COVID-19 KIDS RESEARCH EVIDENCE UPDATE

WHAT THE MELBOURNE CHILDREN'S CLINICIANS, SCIENTISTS, EPIDEMIOLOGISTS, AND MEDICAL STUDENTS HAVE BEEN READING THIS WEEK

Weekly Update No. 18
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WEEKLY UPDATE NO. 18

GUEST EDITORIAL

Dr Amanda Gwee - The University of Melbourne, Murdoch Children’s Research Institute, Royal Children’s Hospital

The 18th edition of the COVID-19 Kids Evidence Update coincides with the third week of Stage 4 lockdown in Melbourne and, reassuringly, a reduction in the daily number of new COVID-19 cases. We remember the families of the more than 700,000 people who have now lost their lives to COVID-19 around the world, including 421 Australians. Over the last 5 months, the COVID-19 Kids team have continued to provide an excellent summary of all the key literature relating to COVID-19 in children and I thank them for their dedication to rapidly producing this valuable resource.

As this pandemic has progressed, we have seen more paediatric-specific data published, particularly around polarising topics such as the role of children in the transmission of COVID-19. Views on school closures as a strategy to mitigate the spread of SARS-CoV-2 have been divided, given the potential social and economic costs. Also, in contrast to other viral infections such as influenza, the role of children as transmitters of SARS-CoV-2 is unclear. This edition features two small studies on the role of children in COVID-19 transmission that suggest that children are less active transmitters of SARS-CoV-2 infection than adults. One of the featured papers is an epidemiological study of family clusters of COVID-19 in Israel, in a city where children aged between 0 and 19 years comprise half the population. This study found that the first diagnosed family member was the parent in 12 of 13 families and that more adults than children were infected within the families (58.3% adults vs 32.5% children aged ≥5 years vs 11.8% children <5 years). The authors concluded that children were unlikely to be the primary source of infection within the family (see EPIDEMIOLOGY & PUBLIC HEALTH section). Similar results were found in a study of household contact tracing for children with confirmed SARS-CoV-2 infection, where the majority (25/32, 78%) of cases originated in an adult household member. Although these data suggest that children are not active transmitters, we really do not know whether children are transmitting the virus undetected as most COVID-19 cases in children are asymptomatic and in most studies, serology has not been done. The broader benefits of school closure were illustrated in a study in 50 US states that found that school closure was significantly associated with a decline in the incidence and mortality of COVID-19 (https://jamanetwork.com/journals/jama/fullarticle/2769034). However, school closures were implemented alongside other public health strategies so the precise role of school closures in reducing transmission is unknown. The role of children in SARS-CoV-2 transmission urgently needs to be addressed through PCR and antibody testing for both symptomatic and asymptomatic contacts, along with seroprevalence surveys. Further, close monitoring for the short and long-term health impacts of school closure is needed.

This edition also includes two papers highlighting the morbidity associated with the severe, post-infectious inflammatory syndrome known either as Paediatric multisystem inflammatory syndrome temporally associated with COVID-19 (PIMS-TS) or Multisystem Inflammatory Syndrome in Children (MIS-C).
The CDC Morbidity and Mortality Weekly Report (see CLINICAL PAEDIATRICS section) described 570 patients who fulfilled the case definition for MIS-C over a 4-month period. This study highlighted the marked variability in treatment approaches (80.5% IVIG, 62.8% steroids, 22.6% immune modulators) as well as the high morbidity associated with this disease. Notably, 63.9% of patients required admission to ICU and almost one in five patients (18.6%) developing coronary artery dilatation or aneurysm.

This is consistent with rates of coronary artery abnormalities reported in Italy (20%) and France (17%). Another study of 8 children in Pakistan found that 5 developed coronary artery dilatation (see https://www.thelancet.com/journals/lanchi/article/PIIS2352-4642(20)30256-X/fulltext). With no currently registered randomised trials for PIMS-TS, there is an urgent need for a high-quality trial to determine the most effective intervention. The RECOVERY trial in the UK is considering a PIMS-TS specific protocol amendment.

As we continue through this pandemic, it is important to highlight emerging evidence on the negative psychological and physical effects of social isolation. The Royal Children’s Hospital national child health poll led by Dr Anthea Rhodes has recently released the results of their poll studying the effects of COVID-19 on the lives of Australian children and families (see https://www.rchpoll.org.au/polls/covid-19-pandemic-effects-on-the-lives-of-australian-children-and-families/). The poll found that 1 in 3 parents said that COVID-19 had negatively affected their child’s mental health and only 1 in 10 children were getting enough daily exercise during the pandemic. This highlights the importance of staying active, staying connected and supporting the most vulnerable and disadvantaged in our population.

Stay safe and enjoy this edition of the weekly!
HIGHLIGHTS

> The latest Royal Children’s Hospital National Child Health Poll summarises Australian families’ experiences during COVID-19 [https://www.rchpoll.org.au/](https://www.rchpoll.org.au/)

> Similar social factors in US children as in adults lead to an increased risk of contracting COVID-19 and having complications.

> ~50% reduction in overall paediatric presentations to paediatric emergency departments has been seen during the COVID-19 pandemic in Melbourne, but an increase in mental health patients has been seen.

> COVID-19 hospitalisation rates for children in the US found the highest rate was among children aged <2 years.

> Children accounted for a very small proportion of confirmed cases and had very low case-fatality rates (below 0.5%) during the first pandemic peak UK.

> In England, SARS-CoV-2 positivity was low, even in children presenting with acute respiratory infections during the first peak but sero-surveillance needed as only the symptomatic tested.

> 63.9% of 570 children meeting the case definition of MIS-C in the US required ICU admission.

> Children between the ages of six months to two years were described the most difficult to assess and treat whilst wearing a mask, by health practitioners.

> Among women of reproductive age with COVID-19, pregnant women in the Americas were 5.4 times more likely to be hospitalised; 1.5 times more likely to be admitted to the ICU and 1.7 times more likely to receive mechanical ventilation, which has profound implications for low- and middle-income countries were these resources may not be available.

> High proportion of pregnant women in Spain who were seropositive for SARS-CoV-2 were asymptomatic.

> There is an ethical obligation for vaccine research and testing to include pregnant women in order to ensure equal access and distribution to vaccines and therapeutics.

> COVID-19 research in low- and middle-income countries is needed and should be embedded into public health and clinical activities and led by local investigators.

> Viral load is positively associated with mortality in adults.

> Imaging is not a screening tool for diagnosis in children; CXR should be used first if imaging is necessary at all, and CT reserved to assess for complications.

> Despite a high density of children in Bnei Brak, Israel, their role in SARS-CoV-2 transmission was considered to be limited, but serology was not done.

> RT-qPCR testing is of limited value in guiding the duration of home isolation in mild COVID-19.
> A fishing boat outbreak with high attack rates found those with pre-existing neutralising antibodies were asymptomatic and did not test PCR positive suggesting possible protection from re-infection.

> An effective routine immunisation program strengthens the immunisation foundation and will facilitate deployment when COVID-19 vaccines become available.

> Recognition that there are numerous questions that need to be clarified for pregnant women, neonates and children from this pandemic through further longitudinal research.

> Universities should design more aggressive diagnostic procedures and stricter isolation policies given the risk of spread within campuses of SARS-CoV-2.
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Response to COVID-19 and any other medical condition at this time is based on science that is new, often uncertain, subject to change, and dependent on context.

Always seek the advice of your physician or another qualified health provider properly licensed to practice medicine or general healthcare in your jurisdiction concerning any questions you may have regarding any information obtained from this publication.

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SARS-CoV-2 viral load predicts COVID-19 mortality
https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30354-4/fulltext

- Evaluation of viral loads in 1145 symptomatic, hospitalised COVID-19 patients who had complete survival data.
- Epidemiology: Mean age - 64.5 years old; Male – 56.9%.
- Viral loads significantly lower in patients that survived compared to those that died.
  - Survived (n=807): Mean log10 viral load 5.2 copies per mL.
  - Died (n=338): Mean log10 viral load 6.4 copies per mL.
- Cox proportional hazard model adjusted for multiple factors:
  - Independent association between viral load and mortality (HR=1.07, 95% CI 1.03-1.11, p=0.0014).
  - 7% increase in hazard per log-transformed copy per mL.
- Quantitative measurement of viral load may assist clinicians in risk-stratifying patients and choosing among available therapies and trials.

Reviewed by: Dr John Cheek
CLINICAL PAEDIATRICS

Emma Tovey Crutchfield - 3rd Year Medical Student, Department of Paediatrics, The University of Melbourne

Masked paediatricians during the COVID-19 pandemic and communication with children

> Mixed methods analysis on the experience of Israeli paediatric health care workers wearing masks and the perceived difficulty treating or assessing patients. The study includes 356 participants, and the data is stratified according to years of healthcare worker experience and age of their patient.

> The main results of the study are:

- 82% report that masks interrupt their ability to interact with children;
- 63% report that children are more fearful of clinicians wearing masks;
- 59% report challenges assessing and treating children whilst masked;
- Common clinical scenarios where health practitioners felt obliged to remove their mask: breaking bad news, emergency situations, a non-cooperative low-risk patient, patients with special needs and a neurological examination of a patient with a movement disorder;
- Health practitioners with more experience found transitioning to wearing a mask less challenging;
- Practitioners found children between the ages of six months and two years the most difficult to assess and treat whilst wearing a mask.

> The most frequently suggested tools to overcome the challenges of mask-wearing: non-verbal communication strategies, verbal strategies, e.g. humour and tone of voice, and illustrated/clear masks or face shields and verbal humour and tone. The article contends more research into this area is required.

> This study is limited, given it lacks analysis of patients’ or their families’ experience, and there is an unclear risk of sampling bias.

Reviewed: Dr Wonie Uahwatanasakul
Samar Hikmat – 3rd Year Medical Student, Department of Paediatrics, The University of Melbourne

https://www.cdc.gov/mmwr/volumes/69/wr/mm6932e2.htm?s_cid=mm6932e2_e&deliveryName=USCDC_921-DM34906

> Multisystem Inflammatory Syndrome (MIS-C) shares features of Kawasaki disease and toxic shock syndrome and occurs in some children two to four weeks following SARS-CoV-2 infection.

> From March-July 2020, a total of 570 patients met the case definition of MIS-C in the US.

- Demographics:
  - Median age: 8 years (range two weeks to twenty years).
  - 55.4% were male.
  - About 2/3 had no underlying medical conditions before MIS-C onset.

- Three unique classes of patients were identified based on different clinical characteristics.
  - Class 1: 203/570 (35.6%) patients.
    - Cases had manifestations that closely resembled MIS-C with no/little overlap with acute COVID-19 or Kawasaki disease.
    - 99/203 (48.8%) had involvement of ≥6 organ systems; the most commonly affected being: cardiovascular (100%) and gastrointestinal (97.5%).
    - Had a higher prevalence of abdominal pain, shock, myocarditis, lymphopenia, markedly elevated inflammatory markers, troponin, brain natriuretic peptide (BNP), or proBNP.
    - 98% had positive SARS-CoV-2 serology +/- positive SARS-CoV-2 RT-PCR results.
  - Class 2: 169/570 (29.6%) patients
    - Cases had manifestations overlapping with acute COVID-19, indicating either co-existence of acute COVID-19 and MIS-C or isolated severe manifestation of acute COVID-19.
    - The majority had respiratory system involvement manifesting as cough, shortness of breath, pneumonia, acute respiratory distress syndrome.
    - Had the highest rates of death (5.3%).
• Had higher rates (84%) of positive SARS-CoV-2 RT-PCR test results (without seropositivity) compared to the other two classes.

• Class 3: 198/570 (34.7%) patients
  - Cases had less severe MIS-C illness and clinical features overlapping with Kawasaki disease; making it difficult to distinguish from true Kawasaki disease.
  - Had highest prevalence of rash (62.6%) and mucocutaneous lesions (44.9%).
  - 63.1% had only positive SARS-CoV-2 serology. 33.8% had both positive serology and RT-PCR test results.

- Treatment:
  - 527/570 (92.5%) received treatment, including: intravenous immunoglobulin (80.5%), steroids (62.8%), antiplatelet medication (58.6%), anticoagulation medication (44.2%), vasoactive medication (41.9%).
  - 63.9% required ICU admission
  - 10/570 (1.8%) died.

- Conclusion: It is essential to diagnose patients with MIS-C from patients with acute COVID-19 and other inflammatory disorders as early as possible to initiate appropriate management

Reviewed by: Dr Wonie Uahwatanasakul

Rafael Lee - 3rd Year Medical Student, Department of Paediatrics, The University of Melbourne

Hospitalisation rates and characteristics of children aged <18 years hospitalised with laboratory confirmed COVID-19 - COVID-NET, 14 States, March 1st - July 25th, 2020 (report) [https://www.cdc.gov/mmwr/volumes/69/wr/mm6932e3.htm](https://www.cdc.gov/mmwr/volumes/69/wr/mm6932e3.htm)

- The report uses a population-based surveillance network across 14 US states to determine hospitalisation rates and characteristics of COVID-19 positive children aged <18 years old from 1st March - 25th July 2020.

- The primary reported findings from this data include:
  - Rate of paediatric COVID-19 associated hospitalisation was 8 per 100,000 population (compared with the adult rate of 164.5 per 100,000 population).
    • Rates continued to increase throughout the study period.
    • The highest rate was among children aged <2 years (24.8 per 100,000 population), with a large proportion of those admitted less than three months old.
    • Substantially lower rates in children aged 2-4 years and 5-17 years (4.2 and 6.4 per 100,000 population respectively).
Of 208 hospitalised children with completed medical chart reviews:

- 69/208 (33.2%) of children were admitted to an intensive care unit (a similar proportion to that for adults).
- 12/207 (5.8%) of children required invasive mechanical ventilation.
- One child died during hospitalisation.
- The median duration of hospitalisation was 2.5 days (IQR 1-5 days).
- 42% had one or more underlying medical conditions.
  - The most prevalent conditions included obesity (37.8%), chronic lung disease (18.0%), and prematurity (15.4%).
  - Hispanic and Black children had higher prevalences of underlying conditions (45.7% and 29.8% respectively) compared with white children (14.9%).
- Among children who had a chest radiograph during hospitalisation, 44/67 (65.7%) radiographs showed infiltrates or consolidation.
- Among children who had CT results available, 10/14 reported ground-glass opacities.
- Since 18th June, 9/83 (10.8%) children received a diagnosis of multisystem inflammatory syndrome in children.

> Limitations:
- Rates are likely underestimated as confirmation is dependent on clinician-order SARS-CoV-2 molecular testing
- Hospitalisation rates by age are preliminary and may change as additional cases are identified during the surveillance period
- Analysis of interventions, treatments, and outcomes was based on convenience sampling of children with complete chart reviews.
- Data on MIS-C was not collected until 18th June.
- Molecular testing likely underestimates the percentage of MIS-C cases among SARS-CoV-2 infections in children.

> Conclusion:
- It would appear that similar social factors in children as in adults lead to increased risk of contracting COVID-19 and having complications.

Reviewed by: Dr Martin Wright
Intussusception in two children with SARS-CoV-2 infection in children


This case report compared intussusception as likely associated with SARS-CoV-2 infection in two 10-month-old infants that presented in Wuhan and London.

> The Wuhan case presented with symptoms suggestive of intussusception, positive abdominal ultrasound, and later developed respiratory symptoms during hospitalisation.
  - Throat swabs, antibody testing, and rectal swabs tested positive for SARS-CoV-2.
  - Although pneumatic reduction was successfully performed, the infant passed away after succumbing to respiratory and non-respiratory complications.

> The London case involved an otherwise well 10-month old girl who presented with preceding mild respiratory symptoms and features consistent with intussusception (including positive ultrasound).
  - Nasopharyngeal and throat swabs tested positive in SARS-CoV-2.
  - The infant survived following surgical reduction after failed air enema reduction.

> Suggested mechanism:
  - Gut epithelial cells’ infection with local reactive mesenteric adenitis that can trigger intussusception.
    - Angiotensin-converting enzyme 2 (ACE2) receptor is the functional receptor for SARS-CoV-2.
    - The ACE2 protein is expressed on the surface of enterocytes in the small intestine.
    - This may allow the gut to be an important entry site for SARS-CoV-2.
    - However, there is still no evidence of viral replication in gut epithelial cells.
    - Mesenteric adenitis secondary to upper respiratory tract infection with SARS-CoV-2.

> Implications: as with other viruses that can have both respiratory and gastrointestinal manifestations, SARS-CoV-2 infection can be associated with intussusception.

Reviewed by: Dr Martin Wright
Sophia Moshegov - 3rd Year Medical Student, Department of Paediatrics, The University of Melbourne

Multisystem Inflammatory Syndrome associated with COVID-19 in children in Pakistan
https://www.thelancet.com/journals/lanchi/article/PIIS2352-4642(20)30256-X/fulltext

Correspondence reporting just eight paediatric cases from Pakistan of Multisystem Inflammatory Syndrome in Children (MIS-C) also known as Paediatric Inflammatory Multisystem Syndrome Temporally associated with Severe acute respiratory syndrome coronavirus 2 (PIMS-TS) between 15th May and 30th June, 2020.

> Six children presented sub-acutely, resembling Kawasaki disease, with no signs of myocardial dysfunction.

> Two children presented with shock or low cardiac output, one of which died from multiorgan failure.

> Coronary artery dilatation seen in five of the eight children, including both children who presented with shock.

> Management: Seven received intravenous immunoglobulin within two days of admission, and three received enoxaparin.

> Seven discharged, one inpatient death.

> Finding highlighted and compared with previous publications:

- The high proportion with coronary artery involvement compares to 20% in Italy, 17% in France, 9% in USA.

- The variable spectrum between settings: Kawasaki disease-like features predominant in Italian case series while relatively more of the acute presentation with shock reported from France and UK.

- Concerns about coronary artery dilatation in the context of challenges for follow-up monitoring.

> Limitations: case series with small numbers and a number of reasons why this may not be representative of the wider spectrum occurring in Pakistan or elsewhere.

Reviewed by: Professor Steve Graham
Emergency department utilisation by vulnerable paediatric populations during the COVID-19 pandemic


> International data suggest a decrease in paediatric ED usage during the COVID-19 pandemic.

> On the other hand, with the closure of some community services, it is possible that some vulnerable groups have no alternative but to seek care in the ED.

> Analysis of emergency presentations of children (<18 years) to four ED services in Victoria: two central/tertiary (RCH and Monash Children’s) and two district/secondary care level (Casey and Dandenong).

> Measured over the two month period from March to May 2020 and compare to the same period in 2019.

> Findings from four EDs in 2020 during the COVID-19 pandemic:

- Overall presentations: significant and large reduction by 47% (26,871 in 2019 vs 14,170 total presentations in 2020), with a significant difference in daily means (440.5 vs 232.3, P < 0.001).

- Conversely, there was a 35% increase (485 in 2019 vs 656 in 2020) in mental health patients (daily means 8.0 vs 10.8, P < 0.001).

- Neonatal presentations did not change significantly (2% increase, 498 vs 507; daily means 8.2 vs 8.3, P = 0.75).

- The numbers of mental health and neonatal presentations are small but have not decreased in line with other presentations.

- Uncertainty over types of presentations reduced - non-severe vs severe - and of the impact of COVID-related public health measures on the community incidence of certain, common illnesses such as acute respiratory infections and non-specific febrile illness in infants and children.

> The authors highlight concerns that community care for vulnerable patient groups is an essential health service, and that face-to-face access should continue during a pandemic (with appropriate patient screening and use of personal protective equipment).

Reviewed by: Professor Steve Graham
EPIEDEMILOGY & PUBLIC HEALTH

Professor Fiona Russell - Director of Child and Adolescent PhD Program, Department of Paediatrics, the University of Melbourne; Group Leader Asia-Pacific Health Research, MCRI

RCH National Child Health Poll - COVID-19 pandemic: effects on the lives of Australian children and families
https://www.rchpoll.org.au/

> The latest RCH Melbourne Child Health poll using a nationally representative summarises what families are experiencing during the pandemic.

> Despite the hardships, the majority of Australian families report their family unit is more connected, spent more time together and used their time at home to consider what's important in life.

> Almost half of the parents (42%) say they are now more connected to their child, with most having spent more time reading (51%) and playing games (68%) together, and 66% have developed new positive family habits since COVID-19.

> Children spent more time on screens for entertainment (51%), spent less time being physically active (42%) and ate more unhealthy food (25%) during the pandemic. Only 10% children got enough exercise each day.

> Majority of children (78%) utilising digital media stay connected with their friends and extended family. 75% said their child was able to learn well remotely using digital devices.

> 70% of parents tried harder than usual to feed their children healthy food and taught children cooking skills, with 63% of children being more involved in preparation of food at home.

> Parents are spending more time with their child reading books, playing games or exercising, which are some of the best ways to create positive relationships, and these activities also come with benefits for both physical and mental health.

> 20% of children who became unwell or injured since the onset of the pandemic, 31% had healthcare delayed or avoided by parents.

> Reasons for this included parents being concerned that their child might catch COVID-19 (59%), wanting to follow government advice to stay home (38%) and not wanting to burden the hospital or GP during the pandemic (28%).

> Important that parents are reassured that healthcare services, including hospitals and GPs, are safe places.
The pandemic has negatively impacted the mental health of both parents (48%) and children (36%).
- Loneliness was a common experience for both parents and children and strongly linked to a negative mental health impact.

Dan Lindholm - 4th Year Medical Student, Department of Paediatrics, The University of Melbourne

How to set up government-led national hygiene communication campaigns to combat COVID-19: a strategic blueprint
https://gh.bmj.com/content/5/8/e002780

- This article offers a blueprint for national governments to develop large-scale public health communication campaigns in the context of COVID-19.
- Authors detail ten steps to develop a national behaviour change communications strategy for the prevention of COVID-19 transmission. These include:
  - Setting up a task force with an appointed leader to champion and coordinate the planning. The authors mention the Swaach Bharat Mission in India, which successfully modelled this approach.
  - Mobilise resources, including the involvement of the private sector. Authors discuss the National Business Compact in Kenya as a strong example of government and business partners collaborating on COVID-19.
  - Define exactly which behaviours must be changed - the authors emphasise hand-hygiene and social distancing.
  - Review already existing local and international strategies. Authors provide links to some reliable resources to help with this.
  - Examine the drivers of these behaviours and rapidly fill knowledge-gaps. For example, much is known about the drivers of poor hand-hygiene, but little is known about the drivers of social distancing.
  - Produce a creative brief and theory of change, which details how this change can be achieved. The authors offer some basic principles of successful communication strategies here.
  - Develop a unifying national brand, including a tagline and a logo. The New Zealand government’s COVID-19 brand is lauded as effective branding.
  - Media specifically designed for COVID-19 response and the use of the most relevant channels for target audiences to deliver public health messages.
  - Rapid pre-testing of messages with samples of a target audience, with ongoing revision and refreshing of materials.
  - Monitor and evaluate the effects of communication strategies and share lessons learnt with others.

Reviewed by: Dr Claire von Mollendorf
Batsho Mandlebe - 3rd Year Medical Student, Department of Paediatrics The University of Melbourne

The role of children in the dynamics of intra-family coronavirus 2019 spread in densely populated area

Although children are thought to be less implicated in SARS-CoV-2 transmission, school closures have been implemented across the world as a way to curtail the spread of COVID-19.

- This study examined the role of children in the transmission of COVID-19 amongst 13 identified family clusters living in the crowded city of Bnei Brak in Israel (a city where the average number of children in a household is 4.57 and children 0-19 years making up 50% of its 200,000 population).

- PCR testing was conducted on all family members.

- SARS-CoV-2 positive PCR in different age groups:
  - 21/36 (58.3%) adults >18 years vs 13/40 (32.5%) children 5-17 years, p = 0.037, RR: 0.61 and 95% CI: 0.39-0.9.
  - 21/36 (58.3%) adults vs 2/18 (11.8%) children 0-4 years p <0.002, RR: 0.47 and 95% CI 0.30-0.71.
  - In 12/13 families, the first diagnosed member was an adult parent.

- This study suggests that despite a high density of children in Bnei Brak, their role in SARS-CoV-2 transmission is limited and thus supports the emerging data that has implied the same conclusion. However, serology was not done, and as children are often asymptomatic, they may become infected and have cleared the virus before testing.

- Limitations – nasopharyngeal sampling may have been conducted before or after infection. Rates of false negative and false positives are unknown. The first diagnosed in each family is the first with symptoms but may not be the first infected.

Reviewed by: Dr Mandie Griffiths and Professor Fiona Russell
Nicholas Wu – 3rd Year Medical Student, Department of Paediatrics, The University of Melbourne

Containing the Spread of Infectious Disease on College Campuses (not peer reviewed)
https://www.medrxiv.org/content/10.1101/2020.07.31.20166348v1

Colleges are highly vulnerable to infectious disease outbreaks. There is a need to develop strategies that best mitigate an outbreak as colleges consider reopening safely during the COVID-19 pandemic.

This study applied a modified stochastic susceptible-exposed-infectious-recovered (SEIR) model to quantify the impact of both Harvard University (HU)’s and Ohio State University (OSU)’s responses to mumps outbreaks in 2016 and 2014, respectively, and determine which interventions were most effective.

At HU, between 1st January and 31st August 2016, there were 189 confirmed and probable cases. HU implemented three main interventions: (i) an email awareness campaign, (ii) more aggressive diagnoses with anyone displaying clinical symptoms quarantined, (iii) strict isolation of all suspected cases.

At OSU, between week 1 and 40 of 2014, there were 528 cases (case numbers for central Ohio but most linked to OSU). OSU implemented one main intervention: (i) advised self-isolation for students who presented with symptoms.

Results:
- There was very good agreement between the observed cases and simulated outbreaks using optimal parameters:
  - Maximum likelihood estimates for HU showed a relatively high baseline removal rate (gH) of 0.85 (95% CI = 0.86-0.93) that further increased by 2.8 (95% CI = 2.16-2.56) after day 61, following the implementation of intervention (ii) more aggressive diagnoses. The reporting rate (rH) was also remarkably high at 0.97 (95% CI = 0.93-0.97).
  - Maximum likelihood estimates for OSU showed an initial effective reproduction number (RE) of 5.95, much higher than HU, which eventually decreased to 0.95 after the implementation of intervention (i) advisories.

- An intervention analysis was performed, quantifying the effect of the assumed defining intervention at HU (i.e. (ii) more aggressive diagnoses) on day 61 and at OSU (i.e. (i) advisories) in week 12 of 2014.
  - For HU, simulations without the defining intervention yielded an outbreak four times the size of the actual outbreak. By varying the day of the intervention from 1 to 61, a linear regression (R2=0.96, p<10^-9) between the day of intervention and reduction of the outbreak was obtained. If the defining intervention was implemented in the first ten days of the outbreak, less than 50 students in total would have been infected.
For OSU, simulations without the defining intervention in week 12 of 2014 yielded an outbreak twice the size of the actual outbreak. The outbreak size as a function of the intervention week showed a strong dependency - best fitted with a sigmoid function ($R^2 = 0.63$, $p < 0.005$). If the defining intervention was implemented in either week 5 or 6 of 2014, it is likely that the outbreak would have been eradicated.

This study suggests that:

- Universities should design more aggressive diagnostic procedures and stricter isolation policies that deem any student with any symptoms of the disease to be infected and infectious, and that require these students to isolate.

- Universities should design effective awareness campaigns that lead to self-isolation of infected students with mild symptoms.

- There is quantitative backing for more immediate and less costly approaches to mitigating the spread of infectious diseases, most notably COVID-19.

- The stochastic SEIR model can be applied to data from other outbreaks in college campuses and small-population settings.

Limitations:

- There are confounding factors that cannot be controlled for (e.g. the HU outbreak subsided in late April, not long before students finished the semester and left campus, potentially decreasing infections).

- OSU data consisted of weekly rather than daily reports. Also, not all cases of mumps were solely linked to OSU with numerous cases reported in the surrounding areas.

- HU is a primarily residential college that is a third of the size of OSU, which is a primarily non-residential college.

- There was direct access to HU administrators to discuss their interventions, but the same level of detail was not available for OSU.

Reviewed by: Dr Claire von Mollendorf
COVID-19 in children: analysis of the first pandemic peak in England
https://adc.bmj.com/content/archdischild/early/2020/07/28/archdischild-2020-320042.full.pdf

> With nearly half a million SARS-CoV-2 tests performed during the first four months of 2020, the positivity rate among 35,200 children tested was only 4.0% compared with 19.1%–34.9% in adults and older adults.

> Children account for a very small proportion of confirmed cases and have very low case-fatality rates (below 0.5%).

> In the community, SARS-CoV-2 positivity was low even in children presenting with acute respiratory infections.

> Community transmission and sero-surveillance will become increasingly important as lockdown measures are gradually eased.

Reviewed by Dr Wonie Uahwatanasakul

Burden of illness in households with SARS-CoV-2 infected children (pre-print, accepted manuscript)

> Analysis of a prospective registry of laboratory-confirmed paediatric COVID-19 cases attending a healthcare provider in USA with symptoms concerning for COVID-19 between 16th March and 14th June, and conducted contact tracing of household members to characterise transmission before and after the child’s diagnosis.

> Of 132 children identified, 32 were evaluated.

> Although the majority of cases originated in an adult household member, seven cases (22%) of presumed child-to-adult transmission were identified in this cohort. This is higher than previously described.

> Children were symptomatic for at least four days before seeking care, the period when they were most likely to be infectious to other household members.

> Limitations: Small cohort of symptomatic patients attending a single hospital system, of which only a fraction were analysed; relied on parent interview and symptom-based diagnosis, with no confirmatory testing of contacts; underestimate of true attack rate as only those with symptoms included and no serology undertaken on contacts.

Reviewed by: Dr Martin Wright and Professor Fiona Russell
The need for COVID-19 research in low- and middle-income countries (commentary)

Research needed urgently in three broad areas to inform the response to SARS-CoV-2 in low and middle-income countries:

- Transmission patterns of SARS-CoV-2 in resource-poor settings.
- Clinical characteristics of COVID-19 and how disease severity in low- and middle-income countries and vulnerable populations differ from observations elsewhere.
- Impact of pandemic prevention and response measures on the health and wellbeing of individuals and communities in low- and middle-income countries and how to implement physical distancing policies in these settings.

Other recommendations:

- A ‘one health’ approach to research will also help prevent or mitigate future pandemics.
- Research should be embedded into public health and clinical activities so as to not compete for limited resources.
- Independent ethics committees in low- and middle-income countries will need to be strengthened.
- Research should be initiated and led by local investigators, but international cooperation and additional funding is required

Reviewed by: Professor Fiona Russell

WHO situation report 209
https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200816-covid-19-sitrep-209.pdf?sfvrsn=5dde1ca2_2

Burnet COVID-19 Global Trends & Analyses: August update 1

Adolescent experiences of COVID-19
https://www.gageodi.org/adolescent-experiences-of-covid-19/
IMAGING

Benjamin Watson – 4th Year Medical Student &
Natalie Commins - 3rd Year Medical Student, Department of
Paediatrics, The University of Melbourne


> Summary of clinical and imaging findings in children who tested positive on PCR for SARS-CoV-2 and evaluation of the necessity of chest imaging in the use of COVID-19 diagnosis.

> Most children had mild symptoms (fever and cough primarily); one third had coexisting medical conditions; 11% had severe symptoms and required Intensive Care.

> Chest radiographs were performed on 89% of patients, and 10% of these were normal.

> Abnormal chest radiographs demonstrated (primarily): perihilar peribronchial wall thickening (58%), and/or air space consolidation (35%).

> CT scans were performed in 21/24 (26%) cases, 8% normal with the most common abnormality being ground glass opacities (88%) predominantly lower lobes and/or consolidation (58%); linear opacities (33%), nodules (25%), tree in bud (25%), lymphadenopathy (17%), vascular engorgement (13%), crazy paving (8%).

> Unlike the previous series - 90% of this cohort had CXR abnormality, possibly because radiologists in other studies were inexperienced or because 93% of children in this cohort were symptomatic.

> ICU patients may have additional features due to septic shock or multisystem organ failure on CT.

> Limitations: multicentre retrospective, heterogeneous data, different CT protocols and only selected images submitted, different quality CXR and CTs, lack of good clinical correlation, concurrent bacterial or viral infections could confound imaging appearance.

> Imaging is not a screening tool for diagnosis in children; CXR should be used first if imaging necessary and CT reserved to assess for complications especially if coexisting medical conditions.

Reviewed by: A.Prof S. Mandelstam
IMMUNOCOMPROMISED / CANCER

Batsho Mandlebe - 3rd Year Medical Student, Department of Paediatrics, The University of Melbourne

Managing cancer patients during the COVID-19 pandemic: an ESMO interdisciplinary expert consensus

https://www.annalsofoncology.org/article/S0923-7534(20)39948-8/fulltext

To minimise the risk of contracting SARS-CoV-2 and its elevated morbidity and mortality risk in cancer patients, an international consortium reviewed existing literature. It sought clinical opinion to address questions regarding the optimisation of multidisciplinary cancer care delivery and improvement of clinical outcomes during the COVID-19 pandemic. The following 28 recommendations were made:

> Strategies for patient management and follow up: face-to-face consultations must be reserved for patients receiving key cancer-related information or those with complex cancer. One support person should be allowed (1).

> Prevention of SARS-CoV-2 infection in cancer patients and prioritisation of cancer care.

- The intensity of cancer therapy should be tailored to the local R\textsubscript{0} index and availability of hospital technical and human resources including ICU ventilation capacity (2).

- SARS-CoV-2 testing must be done for all hospital admitted cancer patients and a COVID symptom screen for those attending outpatient clinics (3). Those testing positive should be isolated or sent home (4). Similarly, healthcare staff should all wear personal protective equipment, including eye protection, a gown and a surgical mask (5).

> GCSF use and thromboprophylaxis in cancer patient during the COVID-19 pandemic: benefits, risks, impacts in COVID- and COVID+ cancer patients: Granulocyte-colony stimulating factors (G-CSF) may be considered in patients at intermediate or high risk of febrile neutropenia, and thromboprophylaxis with LMWH or NOACs is recommended (6,7).

> COVID testing: whom, when and how (PCR, serology): Real-time PCR is the recommended diagnostic tool for SARS-CoV-2 RNA detection (8). IgM and/or IgG cannot replace SARS-CoV-2 nucleic acid testing (9). The virus in different body fluids, secretion and excreta imply the patient is infective; however, we longitudinal studies (10).

> Use of immunotherapy:

- Do not withhold or delay (neo) adjuvant immune checkpoint inhibitors where significant survival benefit is documented unless the patient is SARS-CoV-2 positive (11). This recommendation also extends to patients with particular subset cancers that have shown clear survival benefit (12).
- Avoid high dose steroids in SARS-CoV-2 positive cancer patients and consider the switch to another immunosuppressant (13). Administer anti-CTLA-4 and anti-PD-(L)1 checkpoint inhibitor where indicated subject to local COVID-19 prevalence (14).

- Patients with radiological evidence of pneumonitis/pulmonary abnormalities/dyspnoea while on immune checkpoint inhibitors should receive a nasopharyngeal swab for PCR of SARS-CoV-2 RNA testing and a high-resolution CT scan. If negative, Broncho-Alveolar Lavage should be considered. (15)

> Use of targeted TKI therapies:

- The decision to continue or withhold tyrosine kinase inhibitors (TKIs) of the PI3K/AKT/mTOR or RAS/RAF/MEK axis due to their inference in the innate and adaptive pathway during the COVID-19 pandemic should be determined by the tumour specific context (16).

- TKI therapy can be withheld if the patient has an oncologically stable disease but may be continued in patients with less severe COVID-19 and those with a tumour with a high-risk of flare if TKI is ceased (17).

> Implementation of neo-adjuvant chemotherapy, with prioritisation of adjuvant therapies for:

- Breast cancer – follow management guidelines in a curative setting, avoid delays and provide adequate PPE (18).

- Lung cancer (stage III-III non-small cell lung cancer) – adjuvant chemotherapy is recommended for fit, young patients. Neoadjuvant chemotherapy, followed by surgery, may be considered for a highly selected subset of patients (19).

- Rectal cancer – consider short-course preoperative radiation therapy (5 x5Gy) rather than standard long-course chemoradiation schedules (20).

> Radiation strategies during COVID pandemic:

- Consider the reduction of RT fractionation for patients undergoing adjuvant or definitive lung radiotherapy to minimise severe complications from COVID-19 due to frequent hospital attendance and risks from treatment (21).

- If a lung cancer patient is diagnosed with COVID-19, a continuation of curative intent thoracic radiotherapy is recommended subject to the severity of COVID-19 clinical syndrome and risk of tumour recurrence or progression consideration (22).

> Prioritisation of cancer care and ICU:

- Active and progressing cancer, co-morbidities and administration of cytotoxic chemotherapy increases the severity and mortality of COVID-19 (23).

- Intensive care unit access for cancer patients is dependent on ICU response strain and the ethical value of maximising the number of COVID survivors. Note: staging and specific diagnosis cannot predict survival of concurrent severe acute COVID-19 (24).
Clinical trial activities in the COVID-19 era:

- Risk/benefit balance for the inclusion of cancer patients in clinical trials is subject to local R0 index and caseload of the pandemic determined by the clinical trial sponsor updated risk assessment (25).

- Deviations from clinical trial protocols during the COVID-19 pandemic must be meticulously documented and reported to the sponsor as soon as possible. No deviations in safety reporting will be acceptable (26).

- Lobbying and promotion of clinical cancer research may continue during the SARS-CoV-2 pandemic (27).

- Clinical trials must be ranked in terms of their value for the most appropriate clinical research (28).

Reviewed by: Professor Michael Sullivan
PERINATAL HEALTH

Jenny Pham - 4th Year Medical Student, Department of Paediatrics, The University of Melbourne

Clarifying the sweeping consequences of COVID-19 in pregnant women, newborns, and children with existing cohorts (Viewpoint)
https://jamanetwork.com/journals/jamapediatrics/fullarticle/2769285

> Whilst SARS-CoV-2 has lower rates of maternal and neonatal complications and lower mortality rates in young adults; it is more prevalent and infectious compared with the 2003 SARS.

> There are numerous questions that need to be clarified for us to learn from this pandemic:
  - True incidence amongst pregnant women, including those who are asymptomatic.
  - Vertical transmission of the virus, production and protectiveness of maternally-derived antibodies on the neonate.
  - Breastfeeding recommendations - harm of poor bonding and lactation versus potential transmission of the virus.
  - Long-term outcomes of infection on foetal and child development.
  - Long-term impacts on the health system and how this will impact on antenatal care and screening, perinatal outcomes including psychosocial issues.

> To answer these questions, a large, longitudinal, population-based study assessing outcomes of perinatal outcomes of mothers and neonates needs to be established with appropriate biological sample collection. Such a review would need to reflect the changes in social behaviour in the setting of the pandemic, involve innovation in self-collection of biological samples and IT platforms to follow participants and obtain meaningful data.

> Piggybacking on existing large international birth cohorts and adding in COVID-19 would be appropriate and ideal.

Reviewed by: Prof Suzanne M Garland
Epidemiological Alert COVID-19 during pregnancy

> Compared to non-pregnant women, pregnant women are at a higher risk of developing a severe form of COVID-19, thereby requiring hospitalisations or ICU admissions.

> Data were based on and limited to regions of the Americas.
  - Among women of reproductive age with COVID-19, pregnant women were
    - 5.4 times more likely to be hospitalised.
    - 1.5 times more likely to be admitted to the ICU.
    - 1.7 times more likely to receive mechanical ventilation.
  - Pregnant women in their third trimester have the highest rate of symptomatic infection, hospitalisation and death compared to those in first and second trimesters.
  - In Brazil, most COVID-19 related deaths among pregnant women were reported between the age of 30-39 years, followed by the age of 20-29 years.
  - Common co-morbidities identified amongst the deaths were diabetes, heart disease, obesity, hypertension and asthma.

> PAHO/WHO highlighted the need
  - To address specific risks and vulnerabilities faced by pregnant women;
    - To ensure the continuity of prenatal care services (currently hindered by public health restrictions and closure of some centres);
    - To timely identify and manage severe presentations. Achieved by maintaining communication with pregnant women to allow virtual, face-to-face, or home check-ups in cases of emergencies.

> These findings are particularly concerning for settings whereby oxygen is not available, and co-morbidities in pregnancy are high especially small island populations in the Pacific and Caribbean.

Reviewed by: Professor Fiona Russell
Seroprevalence and presentation of SARS-CoV-2 in pregnancy
https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)31714-1/fulltext

- 874 pregnant women consecutively attending first-trimester screening or delivery from 14th April – 5th May 2020 at three hospitals in Barcelona, Spain were tested for anti-SARS-CoV-2 antibodies.

- Anti-SARS-CoV-2 antibody-positive - 14% (125 of 874).
  - By trimester: First trimester - 15% (54 of 372); Third trimester - 14% (71 of 502).
  - By symptoms: No previous symptoms – 60% (75 of 125); ≥1 symptom – 40% (50 of 125).
  - Admitted to hospital for persistent fever and dyspnoea: 6% (7 of 125).
  - Symptomatic infection, hospital admission, and dyspnoea significantly more prevalent in the third trimester compared to the first trimester of pregnancy.

- Substantially higher prevalence of SARS-CoV-2 in pregnant women than reported PCR positivity in other studies (14% vs 0.78% respectively).

- Authors concluded COVID-19 commonly asymptomatic in pregnant women.

- Increased surveillance may be required in late pregnancy compared to early in pregnancy.

- In this cohort, samples of serum and peripheral blood mononuclear cells have been obtained and stored at biobanks for future studies for complementary immunological tests. Long-term follow-up of the infants is also underway as SARS-CoV-2 is potentially neurotropic.

- Further research is required into these findings.

Reviewed by: Prof Suzanne M Garland
**Neutalising antibodies correlate with protection from SARS-CoV-2 in humans during a fishery vessel outbreak with high attack rate (not peer reviewed)**

[https://www.medrxiv.org/content/10.1101/2020.08.13.20173161v1.full.pdf+html](https://www.medrxiv.org/content/10.1101/2020.08.13.20173161v1.full.pdf+html)

- 122 fisherman all tested by PCR and serology pre-departure.
- The outbreak had high attack rates (85%) based on PCR and serology in 120/122.
- Three who had pre-existing neutralising antibodies were asymptomatic and did not test PCR positive.
- Findings suggest the presence of neutralising antibodies from prior infection provides protection against re-infection.

**Duration of SARS-CoV-2 RNA detection in COVID-19 patients in home isolation, Rhineland-Palatinate, Germany, 2020 - an interval-censored survival analysis**

[https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.30.2001292](https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.30.2001292)

- This study examined the RT-qPCR results of upper respiratory tract samples from 537 symptomatic SARS-CoV-2 positive patients who were in-home quarantine at two, three and four weeks after symptom onset.
- Equivocal RT-qPCR results were considered as positive for the analysis.
- 50%, 25%, and 10% of patients were still positive for SARS-CoV-2 RNA at two, three and four weeks respectively after symptom onset.
  - At 14 days after symptom onset, the typical isolation period, 53.5% of COVID-19 patients still had detectable SARS-CoV-2 RNA.
  - The median time to first negative test 20.0 days (IQR 16.0-28.0); median duration 14.96 days (95% CI: 13.01-16.90) using interval-censored survival analysis.
  - Previous studies have suggested the period of infectivity of SARS-CoV-2 is approximately eight days after symptom onset; 78% of study participants in home isolation remained RT-qPCR positive beyond day eight after symptom onset suggesting that detectable SARS-CoV-2 RNA does not infer infectivity.
The authors concluded that RT-qPCR testing is of limited value in guiding the duration of home isolation in mild COVID-19.

- The use of fixed periods, based on sound estimates of the infectious period, are more appropriate in guiding the duration of containment measures than laboratory-based approaches.
- RT-qPCR-guided containment may lead to additional costs through prolonged periods of isolation and repeated sampling and increases the individual and social burden of the current epidemic.

Reviewed by: Dr Samantha Bannister

**Evelyn Andrews** – 4th Year Medical Student, Department of Paediatrics, The University of Melbourne

**SARS-CoV-2 and the role of orofecal transmission: evidence brief**

https://www.cebm.net/covid-19/sars-cov-2-orofecal-transmission/

- A review of 58 studies examining the potential role of orofaecal transmission of SARS-CoV-2.
- Based on the review of 29 studies, the prevalence of gastrointestinal (GI) symptoms in SARS-CoV-2 positive patients is approximately 12%.
- Patients with GI symptoms have a longer duration between symptom onset and viral clearance, and are more likely to be faecal virus positive (73% vs 14%, p=0.033), compared with those without GI symptoms.
- Many studies have identified SARS-CoV-2 RNA in faeces. Of 540 patients tested for faecal viral RNA, 291 (54%) had positive faecal RT-PCR tests. Whether the virus shed in stools is viable, and hence infective, is unclear. Only three studies reported finding the live virus in faeces, in a total of four patients.
- Faecal shedding of SARS-CoV-2 seems to continue long after respiratory shedding has ceased. Several studies reported positive faecal samples after nasopharyngeal and sputum samples became negative. In one study, the duration of faecal shedding after clearance from respiratory samples ranged from 1 to 33 days.
- SARS-CoV-2 may infect the GI tract by binding the ACE2 protein – a known cell receptor for the virus – to gain entry into gastric, duodenal and rectal glandular epithelial cells. The finding of viral nucleocapsid protein in the rectum also suggests that the virus is capable of surviving the acidic gastrointestinal environment.
- Super-spreading events (such as on cruise ships), and the environmental concentration of SARS-CoV-2 in the toilets of hospitalised patients, may also support orofaecal transmission.
- Sentinel surveillance of wastewater has detected SARS-CoV-2 RNA in multiple settings including the Netherlands, Spain and Italy, with wastewater testing positive in some cases prior to the first detection of known cases in the region.
- Conclusion: various observational and mechanistic evidence supports the hypothesis that SARS-CoV-2 can infect and be shed from the human gastrointestinal tract.

Reviewed by: Dr Celeste Donato
VACCINES

Alastair Weng – 3rd Year Medical Student, Department of Paediatrics, The University of Melbourne

Inclusion of pregnant women in COVID-19 vaccine development
https://www.thelancet.com/action/showPdf?pii=S1473-3099%2820%2930638-1

> The authors highlight the importance of an inclusive population for vaccine trials.
> Although previous coronaviruses have demonstrated severe consequences in pregnant women, the evidence for COVID-19 is still scarce.
> Higher proportions of COVID-19 positive women had preterm births (22%), Caesarean section (48%), and ICU admission (7%). There is not much evidence regarding miscarriage, IUGR, congenital abnormalities, and long-term outcomes.
> There is an ethical obligation for vaccine research and testing to include pregnant women in order to ensure equal access and distribution.
> More data is needed regarding the short and long-term burden of COVID-19 in pregnancy, willingness to participate in trials, and suitable vaccine candidates.

Reviewed by: Professor Fiona Russell

Rose Noble Kizhakekara - 3rd Year Medical Student, Department of Paediatrics, The University of Melbourne

COVID-19 and missed routine immunisations: designing for effective catch-up in Canada
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7408971/

> The COVID-19 pandemic has caused disruptions to routine immunisation programs across the globe and in Canada, which can lead to severe vaccine-preventable disease outbreaks.
> The authors outline three components of designing effective vaccine catch-up programs in Canada.
> Firstly, identify who has been missed:
  - Use data triangulation of public health and school registries as well as physician, clinic, pharmacy, and hospital records. Actively seek those missing from the collected data.
  - Employ public health messaging to raise awareness of the importance of routine immunisations across the life course, from infants to adults, even during the current pandemic.
Secondly, detect delivery gaps, adapt, and adjust, and develop multi-pronged tailored strategies for catch-up:

- Make routine immunisations more accessible by adjusting sites (e.g. in pharmacies or specialised catch-up clinics) and times (e.g. anytime the patient encounters a healthcare service).
- Ensure adequate physical distancing and infection control measures to minimise COVID-19 spread in all settings of immunisation.
- Particularly, the Canadian 2020/2021 fall school immunisation programs will have overlapping cohorts due to school closures; thus, they need to be carefully designed.

Thirdly, communicate, document, evaluate and readjust:

- Use age-group tailored communication about the importance of vaccination, including uptake of the influenza vaccine during this time. Consistent and clear messages from scientists, healthcare providers and public health actors are needed.
- Ensuring transparency and trust with the public is key.
- Follow-up and evaluate the success of the catch-up program.

An effective and robust routine immunisation program strengthens the immunisation foundation and will facilitate deployment for when COVID-19 vaccines become available.

Reviewed by: A/Prof Margie Danchin
OTHER RESOURCES

Burnet Institute research findings, policy and technical reports
https://www.burnet.edu.au/covid-19//36_know_c19_hub

National COVID-19 clinical evidence taskforce: continually updated evidence-based clinical guidelines
https://covid19evidence.net.au/

Lancet COVID-19 papers

Focuses on paediatric clinical, epidemiological, transmission and neonatal aspects

All COVID-19 literature

Oxford COVID-19 Evidence Service
https://www.cebm.net/oxford-covid-19/

Daily updates on COVID-19 literature compiled by Canadian medical students
https://docs.google.com/forms/u/0/d/e/1FAIpQLSIOzCoAuLV0a.js2uWV7r3FaPoZAOIr86d9XBCcT21QcCE_Nw/formResponse

Victorian Department of Health and Human Services

Australian Government

COVID-19 and the kidney, which is currently the recommended US resource
http://www.nephjc.com/covid19

University of Birmingham COVID-19 Research Briefing

Australian Government Department of Health Webinars on the COVID-19 response for primary care practitioners

Global summary, identifying changes in the reproduction number, rate of spread, and doubling time during the COVID-19 outbreak whilst accounting for potential biases due to delays in case reporting both nationally and sub-nationally
https://epiforecasts.io/covid/posts/global/

WHO Rolling updates on COVID-19

Scimex.org – breaking science news portal: COVID-19 stories (research and expert commentary)
https://www.covid19-hpc-consortium.org/

Introduction to Coronavirus: free, online course aimed at teenagers and young adults: scientists and experts from the London School of Hygiene & Tropical Medicine explain research to understand the virus and guide the global response to Coronavirus
https://www.open.edu/openlearncreate/course/view.php?id=5319
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