2020 bush-fires and COVID-19: what does it mean for our respiratory system?

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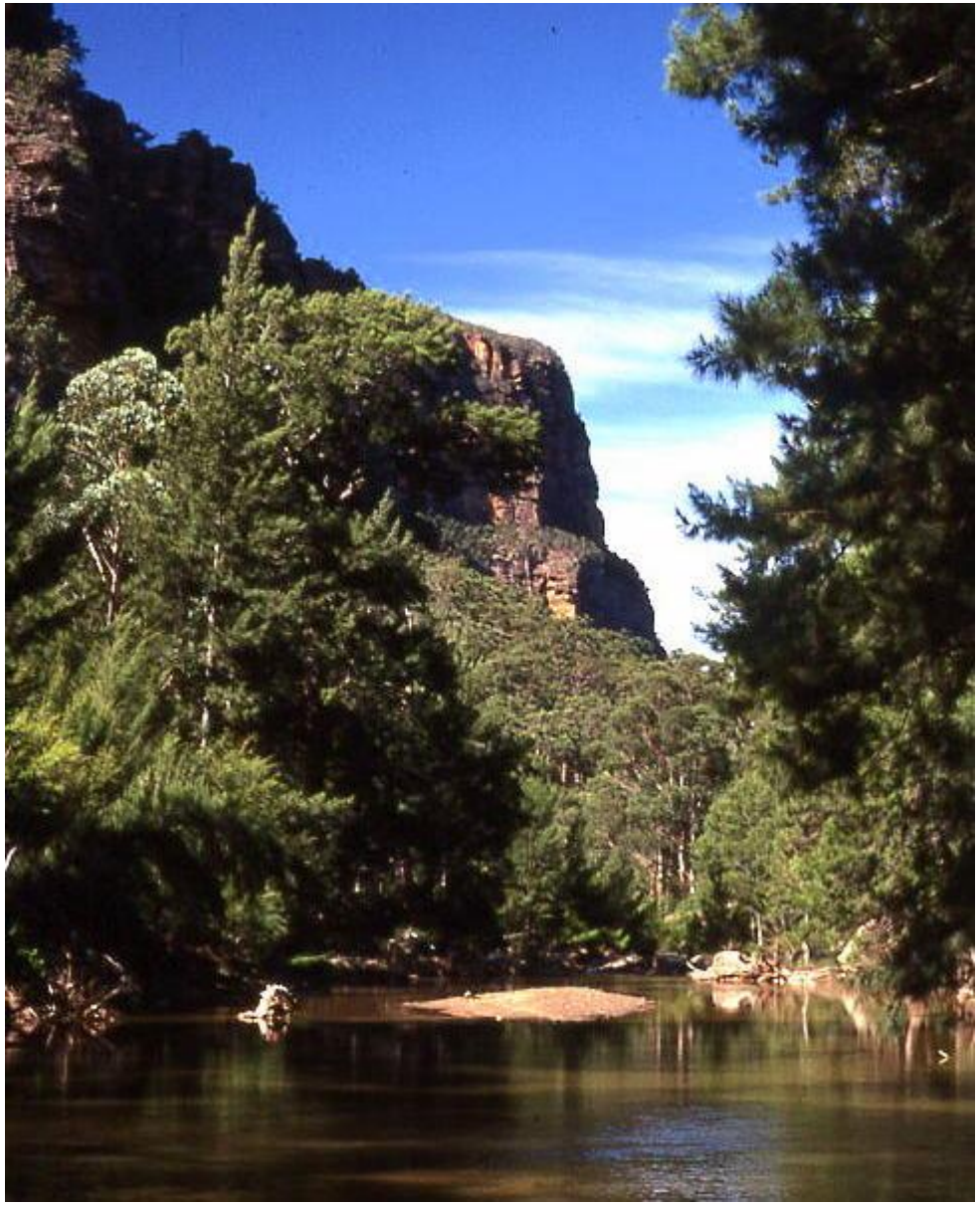
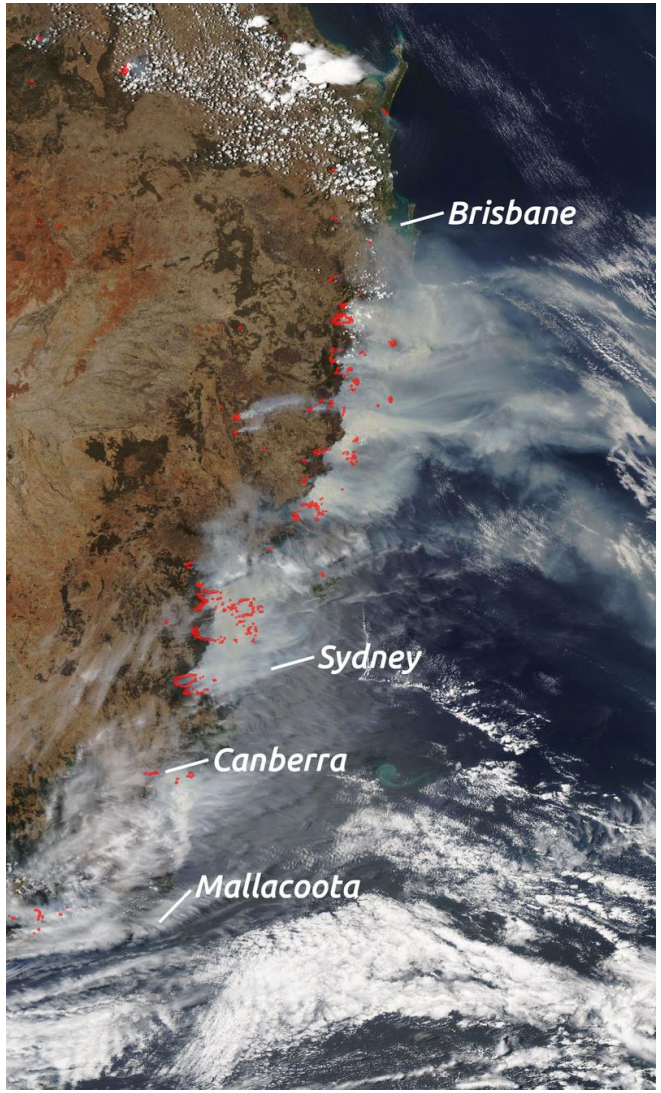
Concord Hospital
University of Sydney



2019 - 2020 A double jeopardy

Bush fires in SE Australia November 2019 – March 2020

- Air quality dropped to hazardous levels in all southern and eastern states
- Air quality index from mid Dec 2019 in ACT was at hazardous levels (>200) on 27 days out of a possible 46
- 2 January 2020, NASA estimated that 306 million tonnes (337 million short tons) of CO2 had been emitted
- By 7 January 2020, the smoke had moved 11,000 kms across the South Pacific Ocean to Chile and Argentina
- Fires
  - burnt an estimated 18.6 million hectares (186,000 square kms)
  - destroyed over 5,900 buildings including 2,779 homes
  - killed at least 34 people
  - killed nearly three billion terrestrial vertebrates alone – the vast majority reptiles
  - killed and deprived millions of birds and animals of their habitats



NASA satellite imagery 7 Dec 2019, overlaid with markers showing bushfires across East coast Australia

Pollutants in bushfire smoke

- complex mix of multiple air pollutants and air toxics
- hazardous particulate matter ≤10 µm in diameter (PM_{10}), and fine particulate matter ≤2.5 µm in diameter ($PM_{2.5}$)
- PM_{10} and $PM_{2.5}$ increase the risk of hospitalization and ED visits in people with asthma and COPD
- Size and specific chemical composition of PM will differ according to the source (e.g. bushfire, plant, synthetic or traffic related)

Temperature

- Heat and humidity stimulates airway C-fibres → asthma symptoms and increasing airway resistance >> rapidly than cold air
- Each 1ºC increase in summertime temperatures is associated with a 5–7% increase in mortality from COPD and other chronic diseases
- High temperatures and sunlight also catalyse the formation of ground level ozone → airway irritation and inflammation

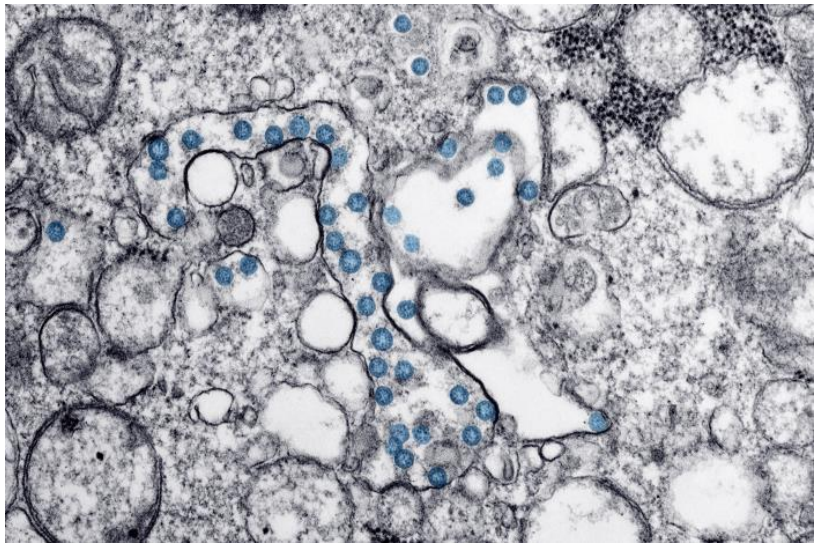
Health impacts of bushfire smoke exposure in Australia

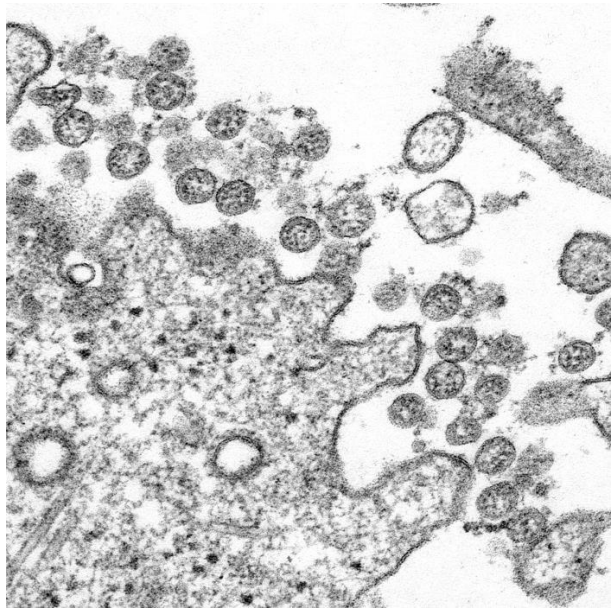
Walter et al Respirology 2020; 25, 495–501

- Narrative review of background airborne particulate matter vs smoke exposure arising from fires. Bushfire smoke shows
  - higher acute respiratory symptom risk associations than background AP
  - strong associations of smoke event days and asthma hospital & ED presentations
  - impact of bushfire smoke increases with age, with the lowest risk estimates for children, followed by adults and then elderly; higher risks for adult females > males
  - Cardiac arrest impacts appear to occur in the first 48 h of exposure with greater effects seen in males
  - Ischaemic heart disease (IHD) impacts were observed at lagged exposure intervals of 2–3 days and were stronger in females and Indigenous Australians
  - Trends to higher cardiac mortality days 2-5 post acute exposure

Chronic or recurrent bushfire smoke exposure

- Effects very poorly understood
- Some international evidence has revealed associations with low birth weight
- Recent Australian study examining fire fighters' exposures during prescribed burns found high mercury concentrations - cumulative impacts remain largely unknown
- Animal models of exposure suggest bushfire smoke suppresses phagocytic activity
- Exposure to biomass smoke is associated with an increased risk of respiratory viral RTI
- Occurs through a number of mechanisms : epithelial barrier dysfunction, inflammation and decreased anti-viral defences (in mouse studies)
- Different thresholds may exist in males and females with regard to the stimulus level required to trigger inflammatory mediators after wood smoke exposure





The devil in the piece

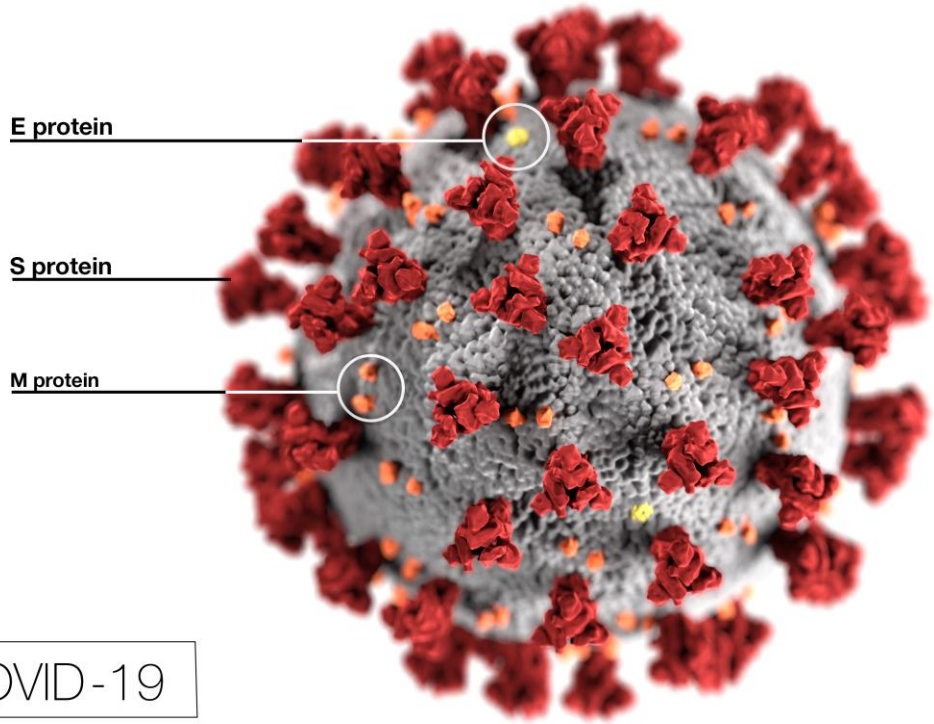
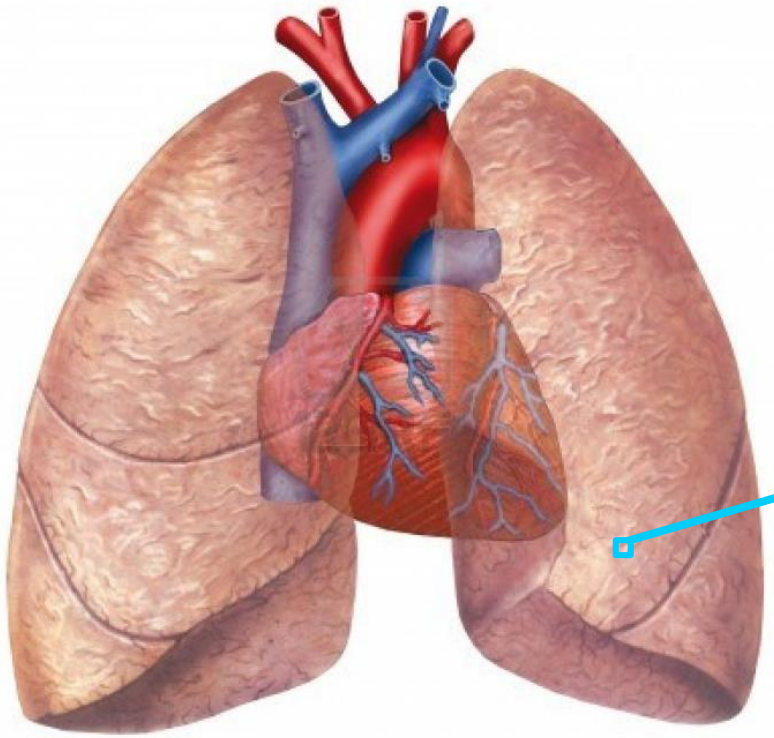


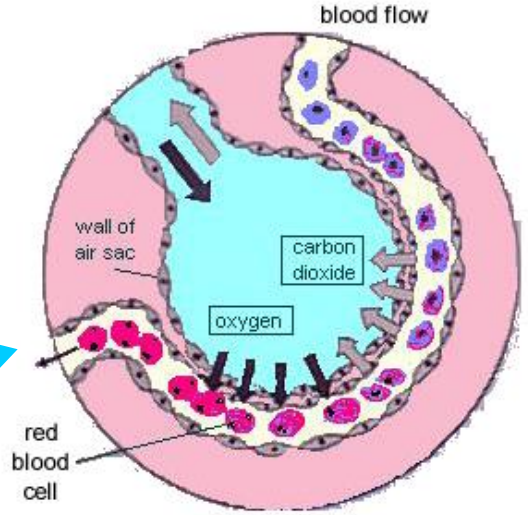
Illustration created at the US-CDC showing the ultrastructural morphology exhibited by coronaviruses. The spikes that adorn the outer surface of the virus impart the look of a corona surrounding the virion, when viewed by EM

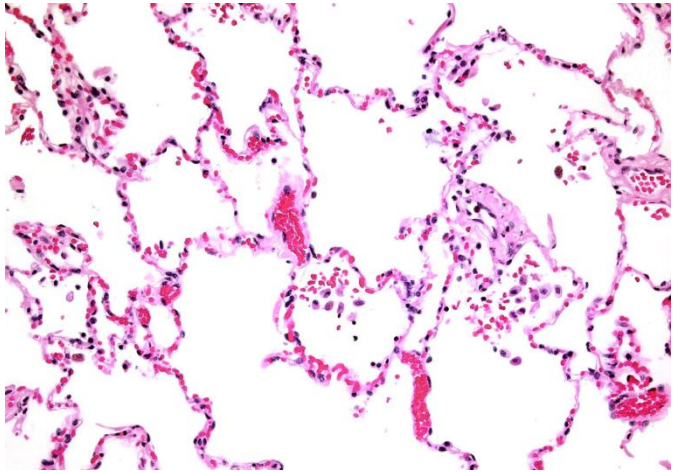
Coronaviruses

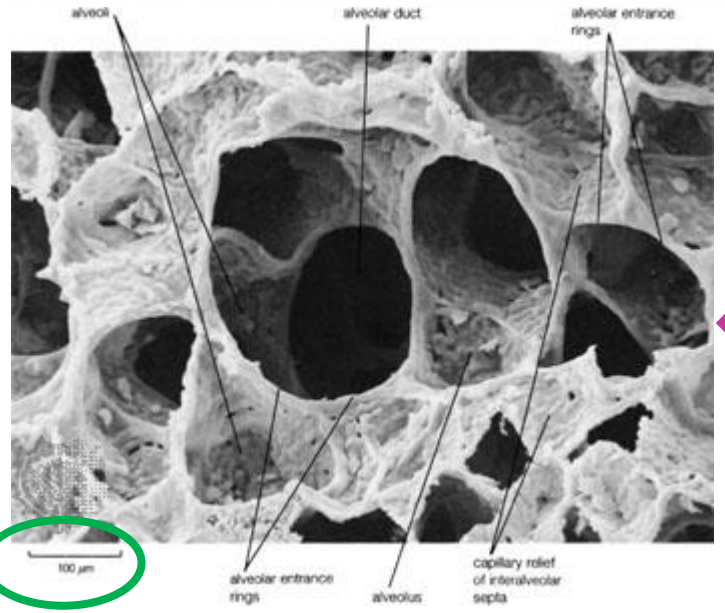
- Enveloped, non-segmented, positive sense RNA viruses, belonging to the family Coronaviridae
- Broadly distributed in humans and other mammals
- Most human coronavirus infections are mild (also true of SARS-CoV-2)
- Two severe epidemics have been the two beta-coronaviruses
  - Severe acute respiratory syndrome coronavirus (SARS-CoV), mortality rate 10%
  - Middle East Respiratory Syndrome coronavirus (MERS-CoV), mortality rate 37%
  - Have caused more than 10,000 cumulative cases in the last 20 yrs

- Some coronaviruses are causes of the common cold
- The SARS-CoV-2 is a large sized virus (approximately 120 nm/0.1μm in diameter)
- Primarily spread person to person by respiratory droplets (>5-10 μm diam) within 1.5m range
- Some experts and evidence suggest aerosol spread may also be important
- Some emerging data that previous coronavirus infection may enhance resistance




blood flow
wall of air sac
carbon dioxide
oxygen
red blood cell




alveoli
alveolar duct
alveolar entrance rings
100 µm
alveolar entrance rings
alveolus
capillary relief of interalveolar septa

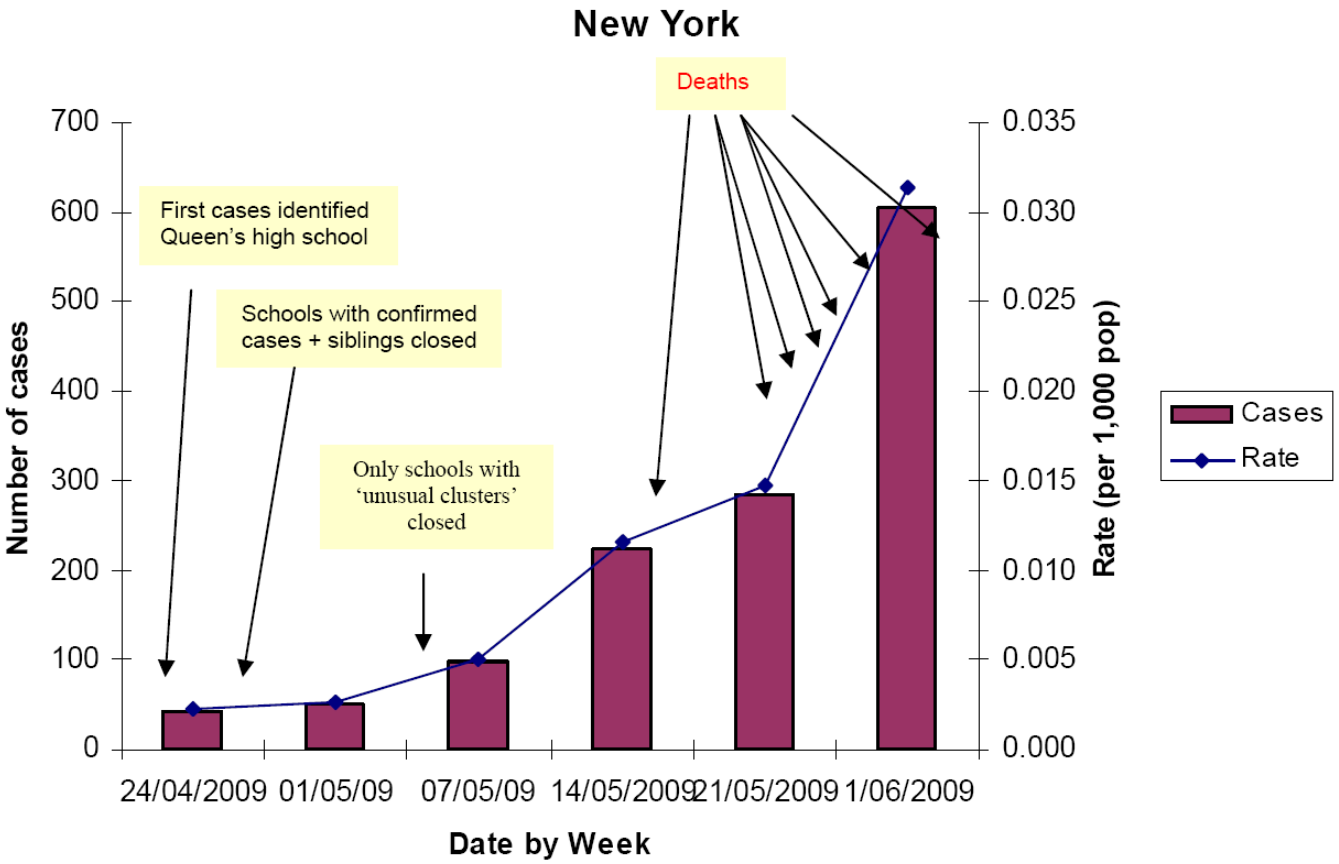
100 µm

- Sea turtles have lungs very like human lungs
- They can hold their breath for up to 10 hours when sleeping
- Their lungs are much bigger than their brains
- They can “breathe” through their rear end

Spanish Flu

- Began in N. hemisphere Spring-Summer 1918
- First wave was a relatively mild disease, few deaths
- Late August 1918, a more virulent strain emerged
- Main wave of global pandemic spread Sept-Nov 1918
- In some US cities > 10,000 people/week died
- Almost 1/3 of US population became ill
- Mortality rate 2-3%
- Most deaths occurred in young adults
- 99% excess deaths occurred in < 60 yr olds
- Reduced mean life expectancy in US by 10 years
- Majority who died succumbed to secondary bacterial pneumonia

Have we been here before?



H1N1-09 Influenza Cases in New York April – May 09

COVID - 19

- Began N hemisphere winter 2019
- First wave highly contagious $R_0 > 2.0$
- So far no mutation to more lethal form
- In some US cities > 10,000/month died
- Outbreaks in all countries
- Mostly < 10% population becomes ill
- Mortality rates highly variable → 15%
- Mortality age related, increases > 60
- Affects 20 – 40 year olds >> older adults
- Children not a reservoir nor source of transmission
- Most deaths due to respiratory failure

COVID-19 Map - Johns Hopkins | Find the facts about COVID-19

coronavirus.jhu.edu/map.html

Apps Bookmarks

JOHNS HOPKINS UNIVERSITY & MEDICINE | CORONAVIRUS RESOURCE CENTER

Home Tracking Testing Tracing By Region News & Resources About

Tracking Home Critical Trends | Global Map U.S. Map

COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)

Total Confirmed
18,316,072

Confirmed Cases by Country/Region/Sovereignty

- 4,718,249 US
- 2,750,318 Brazil
- 1,855,745 India
- 859,762 Russia
- 516,862 South Africa
- 443,813 Mexico
- 433,100 Peru
- 361,493 Chile

Admin0

Last Updated at (M/D/YYYY)
8/4/2020, 9:34:38 PM

2 of 3
Victoria, Australia
Confirmed: 12,335
Deaths: 147

Esri, FAO, NOAA

Cumulative Confirmed Cases

188
countries/regions

Lancet Inf Dis Article: Here. Mobile Version: Here.
Lead by JHU CSSE. Technical Support: Esri Living Atlas team and JHU APL. Financial Support:

Global Deaths
694,715

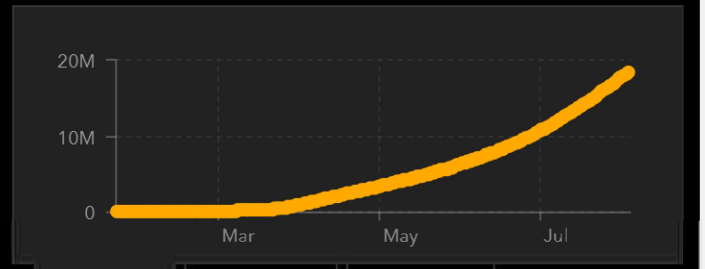
- 155,478 deaths US
- 94,665 deaths Brazil
- 48,012 deaths Mexico
- 46,295 deaths United Kingdom

Global Deaths

US State Level
Deaths, Recovered

- 32,719 deaths, 73,279 recovered New York US
- 15,846 deaths, 32,660 recovered New Jersey US
- 9,507 deaths, recovered California US
- 8,648 deaths, 97,595

US Deaths, Rec...



Confirmed Logarithmic Daily Cases

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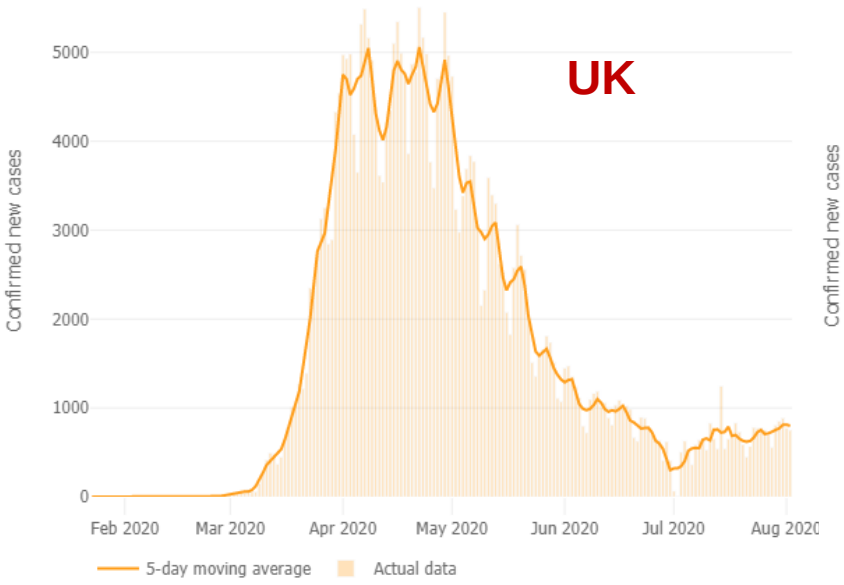
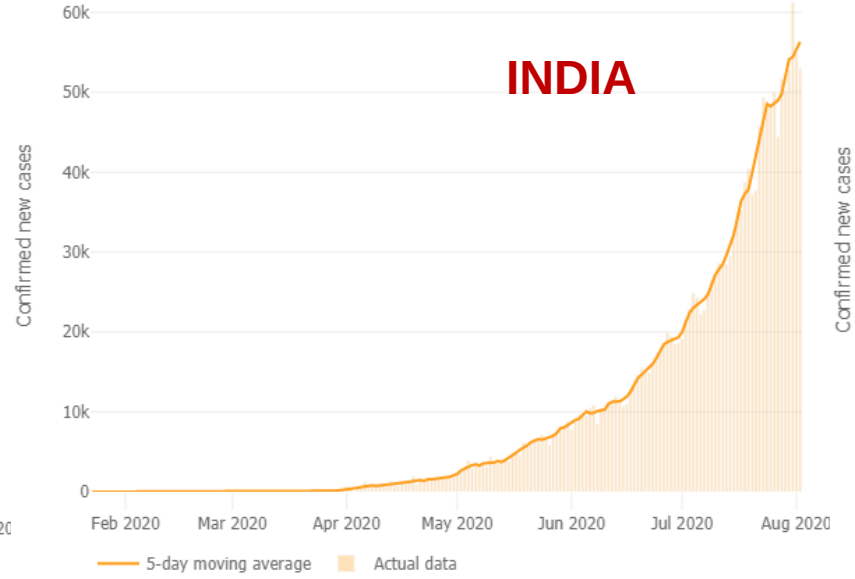
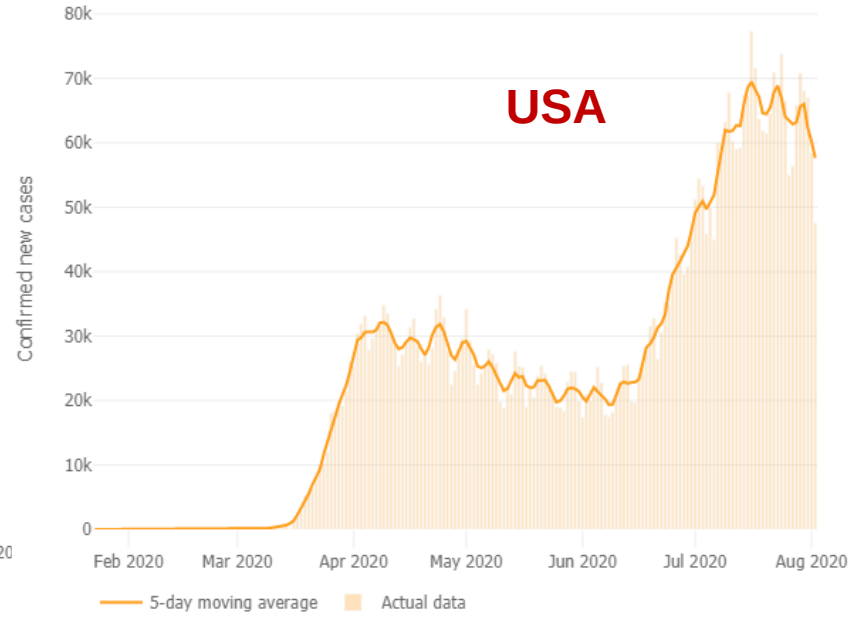
ENG 10:11 PM 4/08/2020

Global comparisons : mortality







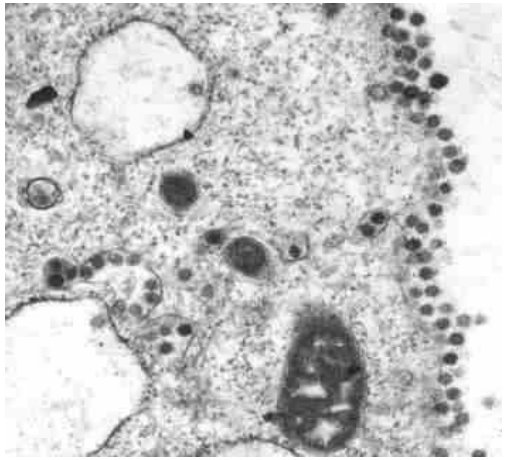
1st case of COVID-19 in UK was reported 184 days ago on 30/1/2020. Since, the UK has **reported 306,309 cases, and 46,286 deaths**

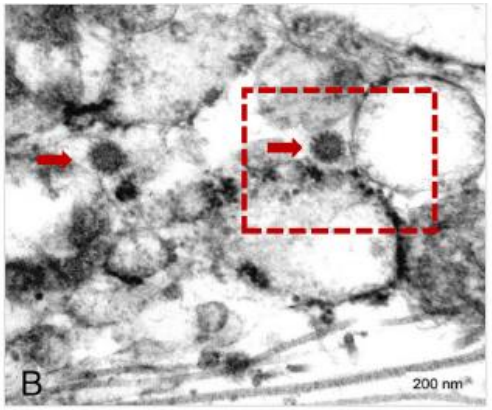
The first case of COVID-19 in India was reported 185 days ago on 31/1/2020. Since, India has reported **1,803,695 cases, and 38,135 deaths**

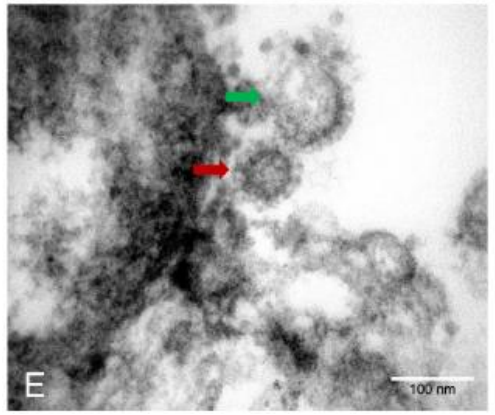
The first case of COVID-19 in US was reported 193 days ago on 22/1/2020. Since then, USA has reported **4,667,955 cases, and 154,860 deaths**

COVID stats 4th August 2020

Country	Cases	Deaths	Case fatality rate	Deaths/100,000
United Kingdom	306,309	46,286	15.1%	69.61
Spain	288,522	28,445	9.9%	60.88
Italy	248,070	35,154	14.2%	58.17
Sweden	80,422	5,743	7.1%	56.40
France	225,198	30,268	13.4%	45.18
Germany	212,828	9,163	4.3%	11.05
US	4,771,080	156,806	3.3%	47.33
New Zealand	**1,567**	**22**	**1.4%**	**0.45**
Australia	**17,938**	**208**	**1.2%**	**0.83**
China	87,985	4,669	5.3%	0.34
South Korea	14,456	302	2.1%	0.58







COVID-19 : A respiratory virus like no other

- Major predisposing risk factors
  - Age > 60, >>70, >>>80
  - Obesity (BMI > 30)
  - Diabetes
  - Hypertension (Rx?)
  - CAD/IHD
  - Male (F = RR 0.8)

Surprises

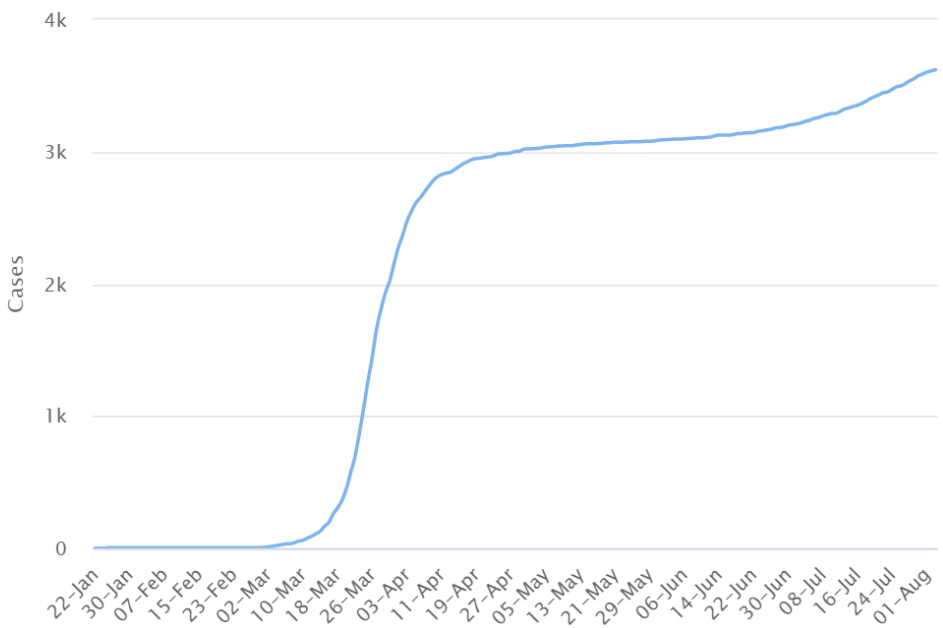
- **Less predisposed to acquire?**
- **Less predisposed to have severe disease?**
  - Smokers
  - Asthma
  - COPD

- Non-survivors
  - Older ≥80 (70% do not survive ICU)
  - Mostly die from ARDS (81% vs 45%), >90% require mechanical ventilation
  - Most have multi-organ damage : ARDS, acute kidney injury, CVA, PTE, cardiac injury, liver dysfunction
  - Only around 30% of people in resp failure have a cytokine storm
  - Secondary bacterial infection is NOT the usual cause of death from lung disease

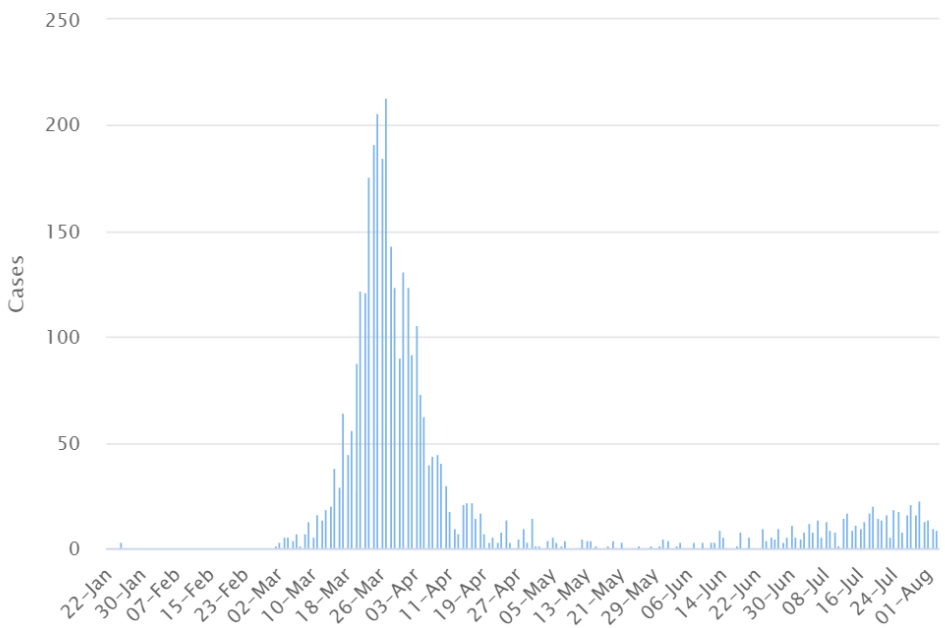
Cases by notification date, age group and gender

4th August 2020

Cumulative number of cases of COVID-19 by notification date

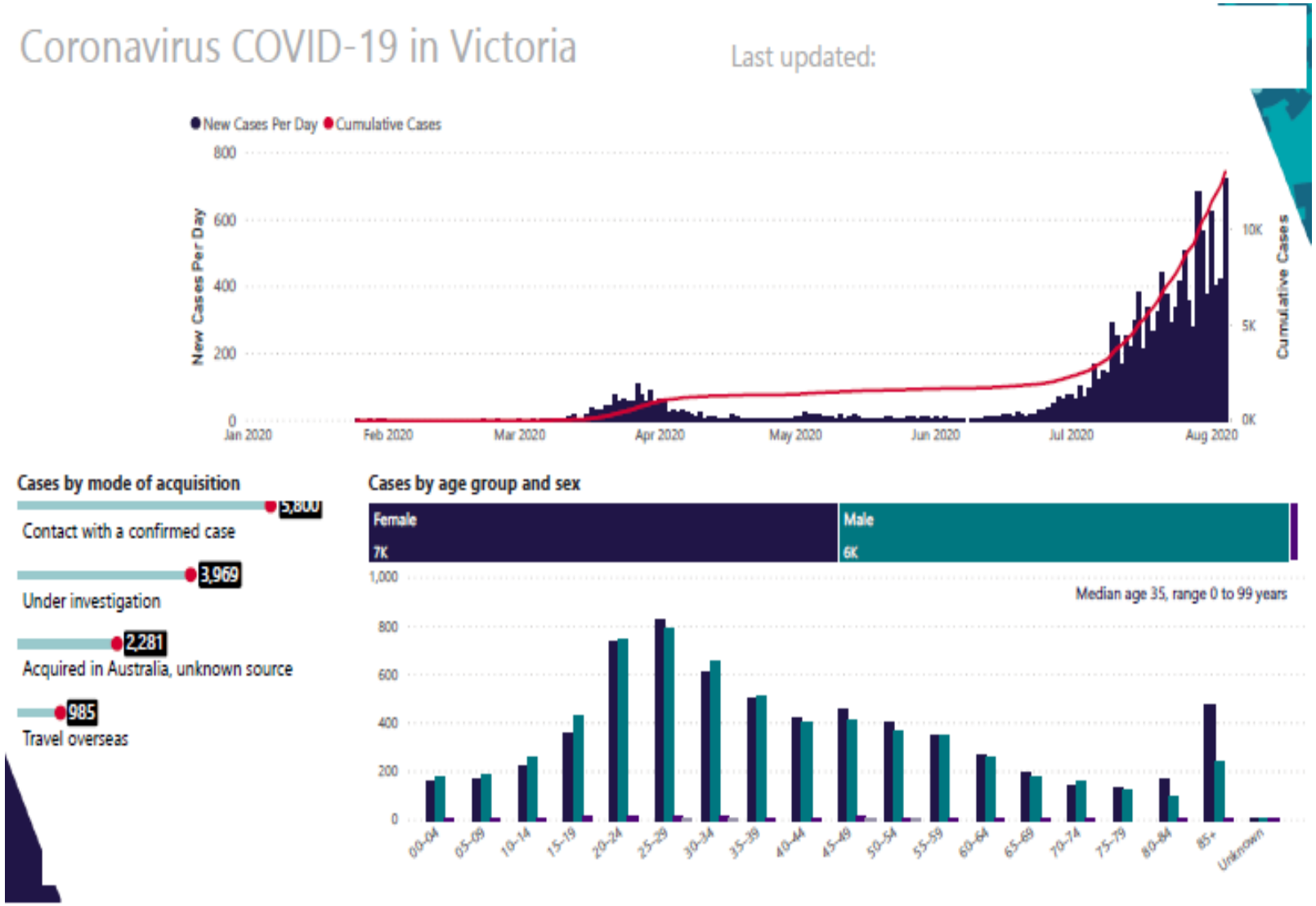


Number of new cases of COVID-19 by notification date



Victoria 6th August 2020

- total COVID-19 cases in Victoria is 13,035
- 725 new cases since yesterday, 561 under investigation
- There are 2,281 cases that may indicate community transmission
- increase of 122 since yesterday
- 538 people are in hospital
- 42 patients in intensive care



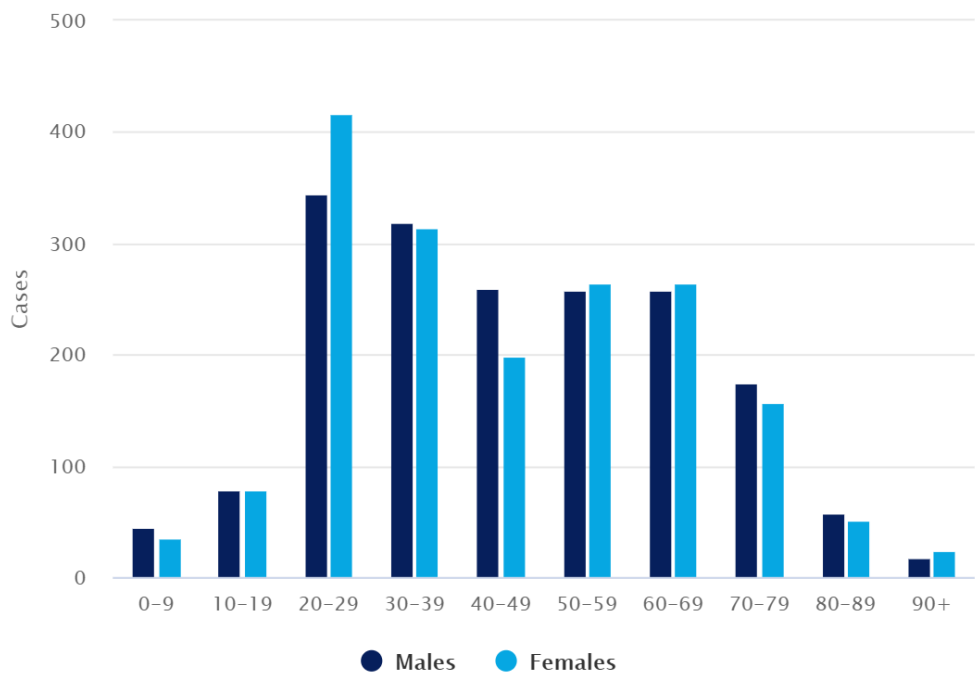
Mortality Analyses - Johns Hopki | Find the facts about COVID-19 |

nsw.gov.au/covid-19/find-facts-about-covid-19

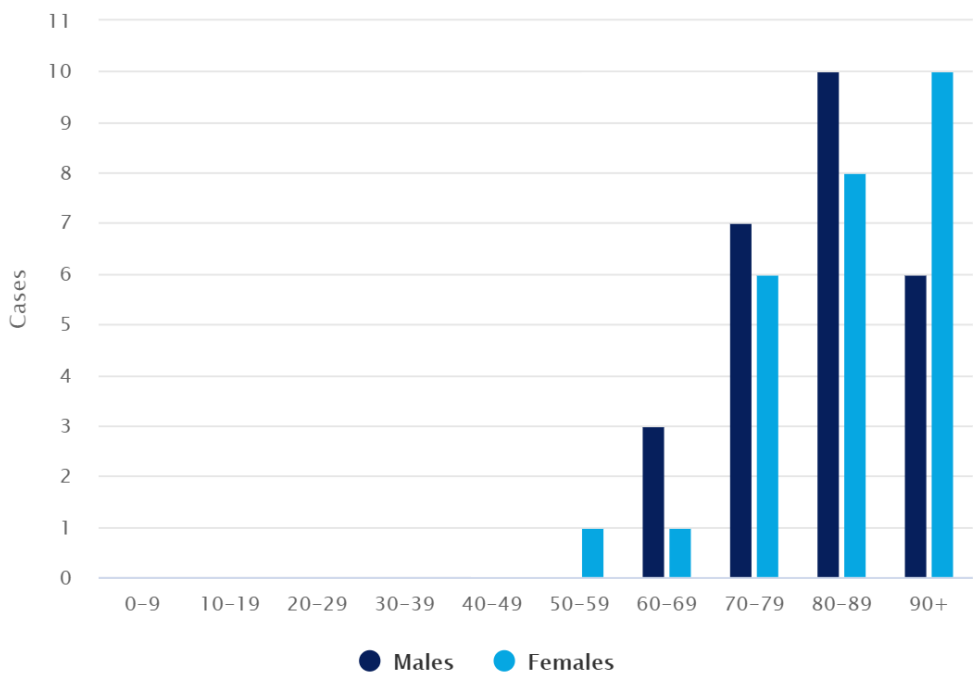
Apps Bookmarks

4th August 2020 https://www.nsw.gov.au/covid-19/find-facts-about-covid-19

Cases by Age Group and Gender



Lives lost by Age Group and Gender



Note: The definition of a confirmed case is a person who tests positive to a validated specific SARS-CoV-2 nucleic acid test or has the virus identified by electron microscopy or viral culture, at a reference laboratory. Data reported at 8pm daily. Case counts reported for a particular notification date may vary over time due to ongoing investigations and case review.

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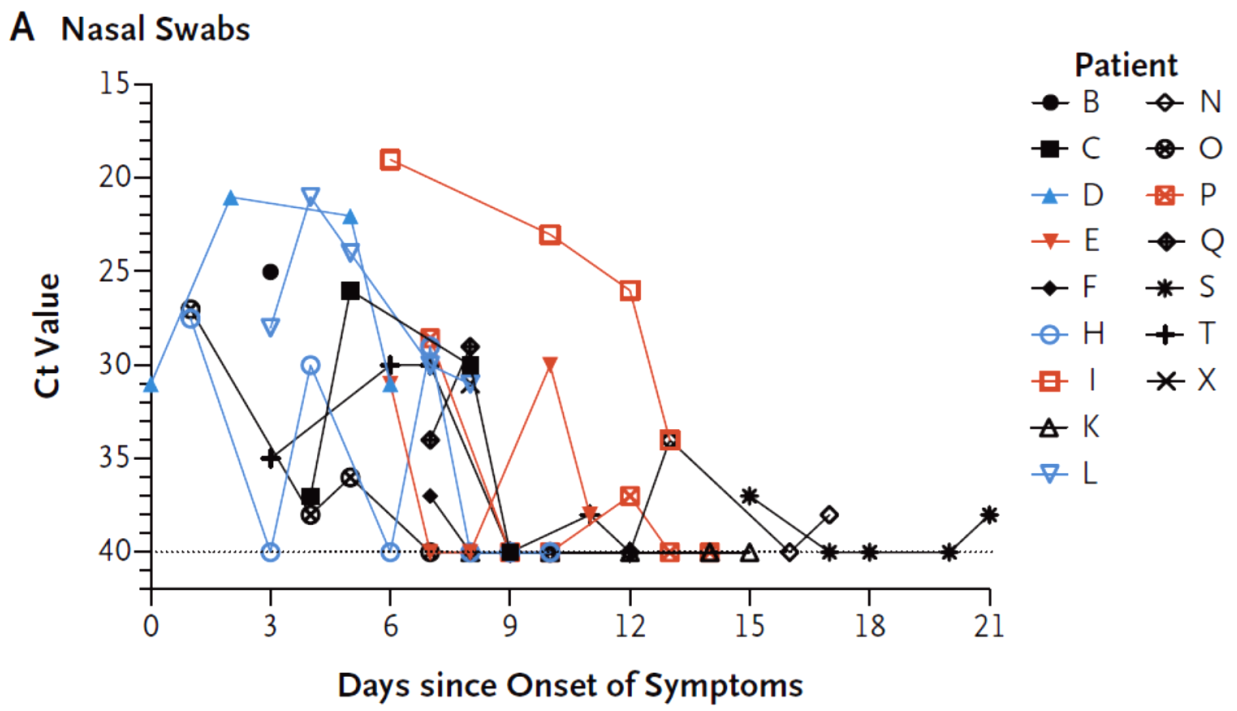
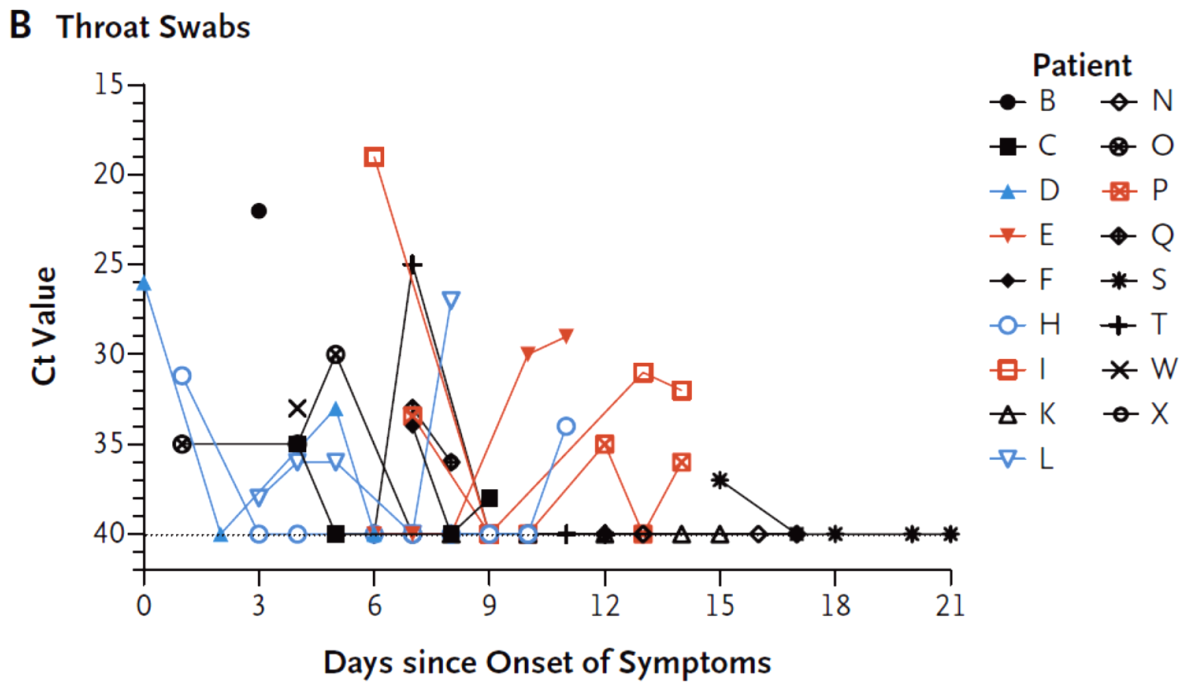
Viral load, lessons for transmission

DOI: 10.1056/NEJMc2001737

Zhou et al. NEJM correspondence





RED = severe
Black = moderate
Blue = 2º contact

SARS-CoV-2 viral load dynamics, duration of viral shedding and infectiousness – a living systematic review and meta-analysis

Cevic et al Preprint doi: https://doi.org/10.1101/2020.07.25.20162107

- Aimed to characterise viral load dynamics, duration of viral RNA, and viable virus shedding of SARS-CoV-2 in various body fluids : 79 studies on SARS-CoV-2, included
- Mean SARS-CoV-2 RNA shedding in URT, LRT stool and serum were 17.0, 14.6, 17.2 and 16.6 days, respectively; max in URT was 83 days

- Pooled mean duration of SARS-CoV-2 RNA shedding was positively associated with
  - Age (p=0.002), but not gender (p = 0.277)
  - **No study to date has detected live virus beyond day 9 of illness despite persistently high viral loads**
  - SARS-CoV-2 viral load in the URT appears to peak in the first week of illness

- Shedding can be prolonged but duration of viable virus is relatively short-lived
- High SARS-CoV-2 titres in week 1 of illness + an early peak at symptom onset to day 5 of illness
- Underscores the **importance of early case finding** and isolation but containment may be challenging even with effective track and isolate

Clinical course and PCR viral positivity

- 80% of PCR +ve detected cases are mild
- This will rise and case fatality will go down as testing protocols expand
- When entire populations are tested, about 50% of patients who test positive are asymptomatic at testing
- In North America
  - about 10% of cases are hospitalized
  - 25% of admitted patients require intensive care support
  - 25 – 50% ICU-admitted patients die
  - 1-20% die from the original PCR +ve symptomatic cases
- For those requiring admission
  - mean time from symptom onset to hospitalization 4 - 7 days
  - to ICU admission 5 - 12 days
  - Mean hospital stay (survival or death) about 2 weeks

The NEW ENGLAND JOURNAL of MEDICINE

DOI: 10.1056/NEJMoa2002032

ORIGINAL ARTICLE

Clinical Characteristics of Coronavirus Disease 2019 in China

Drs. Guan, Ni, Yu Hu, W. Liang, Ou, He, L. Liu, Shan, Lei, Hui, Du, L. Li, Zeng, and Yuen contributed equally to this article.

This article was published on February 28, 2020, and updated on March 3, 2020, at NEJM.org.

- 7736 patients with Covid-19, hospitalized at 552 sites in Hubei as of January 29, 2020, obtained data regarding clinical symptoms and outcomes for 1099 patients (14.2%)
- Median age of the patients 47 years; 41.9% female
- 5.0% admitted to the ICU, 2.3% underwent invasive ventilation, and 1.4% died

- Most common symptoms were fever (43.8% on admission and 88.7% during hospitalization) and cough (67.8%). Diarrhea was uncommon (3.8%)
- Median incubation period was 4 days (IQR 2 to 7)
- On admission, ground-glass opacity was the most common radiologic finding on CT (56.4%)
- No CT abnormality 17.9% with non-severe disease and in 2.9% with severe disease
- Lymphopenia was present in 83.2% of the patients on admission

JAMA Internal Medicine | Original Investigation

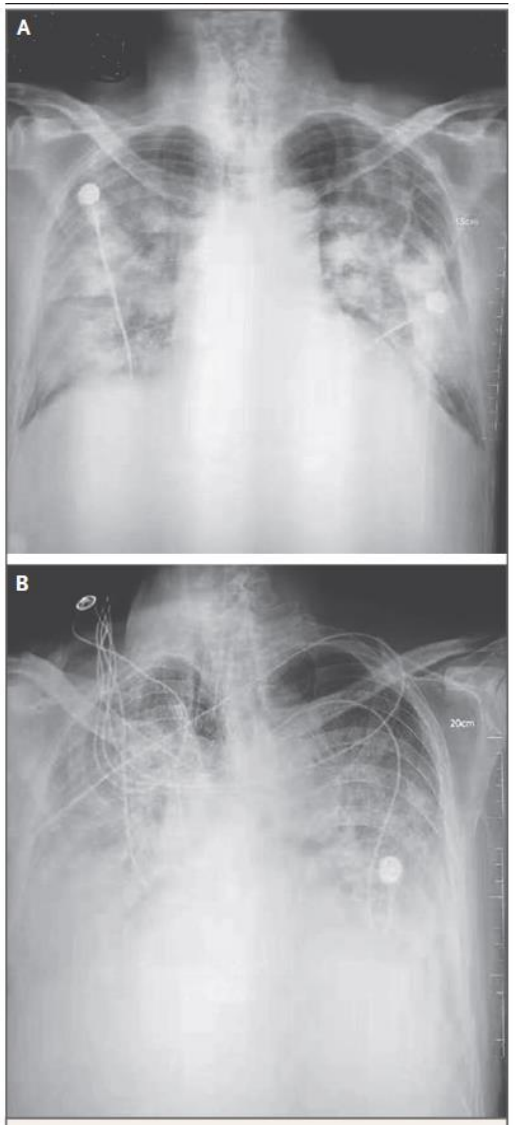
Factors Associated With Death in Critically Ill Patients With Coronavirus Disease 2019 in the US

Gupta et al
doi:10.1001/jamainternmed.2020.3596
Published online July 15, 2020

- Multicenter cohort study, 2215 adults with laboratory-confirmed COVID-19 who were admitted to ICUs at 65 hospitals in US from March 4 to April 4, 2020
- 2215 patients, mean age, 60.5; 64.8% male; 78.5% ≥ 1 chronic comorbidity
- At 28 days after ICU admission, 35.4% had died, 37.2% were discharged, 27.4% remained

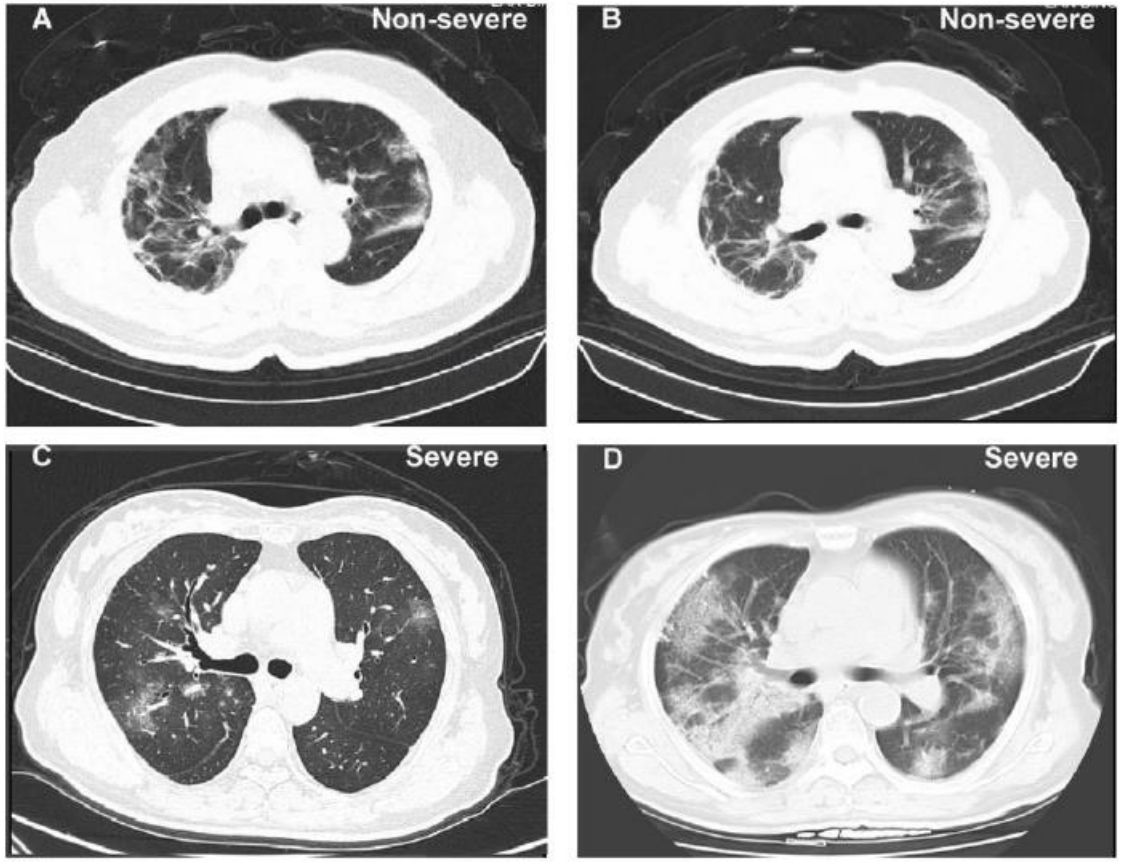
- Factors independently associated with death included
  - Older age (>80 vs <40 years) OR 11.15
  - Male sex OR 1.50; higher BMI (>40 vs <25) OR, 1.51
  - Coronary artery disease (OR, 1.47), active cancer (OR, 2.15)
  - Hypoxemia (PaO2: FIO2<100 vs >300mmHg: OR, 2.94), liver dysfunction OR 2.61, kidney dysfunction OR, 2.43
  - Patients admitted to hospitals with fewer ICU beds had a higher risk of death (<50 vs >100 ICU beds: OR, 3.28; 95%CI, 2.16-4.99)
  - Hospitals varied considerably in the risk-adjusted proportion of patients who died (range, 6.6%-80.8%)

Radiologic and CT imaging changes



(A) Day 8, (B) Day 11 after onset of illness

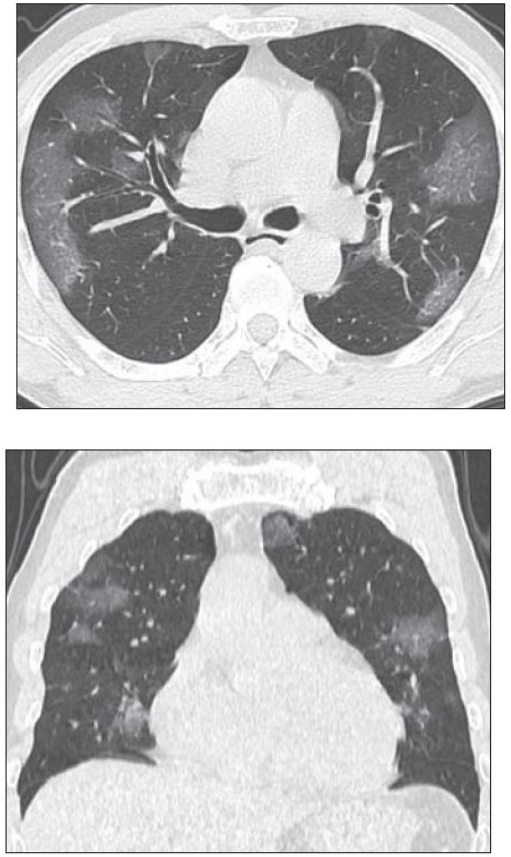
NEJM 2020;382:727



51M day 8 and day15

60F day 1 and day 4

Guan et al NEJM DOI: 10.1056/NEJMoa2002032



64M, no h/o COV-19 exposure Cheng et al 10.2214/AJR.20.22959

CLINICAL RESEARCH ARTICLE

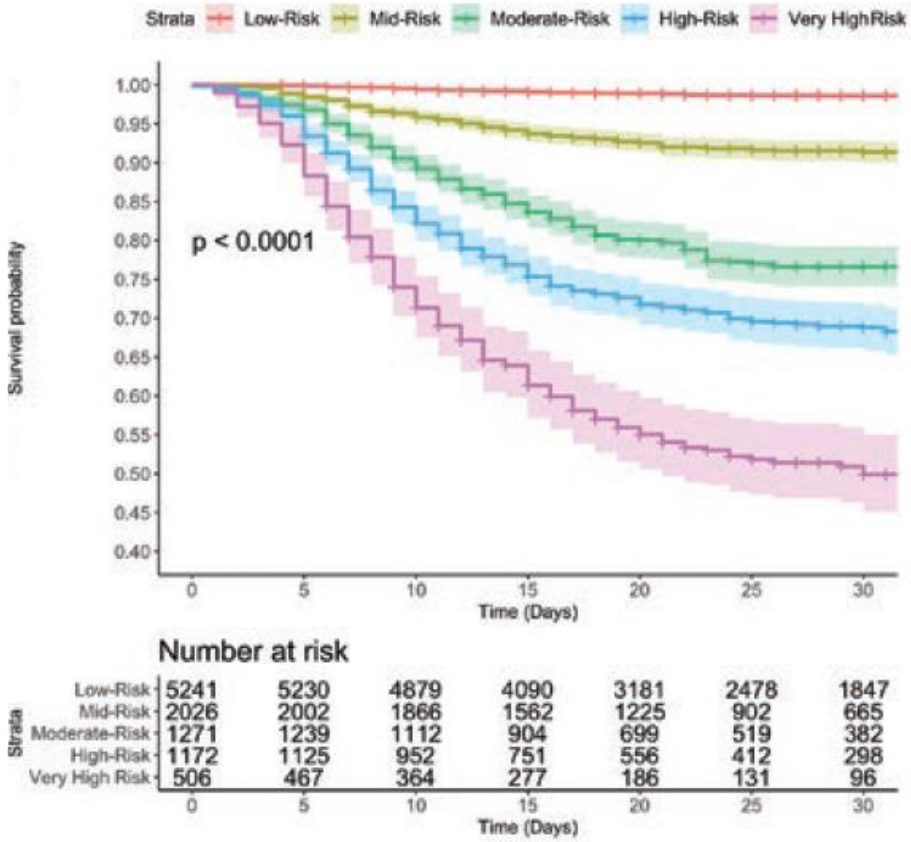
J Clin Endocrinol Metab, August 2020, 105(8):1–10

Predicting Mortality Due to SARS-CoV-2: A Mechanistic Score Relating Obesity and Diabetes to COVID-19 Outcomes in Mexico Bello-Chavolla et al

Our predictive score for COVID-19 lethality included age ≥ 65 years, diabetes, early-onset diabetes, obesity, age < 40 yrs, CKD, hypertension, and immunosuppression and significantly discriminates lethal from non-lethal COVID-19 cases (C-statistic = 0.823)

- 177,133 subjects (May 18, 2020), 51 633 with SARS-CoV-2 and 5,332 deaths

Condition	Score
Pneumonia	7
Diabetes & Age <40 years	5
Age ≥65 years	3
CKD	3
Immunosuppression	1
COPD	1
Obesity	1
Diabetes mellitus	1
Age <40 years	-6
Risk Categories	**Score Intervals**
Very High-Risk	≥12
High-Risk	8-11
Moderate-Risk	4-7
Mild-Risk	1-3
Low-Risk	≤0

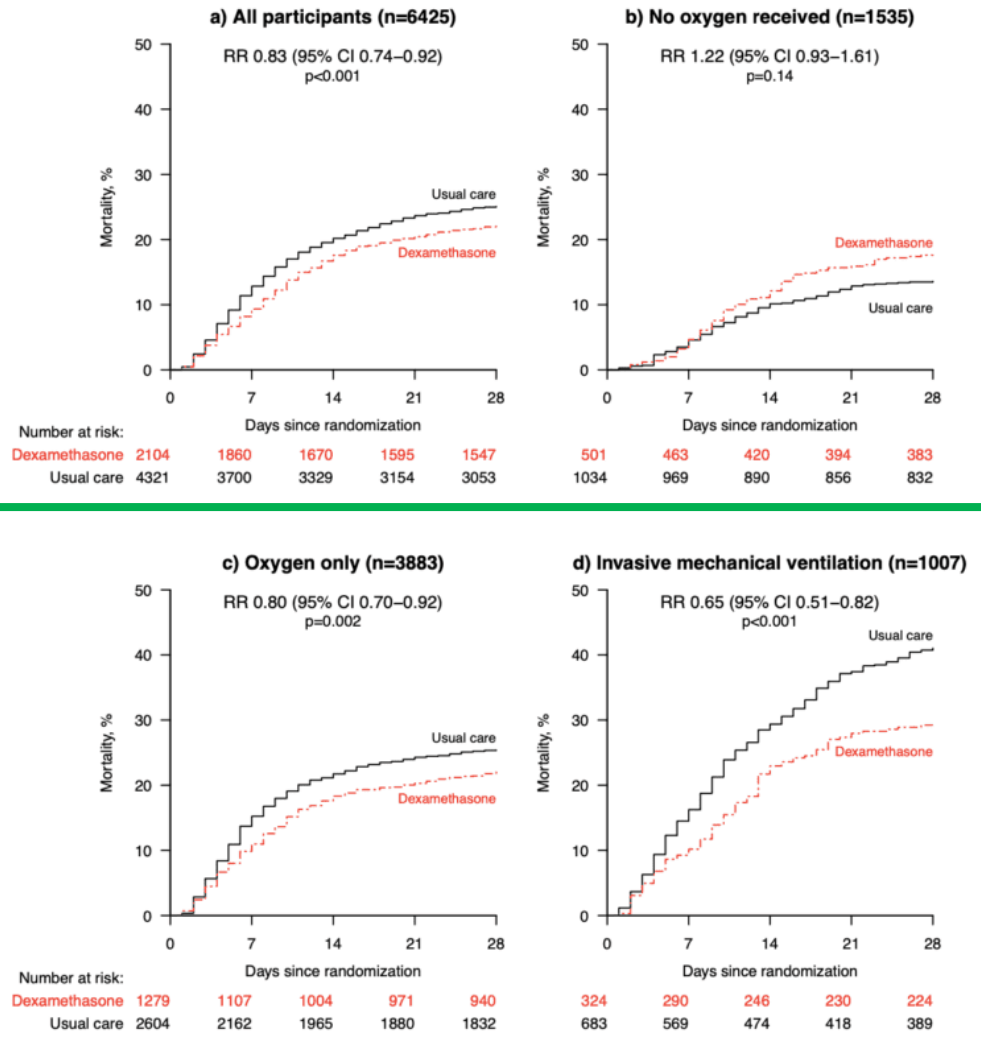


Validation cohort

Treatment : RECOVERY trial

- A large RCT (175 hospitals in UK) of possible treatments for patients admitted with COVID-19
- Over 11,500 patients randomised to the treatment arms, or no additional Rx
  - Lopinavir-Ritonavir 400/100 BD x 10 days
  - Low-dose Dexamethasone 6mgs daily orally or by IVI for 10 days
  - Hydroxychloroquine (now ceased due to lack of efficacy) 200mgs x 4, then daily for 10 days
  - Azithromycin 500mgs daily for 10 days
  - Tocilizumab (2nd randomisation)
  - Convalescent plasma against SARS-CoV-2 (2nd randomisation)
- DXM reduced the 28-day mortality rate by 17% (0.83 [0.74 to 0.92]; P=0.0007)
- Greatest benefit among patients requiring ventilation (test for trend $p<0.001$)
  - Found no evidence of benefit for patients who did not require oxygen
  - Did not study patients outside the hospital setting
- Follow-up complete for over 94% of participants

Figure 1: 28–day mortality in all patients (panel a) and separately according to level of respiratory support received at randomization (panels b–d)



RR=age–adjusted rate ratio. CI=confidence interval. The 'oxygen only' group includes non–invasive ventilation. Note: in the RECOVERY trial press release of 16 June 2020, effects in subgroups of level of respiratory support received were shown with 99% CIs, not 95% CIs as inadvertently stated. The age–adjusted rate ratio and 99% confidence intervals remain unchanged in this analysis: no oxygen required, RR 1.22 (99% CI 0.86–1.75); oxygen only, RR 0.80 (99% CI 0.67–0.96); invasive mechanical ventilation, RR 0.65 (99% CI 0.48–0.88).

Recovery Trial

Randomised Evaluation of COVID-19 Therapy

- 28-day mortality in the usual care group was
  - highest in those patients receiving IMV (40.7%)
  - intermediate in those receiving oxygen only (25.0%)
  - lowest among those who were not receiving respiratory support at randomization (13.2%)
- The greatest absolute reductions in 28-day mortality were seen in the sickest patients

Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis

Chu et al
Lancet 2020; 395: 1973-87

- Investigated by systematic review
  - the optimum distance for avoiding person-to-person virus transmission
  - to assess the use of face masks and eye protection to prevent transmission of viruses
- Obtained data for SARS-CoV-2 and β-coronaviruses that cause SARS and MERS from 21 standard WHO-specific and COVID-19-specific sources
- Transmission of viruses was lower with physical distancing of 1 m or more, compared with a distance of less than 1 m, pooled adjusted **OR 0·18**, 95% CI 0·09 to 0·38
- Protection was increased as distance was lengthened
- Face mask use could result in a large reduction in risk of infection **OR 0·15,** 95% CI 0·07 -0.34
- Stronger associations with N95 or similar respirators compared with disposable surgical masks or similar
- Eye protection also was associated with less infection **OR 0·22**, 95% CI 0·12 to 0·39,

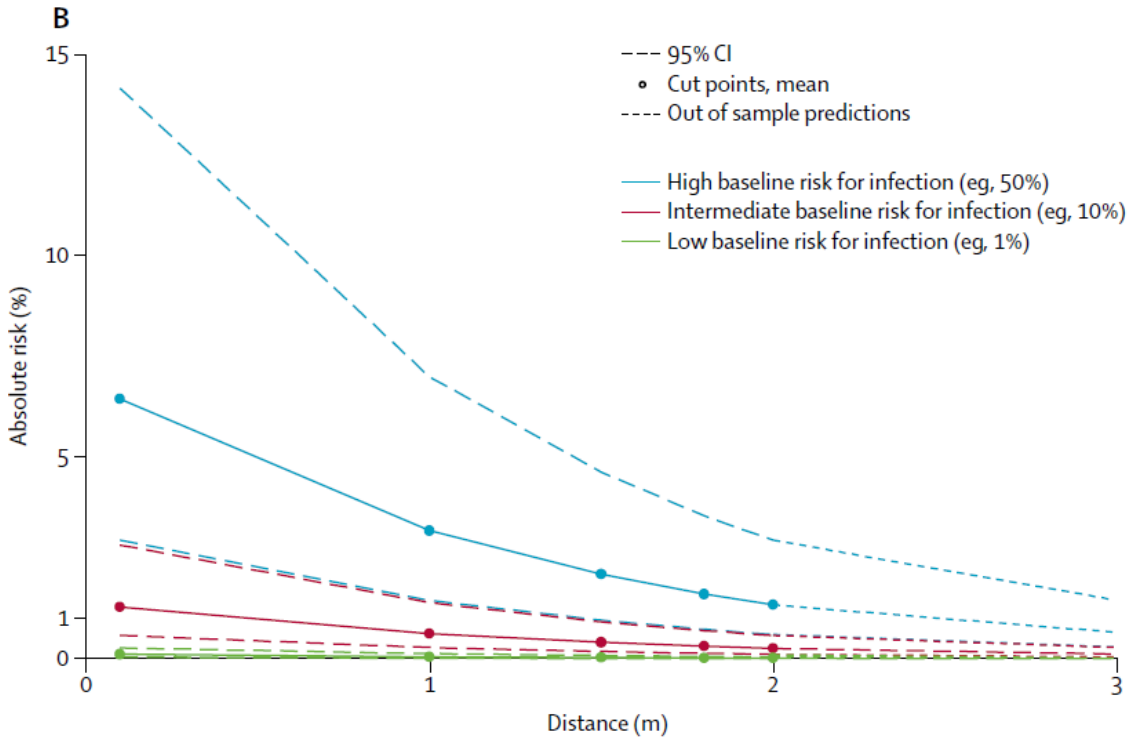
Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis

Chu et al. Lancet 2020;395:1973

	Studies and participants	Relative effect (95% CI)	Anticipated absolute effect (95% CI), eg, chance of viral infection or transmission		Difference (95% CI)	Certainty*
			Comparison group	Intervention group		
Physical distance ≥1 m *vs* <1 m	Nine adjusted studies (n=7782); 29 unadjusted studies (n=10736)	aOR 0·18 (0·09 to 0·38); unadjusted RR 0·30 (95% CI 0·20 to 0·44)	Shorter distance, 12·8%	Further distance, 2·6% (1·3 to 5·3)	–10·2% (–11·5 to –7·5)	Moderate†
Face mask *vs* no face mask	Ten adjusted studies (n=2647); 29 unadjusted studies (n=10170)	aOR 0·15 (0·07 to 0·34); unadjusted RR 0·34 (95% CI 0·26 to 0·45)	No face mask, 17·4%	Face mask, 3·1% (1·5 to 6·7)	–14·3% (–15·9 to –10·7)	Low‡
Eye protection (faceshield, goggles) *vs* no eye protection	13 unadjusted studies (n=3713)	Unadjusted RR 0·34 (0·22 to 0·52)¶	No eye protection, 16·0%	Eye protection, 5·5% (3·6 to 8·5)	–10·6% (–12·5 to –7·7)	Low‖

Physical distancing, face masks, and eye protection to prevent person to person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis

Chu et al. Lancet 2020;395:1973



Absolute risk of transmission from an individual infected with SARS-CoV-2, SARS-CoV, or MERS-CoV with varying baseline risk and increasing distance

- Risk of virus transmission is reduced by 82% with a physical distance of 1 m in both health-care and community settings (OR 0·18)
- Every additional 1 m of separation more than doubles the relative protection

To Do or not to Do : Masks

- Masks and respirators reduced the risk of infection by 85%, with greater effectiveness in healthcare settings (RR 0·30) than in the community (0·56)
- N95 respirators are 96% effective (OR 0·04) vs other masks ~ 67% effective (OR 0·33)
- Eye protection resulted in a 78% reduction in infection (OR 0·22)
- For the community and households cloth masks are effective
  - should be made of water-resistant fabric
  - multiple layers (minimum 3)
  - good facial fit
- Cloth masks can be washed daily
- When lockdown is eased, masks and physical distancing are key measures to control virus spread
- Growing evidence for pre-symptomatic and asymptomatic transmission of S-CoV-2 further supports universal face mask use

Protection – masks?

- Considerations when using a **surgical mask (HCW's)**
  - In the majority of situations where standard respiratory protection is needed, a single use surgical mask is appropriate (minimum Level 1 barrier).
  - Masks should be changed between patients and when they become soiled or wet
  - Masks should never be reapplied after they have been removed
  - Masks should not be left dangling around the neck
  - Touching the front of the mask while wearing it should be avoided
  - Hand hygiene should be performed upon touching or discarding a used mask

- **High particulate respirators (P2/N95) masks**
  - For COVID-19 the use of P2/N95 masks **should be reserved for AGPs** or where the risk assessment places the patient in airborne precautions.
  - When there is a **high probability of aerosol transmission** due to the infectious agent or procedure e.g. bronchoscopy, nebuliser use, chest physiotherapy

Vaccines

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The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

An mRNA Vaccine against SARS-CoV-2 — Preliminary Report

L.A. Jackson, E.J. Anderson, N.G. Rouphael, P.C. Roberts, M. Makhene,

www.thelancet.com Published online July 20, 2020 https://doi.org/10.1016/S0140-6736(20)31611-1

Encouraging results from phase 1/2 COVID-19 vaccine trials

Feng-Cai Zhu*, Xu-Hua Guan*, Yu-Hua Li, Jian-Ying Huang, Tao Jiang, Li-Hua Hou, Jing-Xin Li, Bei-Fang Yang, Ling Wang, Wen-Juan Wang,

Immunogenicity and safety of a recombinant adenovirus type-5-vectored COVID-19 vaccine in healthy adults aged 18 years or older: a randomised, double-blind, placebo-controlled, phase 2 trial

Published Online July 20, 2020 https://doi.org/10.1016/

nature https://doi.org/10.1038/s41586-020-2608-y

Accelerated Article Preview

ChAdOx1 nCoV-19 vaccine prevents SARS-CoV-2 pneumonia in rhesus macaques

Received: 13 May 2020

Neeltje van Doremalen, Teresa Lambe, Alexandra Spencer, Sandra Belij-Rammerstorfer,

nature https://doi.org/10.1038/s41586-020-2607-z

Accelerated Article Preview

Single-shot Ad26 vaccine protects against SARS-CoV-2 in rhesus macaques

Received: 20 June 2020

Noe B. Mercado, Roland Zahn, Frank Wegmann, Carolin Loos, Abishek Chandrashekar,

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

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DOI: 10.1056/NEJMoa2024671

Evaluation of the mRNA-1273 Vaccine against SARS-CoV-2 in Nonhuman Primates

K.S. Corbett, B. Flynn, K.E. Foulds, J.R. Francica, S. Boyoglu-Barnum, A.P. Werner,

Conclusions

- This is the fight of our lives
- There are positive outcomes despite the tragedies
- Many future possible disasters are preventable
- Science, scientists, clinicians and public health expertise will make the difference that maximises survival of humans over the virus
- Resetting our political, economic and moral compass
  - Environment
  - Innovation and flexibility
  - Connectedness and Gratitude
  - Role of government vs politics
  - Civic society vs individualism
  - Articulate a different future
  - Value of scientific endeavour for societal good