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Covid-19: Singapore's Experience

When I first heard about the strange pneumonia cases in Wuhan in December when I was on vacation in Japan, I felt a cold shiver down my spine. I recognized the hallmarks of “cytokine storm” as reported in the CNN article. Little did I realise that my instincts were prescient of this global pandemic that has infected 1.76 million and left 108,000 dead as of today (update as at April 23 - total infected: 2.638m and total deaths:184,249).

Timeline

When the COVID 19 virus came to Singapore, it was from Wuhan residents who had come to Singapore. We diagnosed our first case on 23 January 2020 that was an imported case from Wuhan and we had our first local case on 4 February. These local cases were in retail trade and had contact with tourists that originated from Wuhan.

Our original strategy was to use contact tracing to find links to the original imported cases. We continued to have local spread with cluster of cases and these were managed with contact tracing. We went into heightened state of alert of Dorscon* Orange from Yellow on 7 February when we could not find a link of 3 local cases with the previous cases or clusters. This heighten alert involved measures for large scale gatherings, daily temperature checks at school and work, controlled access to hospitals, preschools and eldercare facilities.

Other ongoing measures included thermal screening at the airport for travelers from Wuhan since early January; extending to all travelers from Hubei on 27 January. On 31 January we required work pass[#] holders coming back from city of Wuhan to be on leave of absence from work for 14 days on returning to Singapore. We have a large population of Permanent residents and work pass holders in Singapore. On February 1 we stopped all travelers coming from Hubei province into Singapore unless they were citizens, permanent residents or work pass holders. If they came back from Hubei province, they had to serve a leave of absence of 14 days. This leave of absence involved payment of allowance of approximately SGD99 daily by the state to the individual.

The economic toll started to affect Singaporeans and we rolled out a scheme to subsidise taxi drivers and private hire drivers on February 1. Other measures were announced to subsidise hotels and businesses that rely on tourism. The government has rolled out economic measures three times on 18 February, 26 March and 6 April. These measures involved helping tourism, aviation sectors, food and beverage sectors, cash flow for small businesses and importantly, to position Singapore for the recovery when it comes. The measures have totaled SGD60 billion, some 12 percent of the GDP.

On 18 February we tightened the border against all travelers coming back from China, they were allowed to come to Singapore but had to serve a **Stay Home Notice** of 14 days. At the end of January we had 16 cases, that increased to 102 cases at the end of February. Somewhere at the end of February we tightened our borders against epicenters in South Korea. We proceeded to close our borders further on 4 March against northern Italy, whole of South Korea and Iran. By 16 March we closed our borders to Europe, Japan, ASEAN countries including our immediate neighbor Malaysia. We have one of the biggest land crossings on Earth with Malaysia involving 450,000 persons daily. By 20 March we had almost closed our borders and required short term visitors to serve Stay Home Notices.

Stay Home Notices were served on persons coming back from various countries and lasted 14 days. This was different from quarantine orders that were served on contacts of known COVID 19 patients. To date we have served 64,400 Stay Home Notices, 11,700 are still serving these Notices. The quarantine orders total 26,189 and 10,575 are still serving their quarantine orders at the time of print.

By mid March we had 226 cases of COVID 19 patients in Singapore and our contact tracing had confined the local cases of 7 clusters. Somewhere starting from 11 March we started noticing imported cases coming from Europe, Japan and Philippines. BY 17 March we were telling our Singaporean students studying aboard to come home. All students coming home would have to serve a Stay Home Notice.

By 21 March we had our first 2 deaths from COVID. That was sobering and the next day, we had closed our borders to all visitors except for our citizens, permanent residents and work pass holders. At 10 March we had 166 cases and by the time we closed our borders completely on 22 March, we had 455 cases. From then on we continued to escalate and had 920 cases by the end of March. In the first 11 days of April we now have 2,299 cases.

As a result, we had to issue a lockdown on 7 April, in Singapore we call it a “Circuit breaker” as it would be easily understood; the word “lockdown” is American colloquialism. We closed all non essential services; all workplaces had to shut down and employees would have to telecommute. We also issued reusable masks to all residents in Singapore from 5 April.

Second Wave of infections

We are facing a second wave of infections with more unlinked cases and surge of migrant worker cases since the return of 63,000 plus citizens and residents to Singapore from Mid March. Part of this surge had come from 696 cases in fourteen foreign worker dormitories and construction sites. We also have 515 unlinked cases that we could not establish causation via contact tracing that likely indicates limited community spread. We did very well up to early March with our aggressive approach of contact tracing; at the peak we had 4,000 contact tracing daily by 20 teams doing investigative work.

We managed to flatten the curve up to mid March but the returning wave of citizens and resident from across the globe imported many infected cases. When the patients returned,

we allowed them to complete their Stay Home Notice within their domicile and with their families. We had 1,200 residents coming back from the UK and US in mid March. It is estimated half of those coming back from the UK carried the virus. This coupled with some non-compliance of the Stay Home Notices and the infection of their families triggered a second wave. The lesson was learned and from 25 March we transported residents coming back from US and UK directly to hotels to serve out their fortnight stay. The government had booked some 8,000 hotel rooms for this exercise with cost borne by the government.

Migrant Worker Dormitories

The other surge we had was the dormitories. We have more than 200,000 foreign workers living in 43 dormitories. There are 6 dormitories that have been locked down and the logistics of isolating tens of thousands of workers, distributing meals, maintaining cleanliness, hygiene and sanitation; and ensuring safe distancing despite toilet needs, personal activity and remitting monies home to their families has been challenging. A multi ministry task force including the police and army is handling the situation. There is also detecting the sick, swabbing and isolating the ill that is ongoing by the army medical corp. As the dormitories are crowded, the different agencies are also providing alternative housing of these workers to social distance them and decanting them to community isolation facilities in a massive exposition centre and army camps.

Health system status

Despite the increases, our health care system remains intact with 31 ICU cases, 912 cases warded and 820 moved to community isolation centers. We had the previous experience of SARS outbreak in 2003 with H1 N1 pandemic in 2009. The institutional memory of these two events is still retained within the politicians /Ministers and the civil service. The leadership had instituted preparations, planning and logistics since 2003. Some of the preparation included building stockpiles of oseltamivir and PPE, building an N95 mask factory in Singapore, mandating the building of isolation rooms in every public sector hospital, increasing ICU capacity throughout the public sector and building a new National Centre for infectious Disease (NCID) that opened in September 2019. We currently have 1,000 isolation rooms with 330 such rooms in the new NCID building. There are estimated 700 ICU beds across the public sector in Singapore. The NCID is now bearing the brunt of the COVID 19 infections; the centre is handling more than half of all COVID 19 patient load.

Perfect Virus

This virus is proving itself to be the perfect virus. I use the 80/20 rule to describe it. 80 percent of the patients have mild disease but will be well enough to transmit it further. In Singapore, a third of our patients are young and below 30 years old. These will have mild disease. The latest surge in the dormitories are also young migrant workers so we will expect milder disease. The other 20 percent is broken up into 16 and 4 percent. The 4 percent will need ICU care with ventilators so they will consume huge resources. The 16 percent will need oxygen to varying degrees.

There is the simple nasal oxygen prongs running oxygen flow at 2 to 4 litres per minute. The next level up is the Venturi mask that can run 10 to 15 litres per minute but causes

aerosolization so you need isolation rooms. If the patient deteriorates further you need BIPAP machines; these are similar in principle to CPAP machines for sleep apnea patients. You have generation of a pressure head of oxygen flow to open up the pharyngeal airway and the lungs. The machine has dual pressure, the higher operates when you inspire and the lower triggers when you expire so it makes expiration easier against the pressure head. However, these machines can generate high pressures and cause barotrauma so you need monitoring by nurses in high dependency. There is also some degree of aerosolization.

In Italy, Spain, Wuhan and New York, your curve generates so many patients that you saturate your ICU capabilities quickly, followed by your BIPAP and high dependencies; soon you saturate your Venturi masks and isolation rooms and finally you don't even have enough oxygen points. At that point, patients come into hospital, gasp, collapse and die in their beds due to overwhelming of resources.

Cytokine Storm

A brief word on "Cytokine storm"; this is where there is a huge viral load in the host and the host launches an overwhelming response and the resultant war kills the host. In our SARs experience during post mortems of healthcare workers that perished; the lungs were heavy, filled with inflammatory fluid and white blood cells. The perished healthcare workers practically drowned in their own fluids. Hence today you have the use of ECMO machines in critically ill that can oxygenate the blood by passing the lungs. The key thing to remember is that your healthcare worker is more frightened of this virus because our immune response will be primed to deliver a massive response. Therefore, it is imperative to protect your healthcare workers with PPE.

Incubation period and Serial Interval

The other interesting data that has emerged is that the mean incubation period is short at 4 days. The median serial interval which measures how fast the spread of virus occurs in a chain of transmission is also 4 days. If you think about it, you can only get good serial interval data from good contact tracing. This all means that there is **pre-symptomatic** spread of the virus. There is also data that shows that the viral load in our local patients is highest in the first few days of symptoms and gradually reducing to the eighth day. Hence it is important to have universal masking, hand hygiene and social distancing.

Droplet spread

We are currently getting all residents to mask whenever they leave the house, in the markets and on public transport in the midst of the Circuit Breaker. Hand hygiene is paramount as the virus is spread by droplets. The droplets fly a distance of a meter and settle on surfaces. The virus is protected by the mucus envelope. On most surfaces, the mucus dries in 30 to 60 minutes and the virus dies. If one touches the droplet and then touches one's face, the virus will likely enter via mucus membranes of the eyes, nose and mouth. Touching or flicking the hair will allow the droplet to stay on the hair ensuring its prolonged viability. Headgear will protect the droplet viability further. If someone asked if it was aerosol or droplet, we still maintain it is droplet spread as the infectivity ratio is still 2 to

2.5. That is to say, one infected person infects two to two and a half persons. If it was indeed aerosol, one would infect fifteen persons as in the case of measles.

Our initial emphasis was on hand hygiene and social distancing, we did not get the population to mask up. This was because there was concerns that the population would use and hoard surgical masks competing with the healthcare workers for precious resources. We have N95 mask factory in Singapore but we do not have surgical masks manufacturing as it is considered low value added.

As for social distancing, there is public messaging to stay home, not leave the house unnecessarily except for groceries and not to visit elderly parents as they are most vulnerable. There is currently enforcement of these messaging in terms of advisories issued to the public by police and not punitive fines.

Testing

We can also talk about testing, we are still doing DNA PCR testing to detect the virus itself as that is the gold standard. We were running 2,000 tests daily up to recently and that is stepped up to 3,000 daily currently. The testing so far is 73,000 tests done and testing rate is 12,800 test per million population. We are still controlling the test criteria. The patient must have clinical signs and symptoms; evidence of pneumonia or exposure to the virus. The criteria have broadened to include those patients with acute respiratory illness of 4 days duration or more. We have also triaged patients at emergency rooms with a Swab and discharge policy. Those who are clinically ill are admitted while the milder cases go home and self-quarantine while the results are pending. On the matter of the antibody kits, the antibodies probably appear 5 to 10 days after patients become symptomatic. The detection of these early antibodies is probably in the order of 90 percent detection. The cases that are missed because we tested too early will go on to trigger subsequent waves of infection. Hence these kits are not useful in the current situation.

Treatments

In Singapore we have not used hydroxyquinine and azithromycin in patients; we are not impressed with the current data and the hype. We are using lopinavir/ritonavir in ill patients with addition of Beta interferon in selected cases. We are also looking at convalescent serum. There are also ongoing clinical trials involving Redemdesivir, hydroxychloroquine and biologics. My personal opinion is that there are few solutions to viral infections that are available off the shelf. We probably need to build an antiviral from scratch.

Vaccine

As for the vaccine, it will be a long struggle as so many things can go wrong in clinical trials. You start with publishing the genome that was done very early on this year on 10th of January. The vaccine makers started development since the publishing of the genome. If you look at the WHO list, there 60 vaccine projects on the WHO list and 2 have moved into early human trials currently. There are so many approaches for vaccines; the traditional way is to use a killed virus or a weakened live virus. These days we are engineering the key protein on the viral surface or taking the gene for the key protein and splicing it into a harmless

common cold virus, messenger RNA, DNA fragments or even into harmless bacteria that can bring the gene into the host.

On the topic of vaccine clinical trials, there are 3 phases; the first involve 10 to 30 patients and you are looking for immune response and safety, the second phase is with larger numbers of 100 to 300 patients and you are still looking for safety and immune response. The third phase is real world deployment with placebo controlled randomized trials. Realistically this will take 12 to 18 months and then anything can go wrong during the three phases.

Fighting disease

So it looks like the way forward is still public health, strange how little things have changed since the bubonic plague and the Spanish flu. However, in fighting disease, one is often humbled and I like to think of fighting disease as Hercules fighting the Hydra. Like the Hydra's many heads, disease comes in all forms and guises. The Hydra's blood and breath is poisonous, you chop off one head and two grow back. The only weapon you have is the Sword of Truth. When you are filled with hubris and think you are the great doctor, disease will strike down your patient to show you who is the boss. The fatigue has seeped in, we are in for a long struggle; the truth matters and this is done with transparency, publishing of daily data and statistics, depending on your experts to guide you on the changing landscape, keeping up with medical data that is published daily, clear constant communication with your public dispelling the fake news, speculations and conspiracies that are rife.

Our leaders in Singapore have the experience, institutional memory, logistics, preparation, monetary reserves, political will to act and the people's trust. I am optimistic that we will flatten the curve with the current lockdown, shorten the tail of the epidemic and then look to restart the local economy and eventually restart commerce with neighbouring countries that have brought the disease under control.

https://www.gov.sg/article/what-do-the-different-dorscon-levels-mean*

non-citizens or residents on employment passes