage liées à son premier super-propagateur du virus, un homme qui a visité une boîte de nuit à Zurich le 21 juin.
Superspreader events: Switzerland

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<tr>
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<th>Anzahl</th>
<th>Prozent</th>
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<tbody>
<tr>
<td>Familienmitglied</td>
<td>216</td>
<td>27.2</td>
</tr>
<tr>
<td>Als medizinisches und Pflegepersonal</td>
<td>17</td>
<td>2.1</td>
</tr>
<tr>
<td>Andere</td>
<td>99</td>
<td>12.5</td>
</tr>
<tr>
<td>Schule</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Arbeit</td>
<td>69</td>
<td>8.7</td>
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<tr>
<td>Privatfest</td>
<td>24</td>
<td>3.0</td>
</tr>
<tr>
<td>Disco/Club</td>
<td>15</td>
<td>1.9</td>
</tr>
<tr>
<td>Bar/Restaurant</td>
<td>13</td>
<td>1.6</td>
</tr>
<tr>
<td>Demonstration/Veranstaltung</td>
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<td>0.1</td>
</tr>
<tr>
<td>spontane Menschenansammlung</td>
<td>17</td>
<td>2.1</td>
</tr>
<tr>
<td>Unbekannt</td>
<td>4</td>
<td>0.5</td>
</tr>
<tr>
<td>Missing*</td>
<td>316</td>
<td>39.8</td>
</tr>
<tr>
<td>Total</td>
<td>793</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Superspreader events: Switzerland

What we know – and do not know:

- Modelling study and media reports suggest superspreader events are the main driver of local epidemiology
- (Newer) epidemiologic data not necessarily supporting this notion

Superspreader events do contribute, but not necessarily main driver

Endo et al. Wellcome Open Research 2020, 5:67
Rapid Review: What is the specific role of daycares and schools in COVID-19 transmission?

– Young children not a major source of transmission (moderate, consistent)
– Clusters traced back to community and home settings, or adults; not amongst children within daycares or schools. Adults were more likely index cases than children (moderate, consistent)
– Linear relationship between age and COVID-19 transmission (low, consistent)
Rapid Review: What is the specific role of daycares and schools in COVID-19 transmission?

- Young children not a major source of transmission (moderate, consistent)
- Clusters traced back to community and home settings, or adults; not amongst children within daycares or schools. Adults were more likely index cases than children (moderate, consistent)
- Linear relationship between age and COVID-19 transmission (low, consistent)
- Limitations:
  - case reports and prevalence studies, no experimental studies
  - IPAC measures not consistently described
**Kids and schools**

Rapid Review: What is the specific role of daycares and schools in COVID-19 transmission?

| Yung, C.H., Kam, K., Nadua, K.D., Chong, C.Y., Tan, N.W.H., Li... Ng, K.C. (2020). Novel coronavirus 2019 transmission risk in educational settings. *Clinical Infectious Diseases.* Epub ahead of print | Jun 25, 2020 | Case report | Singapore | Preschool, secondary school | 1 child with COVID-19 attended a preschool for ages 3–6 (number of contacts not reported): • 34 contacts developed symptoms and were tested; none tested positive. 1 adolescent with COVID-19 attended a secondary school for ages 12–15 (total number of contacts not reported): • 8 contacts developed symptoms and were tested; none tested positive. | Schools were cleaned and disinfected daily. Children were cohorted with staggered recess and lunches. |
**Rapid Review: What is the specific role of daycares and schools in COVID-19 transmission?**

| Yung, C.H., Kam, K., Nadua, K.D., Chong, C.Y., Tan, N.W.H., Li... Ng, K.C. (2020). *Novel coronavirus 2019 transmission risk in educational settings. Clinical Infectious Diseases: Epub ahead of print.* | Jun 25, 2020 | Case report | Singapore | Preschool, secondary school | 1 child with COVID-19 attended a preschool for ages 3–6 (number of contacts not reported): 34 contacts developed symptoms and were...


**Timing of school closures coincided with a reduction in the growth rate of COVID-19 cases and hospitalizations compared to data models with no intervention. However, implementation of concurrent community interventions (e.g., travel restrictions, social distancing, banned gatherings) mean it is difficult to determine which interventions were most effective.**

Reopening of schools among younger student groups and those participating in exams did not result in a significant increase in rates of COVID-19.

**In countries with low community transmission of COVID-19, return of all students did not appear to increase transmission.**

**The return of older students in a country of high community transmission levels appeared to increase transmission among students but not staff.**
Kids and schools

Rapid Review: What is the specific role of daycares and schools in COVID-19 transmission?


Jun 25, 2020

Case report
Singapore

Preschool, secondary school


Jun 26

Cohort

1 child with COVID-19 attended a preschool for ages 3-5 (number of contacts not reported):

- 34 contacts developed symptoms and were tested.
- Germany
- Community

1 additional child attend a primary school.

Children were cohorted with staggered recess and lunches.


Jun 29, 2020

Retrospective cohort

France

Primary school

No infection prevention and control measures were reported.

Schools had been shut down for 4 weeks prior to

510 of 1047 students (aged 6-11 years) at a primary school consented to testing for antibodies to the virus that causes COVID-19:

- 45 of 510 (8.8%) tested positive for antibodies.
- 11.9% parents tested positive for antibodies.

No information was reported on index cases.

The return of older students in a country of high community transmission levels appeared to increase transmission among students but not staff.
Kids and schools

Montreal

28 cases of COVID-19 confirmed at Boucherville day camp

Positive cases found among staff and children at Charlot l’Escargot day camp

Jennifer Yoon · CBC News · Posted: Jul 28, 2020 5:05 PM ET | Last Updated: July 28

At least 28 children and staff have tested positive and everyone who has been to the Charlot l’Escargot day camp is being asked to stay home. (Matt D’Amours/CBC)
Kids and schools

Rapid Review: Why of daycares and schools transmission

A large COVID-19 outbreak in a high school 10 days after schools’ reopening, Israel, May 2020

Chen Steinhorn*, Nitza Abramson, Hanna Shohfi, Errol Libai, Menachem Bitan, Tanya Cahn, Rafael Cayamp, Ian Miskin

1. Jerusalem District Health Office, Ministry of Health, Jerusalem, Israel
2. The Hebrew University of Jerusalem, Faculty of Medicine, Binyan School of Public and Community Medicine, Jerusalem, Israel
3. Clalit Health Services, Jerusalem District, Jerusalem, Israel
4. Maccabi Healthcare Services, Jerusalem and North Region, Jerusalem, Israel
5. Leumit Health Services, Jerusalem District, Jerusalem, Israel

Correspondence: Chen Steinhorn (chen.steinhorn@buj.health.gov.il)

At least 28 children and staff have tested positive and everyone who has been to the Charlot l’Escargot day camp is being asked to stay home. (Matt D’Amours/CBC)
– School closure March 13, fully re-opened May 17
– Facemasks, social distancing, and minimal interaction between classes
– But: large crowded classes (~30 students, 1.1-1.3m²), extracurricular activities (e.g. sports, dance classes), bussing, and heat wave May 19-21 with no mask use
– Two students symptomatic May 26 and 27, respectively (not linked)
– Outbreak declared and mass testing
– 153 students and 25 staff members tested positive
Kids and schools

SARS-CoV-2 Transmission and Infection Among Attendees of an Overnight Camp — Georgia, June 2020

Early Release / July 31, 2020 / 69

Christine M. Szablewski, DVM1; Karen T. Chang, PhD1,2; Marie M. Brown, MPH1; Victoria T. Chu, MD1,3; Anna R. Yousaf, MD2,3; Ndubuisi Anyalechi, MD1; Peter A. Aryee, MBA1; Hannah L. Kirkling, MD1; Maranda Lumsden1; Erin Mayweather; Clinton J. McDaniel, MPH3; Robert Montierth, PharmD3; Asfia Mohammed1; Noah G. Schwartz, MD2,3; Jaina A. Shah1; Jacqueline E. Tate, PhD3; Emillo Dirlikov, PhD3; Cherie Drenzek, DVM1; Tatiana M. Lanzieri, MD1; Rebekah J. Stewart, MSN, MPH1 (View author affiliations)

– In setting of increasing community-transmission in Georgia
– Staff member with COVID-19 Jun 23, camp closed June 25
– 579 Georgian attendees with data available; average age 12y/o
– 344 (58%) with test result, 260 (76%) tested positive
– Attack rate from 29% in >22y/o to 51% in 6-10y/o
– 26% were asymptomatic at the time of testing
Kids and schools

- Analysis of 59,073 contacts of 5,706 COVID-19 index cases
- 1.9% of non-household, and 11.8% of household contact tested positive
### Contact Tracing during Coronavirus Disease Outbreak 2020


### Rates of coronavirus disease among household and nonhousehold contacts, South Korea, January 20–March 27, 2020

<table>
<thead>
<tr>
<th>Index patient age, y</th>
<th>No. contacts positive/total contacts traced (%)</th>
<th>% Positive (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5–9</td>
<td>3/57</td>
<td>5.3 (1.3–13.7)</td>
</tr>
<tr>
<td>10–19</td>
<td>48/231</td>
<td>20.6 (14.0–24.0)</td>
</tr>
<tr>
<td>20–29</td>
<td>240/5,417</td>
<td>4.4 (3.2–5.7)</td>
</tr>
<tr>
<td>30–39</td>
<td>148/1,229</td>
<td>11.6 (9.0–13.5)</td>
</tr>
<tr>
<td>40–49</td>
<td>206/1,749</td>
<td>11.6 (10.3–13.4)</td>
</tr>
<tr>
<td>50–59</td>
<td>300/2,045</td>
<td>14.7 (13.2–16.3)</td>
</tr>
<tr>
<td>60–69</td>
<td>177/1,039</td>
<td>17.0 (14.8–19.4)</td>
</tr>
<tr>
<td>70–79</td>
<td>86/477</td>
<td>18.0 (14.8–21.7)</td>
</tr>
<tr>
<td>≥80</td>
<td>50/348</td>
<td>14.4 (11.0–18.4)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,245/10,392</td>
<td>11.6 (11.2–12.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. contact positive/total contacts traced (%)</th>
<th>% Positive (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonhousehold</td>
<td></td>
</tr>
<tr>
<td>5–9</td>
<td>2/150</td>
</tr>
<tr>
<td>10–19</td>
<td>2/226</td>
</tr>
<tr>
<td>20–29</td>
<td>120/12,993</td>
</tr>
<tr>
<td>30–39</td>
<td>70/7,407</td>
</tr>
<tr>
<td>40–49</td>
<td>161/7,950</td>
</tr>
<tr>
<td>50–59</td>
<td>186/9,308</td>
</tr>
<tr>
<td>60–69</td>
<td>215/7,451</td>
</tr>
<tr>
<td>70–79</td>
<td>92/1,912</td>
</tr>
<tr>
<td>≥80</td>
<td>75/1,644</td>
</tr>
</tbody>
</table>

Total 921/48,481 1.9 (1.8–2.0)
- Kids in camps, daycares or schools may be sources of community transmission, and are catalysts of existing community transmission and mitigation strategies required

- Low community transmission and mitigation strategies required

- Difference in odds of transmissions between <10 vs. >10 y/o (?)

Question: where are the case reports of daycare/schools/camps that did NOT have outbreaks?
The risk of COVID-19 transmission in train passengers: an epidemiological and modelling study

Maogui Hu, Hui Lin, Jinfeng Wang, Chengdong Xu, Andrew J Tatem, Bin Meng, Xin Zhang, Yifeng Liu, Pengda Wang, Guizhen Wu, Haiyong Xie, Shengjie Lai

- 2,334 index patients and 72,093 close contacts (within 3 rows)
- 12/2019 – 3/2020
- Distance and duration of exposure as risk factors
- Mean attack rate: 0.32% (same row: 1.5%)
- In same row, risk increases 1.3% per hour

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Travel: train

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Letter to the Editor

Probable aircraft transmission of Covid-19 in-flight from the Central African Republic to France

Potential transmission of SARS-CoV-2 on a flight from Singapore to Hangzhou, China: An epidemiological investigation
Passengers on 31 flights in Canada may have been exposed to COVID-19 in July

By Katie Dangerfield · Global News
Posted July 15, 2020 12:50 pm · Updated July 16, 2020 9:18 am
Travel: air

1. Closed spaces with poor ventilation.
2. Crowded places with many people nearby.
3. Close-contact settings such as close-range conversations.

Letter to the Editor
Probable aircraft transmission
By K Post

Travel Medicine and Infectious Disease 35 (2020) E1543

An epidemiological investigation
Travel: air

– Despite case reports of transmissions and daily reports of COVID positive passengers...

– Most contact tracings do NOT identify transmission
  • Efficient ventilation system similar to OR or AIIR
  • Cleaning protocols, hand sanitizer, masks...
Travel: air

- Despite case reports of transmissions and daily reports of COVID positive passengers...

• Efficient ventilation system similar to OR or AIIR
• Cleaning protocols, hand sanitizer, masks...

- Likely: higher risk while standing in line at airport, use of public transport or taxis, and baseline risk at travel destination, hotel, etc.

- Air travel >>> safe than train travel

- Should we advise to go back to pre-COVID travel patterns to areas with similar COVID baseline risks?

Risk remains with standing in line at airport/hotel/museum/restaurant, use of public transport or taxis, baseline risk at travel destination, socializing etc.
Asymptomatic and presymptomatic transmission

Rothe et al. NEJM. 2020: DOI: 10.1056/NEJMc2001468
Asymptomatic and presymptomatic transmission

Transmission of 2019-nCoV Infection from an Asymptomatic Contact in Germany

Figure 1. Timeline of Exposure to Index Patient with Asymptomatic 2019-CoV Infection in Germany.

Rothe et al. NEJM. 2020: DOI: 10.1056/NEJMc2001468

myalgia, fatigue
Asymptomatic and presymptomatic transmission

Rothe et al. NEJM. 2020: DOI: 10.1056/NEJMc2001468
Asymptomatic and presymptomatic transmission

Asymptomatic SARS-CoV-2 infections: a living systematic review and meta-analysis

- Living systematic review up to Jun 10, 2020
- 94 studies with 6,832 people (19 countries, 50% China)
- 20% (17-25%) were asymptomatic
- Significant heterogeneity → subgroup analyses

Asymptomatic and presymptomatic transmission

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- 20% (17-25%) were asymptomatic
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- Living system
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Asymptomatic and presymptomatic transmission

Proportion of asymptomatic coronavirus disease 2019
(COVID-19): a systematic review and meta-analysis

A systematic review and meta-analysis of asymptomatic COVID-19

Jingjing He, Yifei Guo, Richeng Mao, Jiming Zhang

Department of Infection Disease, Huashan Hospital, Fudan University, Shanghai, 200000, People's Republic China

– Systematic review up to May 20, 2020
– 41 studies, ~60% of studies from China

11 studies with results by age groups:
- Highest % asymptomatic in children and elderly (~28%)

Asymptomatic and presymptomatic transmission

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Asymptomatic and presymptomatic transmission

Rate of asymptomatics varies significantly from study to study (5 to 69%)

- Presymptomatic and paucisymptomatic presentation lumped together with true asymptomatic carriage in some reports
  - “True” frequency of asymptomatic carriage likely ~20%

→ True contribution to community transmission still unknown (major implications on effect of contact tracing)
Serology studies
Serology studies

New York City  May 2
19.9% have antibodies

Boston  May 15
9.9% have antibodies

Stockholm  May 20
7.3% have antibodies

London  May 21
17.5% have antibodies

Madrid  May 13
11.3% have antibodies

Wuhan (returning workers)  April 20
10% have antibodies

Herd immunity estimate
At least 60% of population
Serology studies

Seroprevalence of Antibodies to SARS-CoV-2 in 10 Sites in the United States, March 23-May 12, 2020

- 16,025 serologic tests
- 7.5% younger than 18y/o
- March 23 – May 12, 2020

Havers et al. JAMA Intern Med. 2020, epub ahead of print
Serology studies

Table 3. Estimated Number of Infections Based on Seroprevalence Estimates and Comparison With the Number of Reported Cases as of the Last Date of Specimen Collection for 10 Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Catchment description</th>
<th>Catchment population, No.</th>
<th>Estimated seroprevalence, % (95% CI)</th>
<th>Cases reported by date of last specimen collection, No.</th>
<th>Estimated cumulative infections, No. (95% CI)</th>
<th>Estimated infections/reported cases, No. (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Washington</td>
<td>King, Snohomish, Pierce, Kitsap, Grays Harbor counties</td>
<td>4 273 548</td>
<td>1.1 (0.7-1.9)</td>
<td>4308</td>
<td>48 291 (29 915-82 907)</td>
<td>11.2 (6.9-19.2)</td>
</tr>
<tr>
<td>New York City metro area (New York)</td>
<td>Manhattan, Bronx, Queens, Kings, Nassau counties</td>
<td>9 260 870</td>
<td>6.9 (5.0-8.9)</td>
<td>53 803</td>
<td>641 778 (464 806-826 070)</td>
<td>11.9 (8.6-15.4)</td>
</tr>
<tr>
<td>Louisiana</td>
<td>Statewide</td>
<td>4 644 049</td>
<td>5.8 (3.9-8.2)</td>
<td>17 030</td>
<td>267 033 (179 725-382 205)</td>
<td>15.7 (10.6-22.4)</td>
</tr>
<tr>
<td>South Florida</td>
<td>Miami-Dade, Broward, Palm Beach, Martin counties</td>
<td>6 345 345</td>
<td>1.9 (1.0-3.2)</td>
<td>10 525</td>
<td>117 389 (63 453-204 955)</td>
<td>11.7 (6.0-19.5)</td>
</tr>
<tr>
<td>Philadelphia metro area (Pennsylvania)</td>
<td>Bucks, Chester, Cumberland, Delaware, Lancaster, Montgomery, Philadelphia counties</td>
<td>4 910 139</td>
<td>3.2 (1.7-5.2)</td>
<td>22 987</td>
<td>156 633 (82 981-254 836)</td>
<td>6.8 (3.6-11.1)</td>
</tr>
<tr>
<td>Missouri</td>
<td>Statewide</td>
<td>6 110 800</td>
<td>2.7 (1.7-3.9)</td>
<td>6794</td>
<td>161 936 (100 828-235 877)</td>
<td>23.8 (14.8-34.7)</td>
</tr>
<tr>
<td>Utah</td>
<td>Adults aged ≥19 y (statewide)</td>
<td>2 173 082</td>
<td>2.2 (1.2-3.4)</td>
<td>4493</td>
<td>47 373 (26 294-74 537)</td>
<td>10.5 (5.5-15.5)</td>
</tr>
<tr>
<td>San Francisco Bay area (California)</td>
<td>Alameda, Contra Costa, San Francisco, San Mateo, Marin, Santa Clara counties</td>
<td>6 662 454</td>
<td>1.0 (0.3-2.4)</td>
<td>7151</td>
<td>64 626 (22 652-162 564)</td>
<td>9.0 (3.2-22.7)</td>
</tr>
<tr>
<td>Connecticut</td>
<td>Statewide</td>
<td>3 562 989</td>
<td>4.9 (3.6-6.5)</td>
<td>29 287</td>
<td>176 012 (128 624-223 307)</td>
<td>6.0 (4.3-7.8)</td>
</tr>
<tr>
<td>Minneapolis-St Paul-St Cloud metro area (Minnesota)</td>
<td>Anoka, Benton, Carver, Chisago, Dakota, Goodhue, Hennepin, Isanti, Le Sueur, McLeod, Mille Lacs, Ramsey, Rice, Scott, Sherburne, Stearns, Steele, Washington, Wright counties</td>
<td>3 857 479</td>
<td>2.4 (1.0-4.5)</td>
<td>8880</td>
<td>90 651 (37 803-173 587)</td>
<td>10.2 (4.3-19.5)</td>
</tr>
</tbody>
</table>

Havers et al. JAMA Intern Med. 2020, epub ahead of print
Serology studies

Prognosis

Austrian Ski Resort Study Shows Pervasive Coronavirus Spread

By Boris Groendahl
25 June 2020, 09:34 GMT-4  Updated on 25 June 2020, 11:28 GMT-4

- Ischgl, Austria, Ski resort
- Large outbreak with dissemination of cases across Europe in March
- 9 hospital admissions among 1,500 population
- 80% participated in serology testing
- 42% seropositivity
  - 85% of these had no positive NPS done → 6x more
  - ~50% reported symptoms in hindsight

The village of Ischgl on April 23. Photographer: Johann Groele/RFP via Getty Images

Stringhini et al. Lancet. 2020; 396: 313-319
Serology studies

Seroprevalence of anti-SARS-CoV-2 IgG antibodies in Geneva, Switzerland (SEROCoV-POP): a population-based study

– Population-based study
– Planned weekly serosurveys over 12 weeks
– First 5 weeks reported (Apr 6 – May 9)
  (lockdown, schools closed)
– Geneva: >5000 cases / 500,000 population
Serology studies

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Estimated 11.6 infections per confirmed cases

Stringhini et al. Lancet. 2020; 396: 313-319
Serology studies

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Silvio Stringhini; Ari Wisniak; Giovanni Piumatti; Andrew S Azman; Stephen A Lauer; Hélène Boysson; David De Ridder; Dusen Petrovic; Stephanie Schrempt; Kailing Marcus; Sabine Yerly; Isabelle Arm Vernez; Olivia Keiser; Sarnia Hurst; Khara M Ponsfay-Barbe; Didier Trano; Didier Pittet; Laurent Géotaz; François Chappuis; Isabella Eckerle; Nicolas Vailliemier; Benjamin Meyer; Antoine Flahault; Laurent Kaiser; Idris Guessous

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<table>
<thead>
<tr>
<th>Age group, years</th>
<th>SARS-CoV-2 serology test result</th>
<th>Relative risk (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
<td>Indeterminate</td>
</tr>
<tr>
<td>5–9 (n=123)</td>
<td>1 (0.8%)</td>
<td>114 (92.7%)</td>
<td>8 (6.5%)</td>
</tr>
<tr>
<td>10–19 (n=332)</td>
<td>32 (9.6%)</td>
<td>295 (88.9%)</td>
<td>5 (1.5%)</td>
</tr>
<tr>
<td>20–49 (n=1096)</td>
<td>108 (9.9%)</td>
<td>970 (88.5%)</td>
<td>18 (1.6%)</td>
</tr>
<tr>
<td>50–64 (n=846)</td>
<td>63 (7.4%)</td>
<td>772 (91.3%)</td>
<td>11 (1.3%)</td>
</tr>
<tr>
<td>≥65 (n=369)</td>
<td>15 (4.1%)</td>
<td>348 (94.3%)</td>
<td>6 (1.6%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sex</th>
<th>Relative risk (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (n=1454)</td>
<td>101 (6.9%)</td>
<td>1333 (91.7%)</td>
</tr>
<tr>
<td>Male (n=1312)</td>
<td>118 (9.0%)</td>
<td>1166 (88.9%)</td>
</tr>
</tbody>
</table>

Stringhini et al. Lancet. 2020; 396: 313-319
Serology studies

- 64k of planned 150k tested (May/June)
- Lower in kids 0-5 (1.3%) and >85y/o (1.8%)
- 42% positive if positive household member
- x6 higher than expected based on NPS

https://www.slideshare.net/slideistat/primi-risultati-dellindagine-di-sieroprevalenza-sarscov2
Serology studies

FIGURA 3. POPOLAZIONE CON ANTICORPI AL SARS-CoV-2 PER PRESENZA DI SINTOMI DA FEBBRAIO A LUGLIO

- N.R.
- Asintomatici
- 1 o 2 sintomi (a)
- 3 o più sintomi (b)

41,5
27,3
24,7
6,5


https://www.slideshare.net/slideistat/primi-risultati-dellindagine-di-sieroprevalenza-sarscov2
Serology studies

Fewer than 1% of British Columbians had coronavirus by the time restrictions eased in May: study

Low SARS-CoV-2 sero-prevalence based on anonymized residual sero-survey before and after first wave measures in British Columbia, Canada, March-May 2020

Danuta M Skowronski, Inna Sekirov, Suzana Sabaiduc, Macy Zou, Muhammad Morshed, David Lawrence, Kate Snolima, May A Ahmed, Ebers Galais, Mike Fraser, Mayank Singal, Monika Naqvi, David M Patrick, Samantha Kawecki, Christopher Mill, Romina C Reyes, Michael T Kelly, Paul N Levett, Martin Petric, Bonnie Henry, Mel Krajden

doi: https://doi.org/10.1101/2020.07.13.20153148

- Use of residual sera, Greater Vancouver
- Up to end of May 2020
- Age-standardized sero-positivity estimated <1%
- ~8x higher than expected based on NPS
Serology studies

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- Use of residual sera, Greater Vancouver
- Up to end of May 2020
- Age-standardized sero-positivity estimated <1%
- ~8x higher than expected based on NPS
New study offers first glimpse into how widespread COVID-19 antibodies are in Canada’s adult population

Initial results indicate fewer than 1 in 100 blood donations have antibodies to the novel coronavirus that causes COVID-19.

PUBLISHED: 23 JUL 2020

Today, Canadian Blood Services and Canada’s COVID-19 Immunity Task Force (CITF) are releasing initial results of the first 10,000 blood donor samples assessed for SARS-CoV-2 antibodies. This analysis reveals that over the period May 9 through June 8, 2020, fewer than 1 per cent of the 10,000 samples from blood donors tested positive for antibodies to the novel coronavirus. Antibodies indicate past infection with SARS-CoV-2, and population studies like this one tell us how many people have likely been exposed to the virus.
Serology studies

New study offers first glimpse into how COVID-19 antibody tests identify new cases.

- 5-10x more cases identified by serology

Limitations and Unknowns:

- false negatives (low/falling titers, T-cell immunity)
- false positives (low pre-test probability)
- generalizability / representativeness
- duration of protective immunity

This analysis of 10,000 testing samples over the period May 9 through June 8, 2020, found that fewer than 1 per cent of the 10,000 samples from blood donors tested positive for antibodies to the novel coronavirus. Antibodies indicate past infection with SARS-CoV-2, and population studies like this one tell us how many people have likely been exposed to the virus.
CFR and IFR

- **CFR:** Case Fatality ratio (CFR, in%) = \( \frac{\text{Number of deaths from disease}}{\text{Number of confirmed cases of disease}} \times 100 \)

  Proportion of those diagnosed with a disease who die from the disease among detected cases
  - severe cases overrepresented, misses (most) mildly and asymptomatic cases
  - detected cases may subsequently die

- **IFR:** Infection fatality ratio (IFR, in%) = \( \frac{\text{Number of deaths from disease}}{\text{Number of infected individuals}} \times 100 \)

  Proportion of those (estimated to be) infected who die from the disease
  - Based on (estimated) cases that were infected –asymptomatic to severe cases

Case fatality rate of the ongoing COVID-19 pandemic, Aug 4, 2020

The Case Fatality Rate (CFR) is the ratio between confirmed deaths and confirmed cases. During an outbreak of a pandemic the CFR is a poor measure of the mortality risk of the disease. We explain this in detail at OurWorldInData.org/Coronavirus

Source: European CDC – Situation Update Worldwide – Last updated 4 August, 13:26 (London time)
Why the heterogeneity? The same virus after all!

- Transparency/reliability of reporting COVID-deaths
- Population affected (LTCF vs. low risk population)
- Surge of health care system
- Criteria for testing. The more you test → the more mild cases you find → the lower the CFR → and the closer to the IFR you get

**CFR and IFR**

Case fatality rate of the ongoing COVID-19 pandemic, Aug 4, 2020

The Case Fatality Rate (CFR) is the ratio between confirmed deaths and confirmed cases. Since in an outbreak of a pandemic the CFR is a poor measure of the mortality risk of the disease, we introduce the incidence fatality rate (IFR)

OurWorldInData.org/Coronavirus

Source: European CDC – Situation Update Worldwide – Last updated 4 August, 13:26 (London time)
Case fatality rate of the ongoing COVID-19 pandemic, Aug 4, 2020

The Case Fatality Rate (CFR) is the ratio between confirmed deaths and confirmed cases. During an outbreak of a pandemic the CFR is a poor measure of the mortality risk of the disease. We explain this in detail at OurWorldInData.org/Coronavirus

Source: European CDC – Situation Update Worldwide – Last updated 4 August, 13:26 (London time)
CFR and IFR

Serology-informed estimates of SARS-CoV-2 infection fatality risk in Geneva, Switzerland

The infection fatality risk (IFR) is the average number of deaths per infection by a pathogen and is key to characterising the severity of infection.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Population</th>
<th>Seroconverted population as of May 6 (95% CrI)</th>
<th>Deaths as of June 1</th>
<th>IFR (95% CrI), %</th>
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<tbody>
<tr>
<td>5-9 years</td>
<td>26,466</td>
<td>1,200 (400-2,400)</td>
<td>0</td>
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</tr>
<tr>
<td>10-19 years</td>
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<tr>
<td>20-49 years</td>
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<td>28,800 (21,400-37,300)</td>
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<tr>
<td>50-64 years</td>
<td>98,528</td>
<td>10,300 (7,200-13,900)</td>
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<td>≥65 years</td>
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<td>268</td>
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<tr>
<td>All</td>
<td>506,765</td>
<td>54,800 (41,300-70,700)</td>
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CrI = credible interval, IFR = infection fatality risk. SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2. *Of whom approximately 4065 (4.9%) live in assisted care facilities.

Table: Age-stratified estimates of the IFR of SARS-CoV-2 in the canton of Geneva, Switzerland

Lancet Infect Dis 2020
Published Online
July 14, 2020
https://doi.org/10.1016/S1473-3099(20)30584-3

Javier Perez-Saez, Stephen A Lauer, Laurent Kaiser, Simon Regard, Elisabeth Delaporte, Idris Guissous, Silvia Stringhini, Andrew S Azman, for the Serocov-Pop Study Group. azman@jhu.edu
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Questions?
We Appreciate Your Feedback

Please take a few moments following the webinar to complete the evaluation form.

The Survey has also been linked in the chat box prior to the end of the webinar.
An email will be sent to you tomorrow with a survey link.

Accreditation

This activity is eligible for MOC section 1 credits as an unaccredited group learning activity. Please note that unaccredited group learning activities are only eligible for 0.5 credits for every hour of learning, with a maximum of 50 credits per cycle. If you have any questions about how to enter these credits into Mainport, please contact the Royal College Service Centre at cpd@royalcollege.ca
Thank you for joining us!

A recording of all the CUPA-T.E.A webinars are available on the AMMI Canada Website (ammi.ca) under the Clinical Update tab.

Upcoming Events

Stay tuned for more CUPA-T.E.A (Clinical Updates from PHAC and AMMI Canada) in September!