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The Executive Summary is produced weekly and contains in-depth analysis.

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LET US VENTILATE: EXPLORING AND LIMITING AEROSOL TRANSMISSION OF COVID

Here we examine some implications of COVID-19 aerosol / microdroplet transmission

THE AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR-CONDITIONING ENGINEERS (ASHRAE)

When updated in April 2020, the [ASHRAE position document on infectious aerosols](#) included statements relating to SARS-CoV-2:

1) Statement on airborne transmission of SARS-CoV-2:

Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures.

2) Statement on operation of heating, ventilating, and air-conditioning systems to reduce SARS-CoV-2 transmission:

Ventilation and filtration provided by heating, ventilating, and air-conditioning systems can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air. Un-airconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection. In general, disabling of heating, ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus.

LIDIA MORAWASKA'S ARTICLE THAT MADE US FOCUS ON AIRBORNE SPREAD

After significant pushback, Lidia was able to publish her research findings [PubMed.gov](https://pubmed.ncbi.nlm.nih.gov/34411111/) in June 2020. Lidia and the British researcher, Donald K Milton, then made this appeal in the article "It is Time to Address Airborne Transmission of COVID-19" published in [Clinical Infectious Diseases](https://doi.org/10.1093/cid/ciaa1111)

"We appeal to the medical community and to the relevant national and international bodies to recognize the potential for airborne spread of COVID-19. There is significant potential for inhalation exposure to viruses in microscopic respiratory droplets (microdroplets) at short to medium distances (up to several meters, or room scale), and we are advocating for the use of preventive measures to mitigate this route of airborne transmission."

Their appeal received wide distribution when reported in the magazine [Nature](https://www.nature.com/articles/d41586-020-00000-0)

WHO: 29 JULY 2020

[WHO: What steps can be undertaken to improve the ventilation](#) in indoor public spaces and buildings?

Ventilation is an important factor in preventing the virus that causes COVID-19 from spreading indoors. Below are steps to consider which can improve indoor ventilation. These steps should be considered in consultation with a heating, ventilation, and air-conditioning (HVAC) professional.

- Consider using natural ventilation, opening windows if possible and safe to do so
- For mechanical systems, increase the percentage of outdoor air, using economizer modes of HVAC operations and potentially as high as 100%. Before increasing outdoor air percentage, verify compatibility with HVAC system capabilities for both temperature and humidity control as well as compatibility with outdoor/indoor air quality considerations
- Increase total airflow supply to occupied spaces, if possible
- Disable demand-control ventilation controls that reduce air supply based on temperature or occupancy
- Improve central air filtration:
 - Increase air filtration to as high as possible without significantly diminishing design airflow.
 - Inspect filter housing and racks to ensure appropriate filter fit and check for ways to minimize filter bypass.
 - Consider running the HVAC system at maximum outside airflow for 2 hours before and after spaces are occupied, in accordance with manufactory recommendations
 - Generate clean-to-less-clean air movements by re-evaluating the positioning of supply and exhaust air diffusers and/or dampers and adjusting zone supply and exhaust flow rates to establish measurable pressure differentials. Have staff work in "clean" ventilation zones that do not include higher-risk areas such as visitor reception or exercise facilities (if open)
 - Ensure exhaust fans in restroom facilities are functional and operating at full capacity when the building is occupied

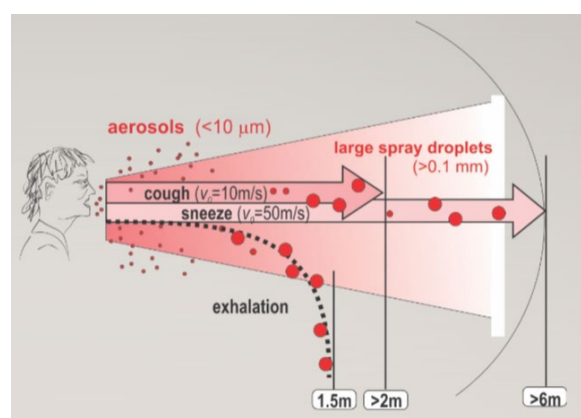
MICRODROPLETS PROVIDE A MECHANISM FOR AIRBORNE TRANSMISSION OF THE CORONAVIRUS

- In collaboration with Patrick Chambers, one of Australia's leading Heating, Ventilation and Air Conditioning (HVAC) engineers
- Patrick works for Stantec Australia Pty Ltd
- Read Patrick's 3 August article in



Airborne Transmission via Suspended Microdroplets

- Water particles are released when breathing, talking, coughing, singing, sneezing etc.
- Water particles begin evaporating immediately after being expelled
- Once particles are small enough, they become buoyed by air currents and diffusion and can become suspended in air
- Once suspended, microdroplets can travel for many meters from where they originated



Further recommended viewing: [NHK investigation into microdroplets on YouTube](#)

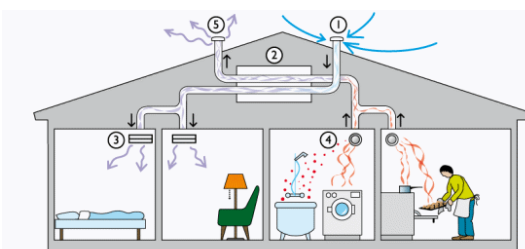
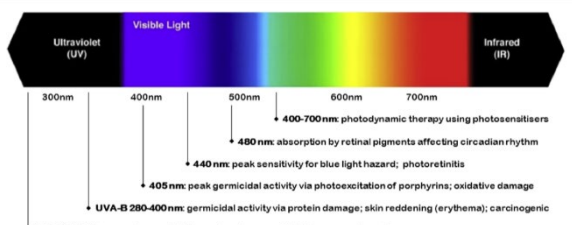
Droplet characteristics

Larger droplets	Smaller droplets
<ul style="list-style-type: none"> • Have a lower surface area to mass • Are expelled at high momentum • Can travel at least five meters 	<ul style="list-style-type: none"> • Have a larger surface area to mass and aerosolize (i.e. evaporate or dehydrate - rate depends on relative humidity) • Are expelled at a lower momentum • Can only travel about 15cm

Effect of relative humidity on aerosolization

- 100% relative humidity (RH): Minimal aerosolization occurs
- Lower RH results in increased drying out of mucosa and faster evaporation of droplets
- General recommendation from WHO is 40-60% RH

KEY ENGINEERING CONTROLS TARGETING AIRBORNE TRANSMISSION

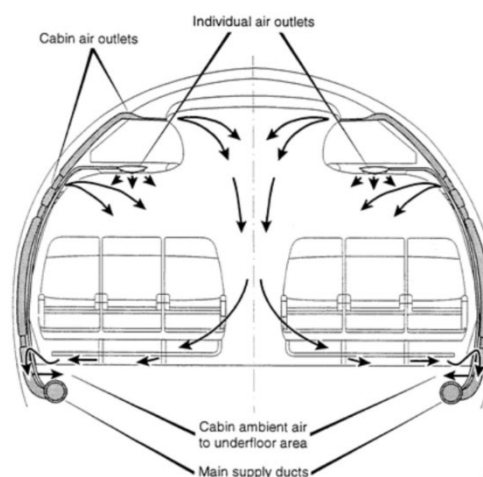
TRANSMISSION MITIGATION STRATEGIES	
a) Dilution strategies	Replacing the air within buildings with “clean air” so as to dilute virus/bacteria/contaminants to safe levels (The “safe” virus exposure concentration is unknown)
b) Filtration strategies	<ul style="list-style-type: none"> • Coronavirus virions are spherical in diameter and are circa 120nm diameter = 0.12 microns • At this size, HEPA filters have near ~99.7% “arrestance” efficiency (ability to filter particles) • Aerosols are known to be airborne from <1 micron to 100 microns in size, therefore traditional filtration also plays an important role.
c) Expulsion strategies	<ul style="list-style-type: none"> • Exhaust strategies and Natural Ventilation aim to expel the virus-laden microdroplets from the building 
d) Containment Strategies	<ul style="list-style-type: none"> • Pressure control provides physical air containment between spaces. Key applications include: <ul style="list-style-type: none"> ○ Negative pressure wards, ○ Isolation rooms, ○ Operating theatres
e) Disinfection of coronavirus via UV	 <p>Figure 1. Ultraviolet (UV), visible light and infrared regions of the electromagnetic spectrum. Highlighted are key UV and visible/blue wavelengths with details of their germicidal action and safety aspects. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)</p>

HOSPITAL VENTILATION DESIGN AND COVID

- Hospitals typically set at 21-24°C / 40-60% humidity
- Ward airflow design is often to supply air into the individual rooms and extract it in the corridors (meaning air flows from the rooms to the corridors)
- With the concern of aerosol transmission in hospitals, HEPA filters were considered but these are hard to retrofit because the pressure required to force the air through the filter. Extra fans, often located in ceilings would be required, however usually these are not practical
- However other high efficiency filters can be retrofitted

AIRPLANE VENTILATION DESIGN AND COVID

- Laminar air flow
- Air enters in the ceiling and is exhausted below at floor level
- Individual air nozzles cause turbulence due to fast nozzle velocity
- Person next to you can be at risk (see diagram)



Recommendations:

1. All wear masks
2. Do not use individual air nozzles

OFFICE BUILDING VENTILATION DESIGN AND COVID

- Dilution of inside air with outside air is key to reduce the risk of microdroplet spread
- Offices usually have a minimum two complete air changes per hour, but a well-ventilated office may have six changes per hour (an operating theatre may have 20 changes per hour)
- The usual mix of office air is about 15% outdoor air and 85% recirculated
- Often this can be increased. As a rule of thumb, most commercial ducted systems should be capable of handling up to 30% outdoor air component, subject to how the air intake ductwork is sized and configured. Often only minor changes are required to facilitate a larger outdoor air component
 - But the systems are designed to cope with the extremes of climate (hot /cold) and so usually cannot exceed 30%-70% when weather at the extreme
 - At other times of the year when there is less stress on the system they could be capable of processing substantially more fresh air, subject to the configuration of their outdoor air intake infrastructure.
 - In most cases, air intakes are not designed to cope 100% fresh air

FILTERS IN DETAIL

HEPA (High Efficiency Particulate Air) traps 99.97% of particulates 0.3 microns or larger. They trap air contaminants in a complex web of fibres. Depending on the size of the particle, this can happen in four different ways:

- 1) Inertial
- 2) Impaction
- 3) Diffusion
- 4) Interception (Sieving)

- HEPA filters require high force of air and so are usually not suitable for retrofit without extra fan power
- However, other high efficiency filters may be suitable for retrofitting

MERV rating of filter efficiency: the international metric system that reports a filter's ability to capture larger particles between 0.3 and 10 microns (μm).

- MERV system developed by ASHRAE
- MERV1 (least filtration) -> MERV 17 (most filtration)
- In a study undertaken by Stantec, it was found that **MERV 15 filters are the highest efficiency filters that can typically be retrofitted to existing commercial HVAC systems without requiring significant infrastructure upgrades.**
- Does not need high-pressure drop across the filter

MERV Rating	Average Particle Size Efficiency in Microns
1-4	3.0 - 10.0 less than 20%
6	3.0 - 10.0 49.9%
8	3.0 - 10.0 84.9%
10	1.0 - 3.0 50% - 64.9%, 3.0 - 10.0 85% or greater
12	1.0 - 3.0 80% - 89.9%, 3.0 - 10.0 90% or greater
14	0.3 - 1.0 75% - 84%, 1.0 - 3.0 90% or greater
16	0.3 - 1.0 75% or greater

Clarification on the particle sizes and MERV filters

- Coronavirus virions are on average 0.12 microns
- Droplets carrying coronavirus can vary from <1 micron to 100 microns. The smaller ones are going to travel further through ventilation systems.
- The MERV 15 filters have nearly 100% efficiency from 1 micron up. It would only be the very small droplets (say 0.5 microns) which may go through, as they have only 80% efficiency at this size
- Even some less-expensive filters have good efficiency with >10 micron-sized particles

COULD ULTRAVIOLET TECHNOLOGY FIGHT THE SPREAD OF CORONAVIRUS?

[COLUMBIA UNIVERSITY NEWS, 30 JUNE, 2020:](#)

"A technique that zaps airborne viruses with a narrow-wavelength band of UV light shows promise for curtailing the person-to-person spread of COVID-19 in indoor public places.

"The technology, developed by Columbia University's Center for Radiological Research, uses lamps that emit continuous, low doses of a particular wavelength of ultraviolet light, known as far-UVC, which can kill viruses and bacteria without harming human skin, eyes and other tissues, as is the problem with conventional UV light.

"Far-UVC light has the potential to be a 'game changer,'" said David Brenner, professor of radiation biophysics and director of the center. "It can be safely used in occupied public spaces, and it kills pathogens in the air before we can breathe them in."

[NEWS MEDICAL LIFE SCIENCES, 8 JUNE 2020:](#)

An article entitled "**Irradiation with UV light kills SARS-CoV-2**" had the following conclusion:

"Researchers in Italy have found that it is possible to completely inactivate severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) using short-wavelength UV (UV-C) irradiation.

"At a viral concentration equivalent to the low-level found in settings such as hospital rooms and to the level typically found in the sputum of coronavirus disease 2019 (COVID-19) patients, a very low dose of UV-C radiation was sufficient to inactivate SARS-CoV-2 completely.

"At a viral input equivalent to that found in terminally ill patients, a higher dose of radiation also completely inactivated the virus.

"Mario Clerici (University of Milano) and colleagues say that since UV light from the sun seems to be effective at inactivating the virus, the findings could explain trends observed in the distribution, incidence, and spread of SARS-CoV-2."

At this stage, there have been no scientific trials of retrofitting UV light into office HVAC systems although many UV suppliers are applying pressure to HVAC engineers to buy their products.

MELBOURNE IN STAGE 4 LOCKDOWN – IT'S TOUGH

WHAT WENT WRONG? A LESSON FOR THE WORLD

Following the March/April country-wide lockdowns, Australia appeared to have successfully suppressed COVID-19 and had eradication in its sights. However, since June, an outbreak in Melbourne has exploded. It is thought to have started with failures in the hotel quarantine of arriving international travellers.

In early May over 100 cases were eventually linked to a virus cluster among workers at an abattoir in Melbourne's west. Rapid trace-and-track response had been instituted. Lockdown restrictions eased a month later, allowing people to again visit friends and family, and eat out at restaurants. However, it is now believed that secondary cases from the abattoir cluster were already growing undetected in the community.

Some became complacent

With the relaxation of lockdown and Australia's apparent success, the public also became less vigilant. Officials were still recommending social distancing, but group limits were expanded. Large family groups reconnected, and some cases stemmed from people with mild symptoms attending those gatherings.

"Once the feeling got around that it was over - when it really wasn't - then Victoria copped it," Prof Ian Matthews from Melbourne University said.

Poor messaging to non-English-speaking communities

The locked-down "hotspots" in Melbourne's north and west have large migrant communities. A language other than English is spoken in almost 35% of households. It is suspected that communication of public health orders was insufficient for non-English speakers, and this was exacerbated as restrictions rapidly changed throughout May.

STAGED LOCKDOWN: INCREASE OF INTERVENTIONS DID NOT HALT THE OUTBREAK

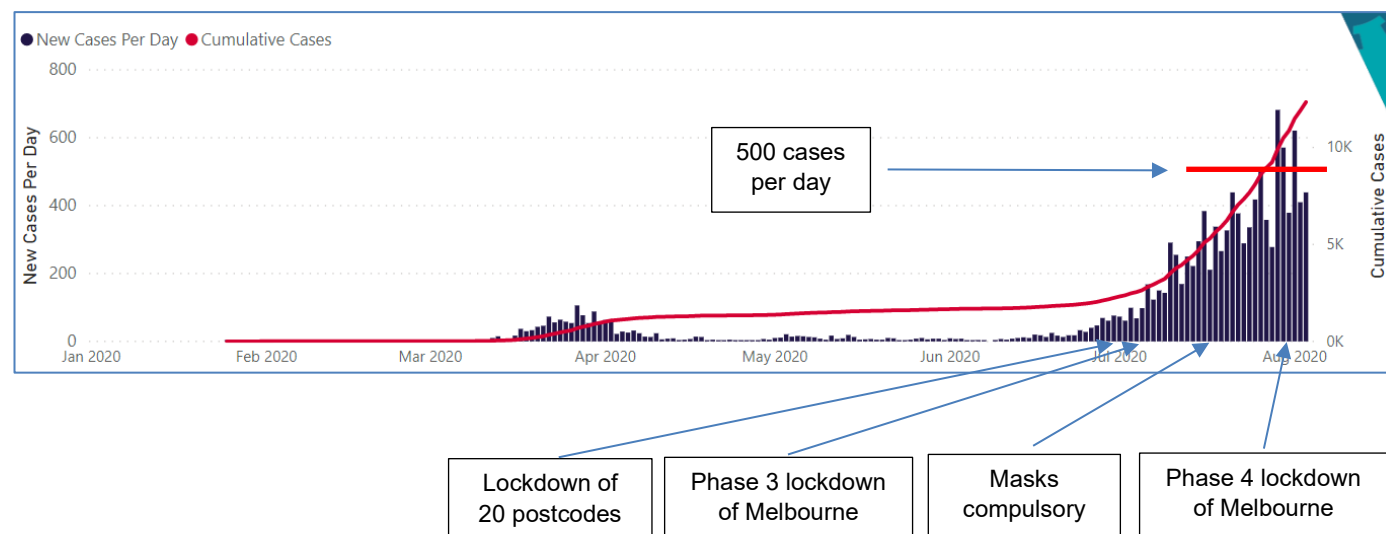
- 1 July: 20 Postcodes go into lockdown
- 7 July: All of Melbourne Phase 3 lockdown
- 19 July: Mask compulsory outdoors
- 3 August: All of Melbourne Phase 4 lockdown / rest of Victoria Phase 3 lockdown

Some of the issues identified:

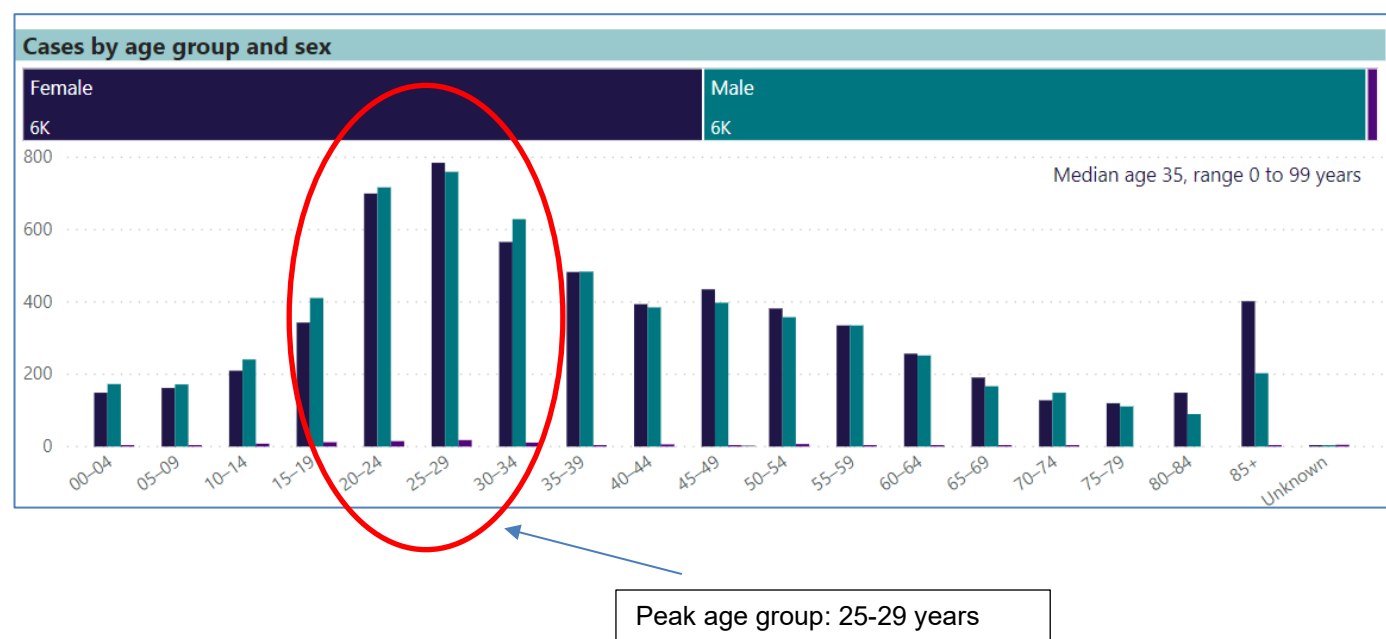
- Going to work while sick (some could not afford not to work)
- More than half of newly infected people had not self-isolated while waiting 48 hours for their test result
- Nine out of 10 failed to immediately get tested after feeling symptoms
- One in four confirmed cases not at home when checked on by authorities
- Young people having parties
- Some are claiming lockdown rules breach their human rights
- Management of the Aged-care system (managed and funded by the Australian Federal Government)
 - Now over 500 residents of aged-care homes infected / make up many of Victoria's deaths
 - Many staff "personal care" workers / minimal training / many newly arrived in Australia
 - Many staff are casually employed / no sick pay
 - Many staff not trained in PPE
 - Many staff working in more than one aged-care home and so transmitting virus between facilities
 - Some aged care homes did not separate infected from non-infected residents
 - In some aged-care homes, 50% of infected residents have died

THE CURRENT EPI IN VICTORIA

COVID-19 cases in Victoria (source [Victorian State Government](#))



Cases by age group and sex (source [Victorian State Government](#))



PHASE 4 LOCKDOWN IMPLEMENTED AND STATE OF DISASTER DECLARED

Premier Daniel Andrews: "The time for warnings and cautions is over"

- Industry-wide shutdowns
- Stay at home order
- Curfew: 8pm to 5am with limited exemptions
- Supermarkets, pharmacies, bakeries, and butchers remain open
- One shopping trip per day by only one person for each household
- Exercise or shopping must be within 5km of home
- Restaurants can provide takeaway meals only
- Confirmed cases cannot leave home to exercise
- Essential workers need documents signed by employer to leave home
- Defense Force personal and Police to monitor streets

THE HOPED-FOR OUTCOME

- It is expected that the Phase 4 lockdown in Melbourne will suppress or eradicate COVID
- Victoria may then be in lockstep with the rest of Australia which seems now to be pushing for eradication a la New Zealand

A VIEW FROM THE LABORATORY: PROFESSOR JOHN OXFORD

Two weeks in the life of COVID-19 and Johnny Depp

Last week I camped in the Wye Valley, miles from internet sites, TV and even newspapers. When I started the holiday every newspaper and TV was in touch and demanding explanations of R_0 , aerosols, masks and so forth. But on the day I returned to London it was as if the world had been reinvented, Headlines were about the film star Johnny Depp and his wife falling out with accusations of battering, money and divorce. I always knew that news is fickle.

Now we were back again from vacation but half-heartedly I read about COVID-19 but with new twists: "Angry UK holiday makers in Spain have to be self-quarantined when they return home". They are photographed with masks askew and complaining faces. "We didn't even see a case in Spain".

And here we have, exposed again, a basic ignorance or our self-disdain of the new virus. The Prime Minister had declared that we are "waking up from our hibernation". But I know of no natural animal hibernation where 65,000 participants have died. There followed a focus on Mr. Johnson, his weight as disclosed from the teaching hospital, where he was treated, was 16-17 stone. Now, by any standards, he is in a high-risk group along with his age. He had already set a poor example by continuing to shake hands and greet people as before. Even his inner scientific/political team became infected and at least one broke the principle of the lockdown rules.

The UK became one of the biggest "buyers" of COVID-19 vaccines even before evidence of efficacy

The UK pandemic plan published around 2014 envisaged a shortage of vaccines at the time of any pandemics. The document appreciated that countries making the vaccine would have priority over other countries. A way forward then and now is to pre-order. In other words, "take a gamble".

So even before we know licensing date and efficacy of a vaccine, governments can agree to buy vaccine. In this way the UK now becomes the proud "owner" of four different vaccines with a theoretical stockpile of 250 million doses. The latest edition to the "stockpile" is 60 million doses of the GSK/Sanofi Pasteur vaccine. This is in addition to the 100 million doses of the Astra Zeneca/Oxford Institute vaccine and 90 million doses of two others.

The plan is to vaccinate priority groups such as healthcare workers and the elderly in the first half of 2021. The UK has expectations to buy into a total of 12 vaccines. It seems that having failed the country in preventative medicine so far, making the UK the EU capital of excess deaths, they want to make up for this by vaccinating the survivors.

The scientific idea is to pre-purchase vaccines which work differently:

- The GSK vaccine is like a flu vaccine focussing on the spike protein
- There is the Astra Zeneca vaccine based on the chimpanzee adenovirus of “a live carrier” and which cannot go on to replicate further. The single virus cycle provides the cell with a blueprint to make COVID-19 “spike” protein
- The Moderna group vaccine focuses on injecting RNA into the cell. Other vaccines use science such as genetically modified live virus hopefully attenuated (like polio) and whole virus killed (hopefully killed by inactivity)

One cannot argue with the strategy, and I do not. I shall be pleased to unroll my shirt sleeve and receive a dose, hopefully before Christmas!

I have looked back to the older scientific literature with Beta Coronaviruses. Natural infections can give quite good protection for at least a year. So, I am personally optimistic that many of the 100 or so vaccines under development will work.

I expect many people will be surprised at the immense size of the Pharma Industry in China. Much as they have supplied the world with steel and electrical goods, I can see that their production of vaccines will be huge. Russia may have the first licensed vaccine and one of their team called it a “sputnik moment”.

Polio and the start of ICU's to the modern day

Polio causes respiratory failure and in the crisis of the global epidemic seventy years ago, many adults and children needed assisted breathing. An early ICU was set up in Copenhagen by B. Ibsen. The patient was anaesthetised, and mechanical assistance given using a bag attached to a tracheostomy tube.

Now ICU's are run by trained nurses on a 1:1 basis. At the height of the COVID a few weeks ago, this ratio was reversed in the UK to 1 nurse/doctor for 5 patients. The nurse is viewed as an airline pilot with eyes on all the dials as highly trained and experienced.

A very positive trial in the UK has been “Recovery” allowing randomised control trials of new and existing drugs. This venture uses the strength of the NHS.

But a side effect of the ICU is now recognised as post-traumatic stress disorder (PTSD). Now psychotherapy is introduced while the patient is in the unit.

Obviously, the Salk and Sabin vaccines alongside hand hygiene and sewage containment conquered polio. I am sure we will do the same with COVID. It is a perfectly ordinary virus but needs our serious scientific attention. In fact, I have never before seen such interference during pandemics by non-scientists (1957, 1968, 1977, 2009) as we are experiencing today.

Pandemic plans for the future

Dr. Laha from Preston and a critical care consultant commented in the Guardian newspaper that his unit was overwhelmed in the (mild) flu pandemic of (H1N1) in 2009. But H1N1 was forgotten about almost immediately and there was no consideration how intensive care could be improved. Could all this happen again?

Personally, I contributed to meetings on the UK pandemic plan. I was pleased that the Department of Health rehearsed the plan a few years ago. But I had no inkling that since that time a new breed of politicians who were more interested in balance sheets and so counted down the stockpiles and reduced training. Public Health experts around the country quietly disappeared. So, this year we were bereft of masks, gowns, and ICU equipment. We will have to be more alert in the future.

How dangerous were recent influenza epidemics in the UK?

I was sent a table this week by a journalist writing in the Daily Mail. She had collected mortality figures from influenza and also the number of patients in ICU. The figures rather dismayed me, especially when we had plenty of influenza vaccine on offer at that time.

There were 18,000 flu deaths in 2016 and 26,000 in 2017. I suspect that these figures actually underestimated the total. So, a bad “flu” year can have the impact of a COVID-19 year!

Did we ignore flu during that period or are we overreacting to COVID-19 at the moment which gives us figures of 45,000 deaths in the UK? I believe that, when we have time, the comparison needs to be more closely examined.

The at-risk groups are the same, people over 65's, people with diabetes and who are overweight, or with pre-existing heart disease etc. Vaccine rates for flu have never exceeded 70% in most countries. So will COVID-19 settle down, like flu, to take its death toll without too much bother? Could COVID-19 displace flu or work alongside it to cause even more trouble? Could COVID-19 be displaced by an “experienced” virus like influenza.

Will we ever know the full extent of COVID-19 inflicted death and serious illness?

The more I look back to 1918, the more I begin to realise that with the best will in the world we will never know the full impact of the Spanish flu or COVID-19! The 1918-1919 Spanish flu's 100 million deaths is one for the Guinness Book of Records. Those figures are quite widely accepted now by epidemiologists and historians alike, but they climbed from early estimates of only 20 million.

We are personally experiencing how quiet deaths can be in care homes and at home. In 1918 many patients died quietly at home without too much fuss. After all, Europe and the nations of the British and French Empire's had already suffered over three million deaths in World War 1.

The same age groups were attacked by Spanish influenza (25 year-olds) as died in the war. Incidentally, I would call it the ‘American flu’ if I believed the old reports in the textbooks and if I were a politician on the rampage.

American historians now describe a virus emerging in Texas in 1918 and spreading eastwards. The story has been swallowed wholesale except that the recent analysis of the epidemic itself contradicts this. American epidemiologists now describe classic Spanish influenza in young people in Boston with heliotrope cyanosis in 1916/17 which then spread westwards across America to Texas. So perhaps we should hear less about “Chinese Flu” currently and we in our turn will keep quiet about “American” influenza!

One thing the American's did well 100 years ago was to react quickly. Masks, handwashing, social distancing, theatres closing, etc. were enacted quickly by some large USA cities. These interventions delayed the peak mortality and flattened the mortality curve. On the other hand, cities that procrastinated suffered quickly.

But to return to more secure, but still shaky ground, COVID-19 has quickly discovered the soft unprotected underbelly of our society in the elderly, perhaps alone, or just lonely souls living out their twilight years sometimes forgotten, sometimes not, "homes of the elderly".

The other deaths from COVID were more or less ignored, at least in parts of the UK, and pushed to one side and even not calculated. And why? Well I feel we have been exposed to a group of self-proclaimed "experts" on pandemics. Unfortunately, many had not heard of "excess deaths" and perhaps even believed what was written on death certificates?

My colleague and I have looked at the certificates from soldiers in camps in France in 1916, 1917 and 1918. Surely the RAMC would have accurate figures. But many deaths from influenza are simply recorded under cause of death as "died".

So, in the UK, the elderly died quickly at home, or aged care facilities, from COVID, just as young people did in 1918. When the social history is written I fear that the reputations of many scientists who provided cover support for the lack of action of the politicians will suffer.

At the moment, around the world the virus has relocated to sub-groups in societies including poorly paid immigrants working in meat processing plants and abattoirs and living ten to a room. They are folks desperate for money and carry on working, regardless of social distancing etc.

And so, the adage of public health, "**we are only as strong as the weakest link**" returns to haunt us.

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