

to work on areas where a factor of ten shift in technology is needed.

The building itself has been designed around science, providing an environment that mixes biologists and physical scientists to create something special. We have a unique electron microscopy facility, extensive tissue culture, a next generation chemistry lab and a dedicated mass spectrometry workshop. From the start we

have designed features in the building to encourage collaboration and technology development. We are welcoming engineers, physicists, chemists, biologists and medics from our university partners and from industry. You could say we are increasing collisions to get a reaction.

FUNDING FOR DIVERSE PROGRAMMES

There are no 'silver linings' of COVID-19, but one outcome

seems to be a recognition of how important it is to have a high-capability science base. This needs to include funding for what might seem to be esoteric programmes, such as antibodies from llamas, that subsequently turn out to be crucially important. We welcome the Government's recent R&D Roadmap announcement as a step towards this, along with the increase in public investment in research and development to £22 billion in the next five years.

For the UK to become a 'science superpower' however, the kinds of disruptive discoveries we aim to foster will be more important than ever.

There's a vital role for experimenting in innovative ways with new technology. We believe that's a view Rosalind Franklin would support. □

THE SCIENCE OF COVID: LESSONS TO BE LEARNED FROM THE FRONTLINE



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The Covid pandemic is a witches' brew. The recipe starts with environmental destruction, changes in animal husbandry and 'wet meat' markets abroad, mixing different species in high density and in close proximity to humans. We then add the virus itself.

Until recently, only four coronaviruses infected humans, causing generally mild upper respiratory tract disease. But in only 17 years, three more have jumped from animals to infect humans: SARS-CoV-1 (from bats/civets) in 2003, MERS (from camels) only 10 years later, and SARS-CoV-2 (which causes COVID-19 disease) seven years after that. Whilst SARS-CoV-1 and MERS were highly dangerous (killing 14% and 34% respectively of those infected), they were not hugely infectious. SARS-CoV-2 is different. It still kills 1-2% of those infected (compared to 0.1% for seasonal flu), and one in 5 of those over 80 years of age. But it is highly contagious through droplet spread (over 2m or so distance), by hand through

contact with surfaces on which those droplets (and then contact with the mouth or eyes) but also (perhaps to a lesser extent) through distant aerosol carriage.

Add an incantation of 'we must all now meet again, on hols and boardroom and on plane'. Fifty-nine years ago, not a single commercial airline passenger had ever flown in a jet. By the end of 2004, two million jet passengers flew each year. In 2019, 144 flew every second.

Don't forget the inequality and poverty. The poor tend to live in close proximity. And when you do lock down, they have to go to work, often in public facing roles (care workers, shops, public transport). They are far more likely to have the sorts of diseases which make severe

COVID more likely (obesity, diabetes, high blood pressure and more).

Delay lock downs, and watch as each person infects 3 more. Who each infect three. By the 10th cycle, nearly 90,000 people have been infected. Over 1770 will die. On 11th January, there were 41 cases worldwide. Eleven weeks later, there were over 4 million. By late September, there had been over 31 million.

On the frontline in Intensive Care Units (ICUs), we heard the roar of the approaching tsunami, but could not truly be prepared. This was unlike any other disease we had ever seen-affecting the lungs, yes, but also (we learned as we went along) the brain, nerves, muscle, heart,

kidneys, liver, immune and blood clotting systems. 'Intensive Care' was practiced on general wards, by nurses without ICU experience. The sickest went to ICU, cared for by trained staff but also by dental receptionist volunteers. Drugs ran short. Many patients stayed for weeks or months. Upwards of one in three ICU patients would die.

However, much good appeared from the crisis. The red wax of bureaucracy melted away, and research trials received ethics clearance in days rather than months. Approvals to work happened in hours. New ways of working appeared overnight: telemedicine consultations became an immediate norm. While lives were lost when the sick failed to seek help, or when screening stalled, emergency departments were empty of those who, by and large, had minor self-terminating illnesses. With bars shut, trauma units were empty: nobody was getting drunk outside, fighting or falling or crashing cars. With few cars on the roads, pedestrians and cyclists were not run over. The air was clean of particulates and nitrogen oxides, meaning that cases of asthma and other lung diseases fell.

Britain had invested in Universities, which leapt into action as staff provided clinical and research leadership. We had a vibrant tech development and manufacturing capability. Partnerships with academia appeared, and new ventilatory support devices were created and cleared for medical use in days. We had invested in a National Institute for Health Research (NIHR) which was able to work with them to establish massive trials- which yielded the most effective treatments (steroids) yet found in the world. We had invested in 'Big Pharma' (such as Astra Zeneca) who

could work with those academics (such as those in Oxford) to develop a vaccine.

There were gaps, though: we *still* don't have an integrated collated set of all NHS data. Had that existed, we would have been able to rapidly work out what management worked best- why one centre was doing better than another- and run trials with even greater efficiency.

We also know a lot more about the disease too. Perhaps half of those infected have minor symptoms, or none at all. Infectivity is greatest in the two days *before* symptoms appear. And we know who is at risk: men (more than women), BAME groups, the obese and, most of all, those who are older. Mortality rates in those under 20 are close to zero. Even in those under 65, mortality is probably only a little over 1%, and most of that in high risk individuals. This raises the question of the preventative approach to be taken: could we let the disease run wild in otherwise healthy the young and middle aged, whilst maintaining an economy and a functioning health service and shielding the at risk groups? Certainly, we are all seeing a large number of patients presenting with advanced or terminal disease who might otherwise have been treated or cured if seen earlier. And no health service or social care system can function well if our nation descends into debt.

But there are other lessons. We face a climate crisis in just one generation, the impact of which will utterly dwarf the impacts of COVID. Only in January, Australia was ablaze. Now, so too are Indonesia, Borneo, Congo, the Amazon, and at least three US states. The Greenland ice sheet alone is losing >1million tonnes of ice a second. Sea levels are rising by nearly 1cm every two

years already. Crops are failing- our own wheat crop being drastically impacted by extreme weather this year. Just as for Covid, the lessons have been noted. But will they be learned?

- Invest in 'Public Health', recognising that most such activity occurs outwith the traditional 'health' space- in agriculture, transport, urban planning, taxation and more. We need to curtail the use of antibiotics in agriculture, a major driver of the emergence of antimicrobial resistance. We must create an agricultural system which promotes production and provision of cheap healthy food with low air miles, and which makes obesogenic foods more expensive: less disease spread, fewer greenhouse gases, less obesity (and thus Covid deaths). We should build on the fall in flying, not rush back to promote it, any more than we should a return to 'boozing Britain' as a way to drive our economy. Economic stimulus packages should not deliver more runways and roads, but walking and cycle paths, tree planting and parks, and clean secure energy generation. Again, less obesity and less pollution. An estimated 1m smokers have quit during the Covid
- crisis: capitalise on this, increasing tobacco taxation and 'quit' messaging.
- Actively reduce inequality and poverty, which drive non-communicable disease and susceptibility to infectious agents, and value those who do those jobs upon which we all depend.
- Connect all NHS health data
- Create a new vision of Great Britain and what it is for- not an economy that simply recycles money in service, but which creates and contributes to green tech design and manufacture.
- Invest in the UK pharmaceutical industry and in university research facilities, and facilitate partnerships between them both
- Burn the red tape of trials: establish a small expert group of frontline researchers and pharma to determine the most efficient route.
- Bolster international collaboration: as healthcare professionals, we shared knowledge with Israel, Iran and Qatar, and with China, Korea, Italy, Germany, Australia, America and more. Collaboration is good for health, politics and peace.

Insanity is doing the same thing and expecting a different result. Now is the time to learn the lessons and act upon them. We must change – but not by any small increment. Now is the time for disease-stimulated and science-led imagination and transformation of our society.

Who will have the vision and who will carry the torch? □