COVID-19: a global pandemic

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On 11 March 2020 the World Health Organization (WHO) announced that Coronavirus disease-19 (COVID-19) had become a pandemic, with 118 319 cases in 114 countries, and 4 292 deaths worldwide.[1]

COVID-19 is the disease caused by a novel betacoronavirus of the *Coronaviridae* family, that emerged from Wuhan – the capital city of the Hubei Province in China – in December 2019, 'when a cluster of patients were experiencing pneumonia from an unknown aetiology.'[2,3] By Januray 2020, the pathogen was identified, through whole genome sequencing techniques of samples taken from hospitalised patients in Wuhan,[4] and later named the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).[5]

Figure 1 illustrates the structure of the SARS-CoV-2. The outer capsule of the virus, known as the cuspid, consists of a lipid-protein envelope that surrounds the single stranded RNA. The club-like projections of the envelope are known as spike proteins. These proteins give the virus a 'crown-like' appearance, after which they were named – derived from the Latin word for crown – 'corona'. These spike proteins are adequately adapted to binding to the angiotensin-converting enzyme 2 (ACE2) receptors of lower respiratory track cells in humans, and other mammals.[6]

The origin of the COVID-19 virus is believed to be a zoonotic virus that was transmitted from an animal to a human. An investigation lead by Zhou et al. found that SARS-CoV-2 is '96% identical at the whole-gemone level'[7] to a coronavirus found in the *Rhinolophus affinis* bat species found in the Yunnan province of China, suggesting that bats are a reservoir host of SARS-CoV-2. In another study, Zhang et al. conducted a comparitive study on genetic similarities of coronaviruses found in Malayan pangolins and the *Rhinolophus affinis* bat. They found that the Spike S1 protein of SARS-CoV-2 was more closely related to the pangolin S1 protein and concluded that the pangolin could be a possible 'intermediate host' that caused the 'spill-over' to humans, but more research into identifying a possible intermediate host is needed.[8]

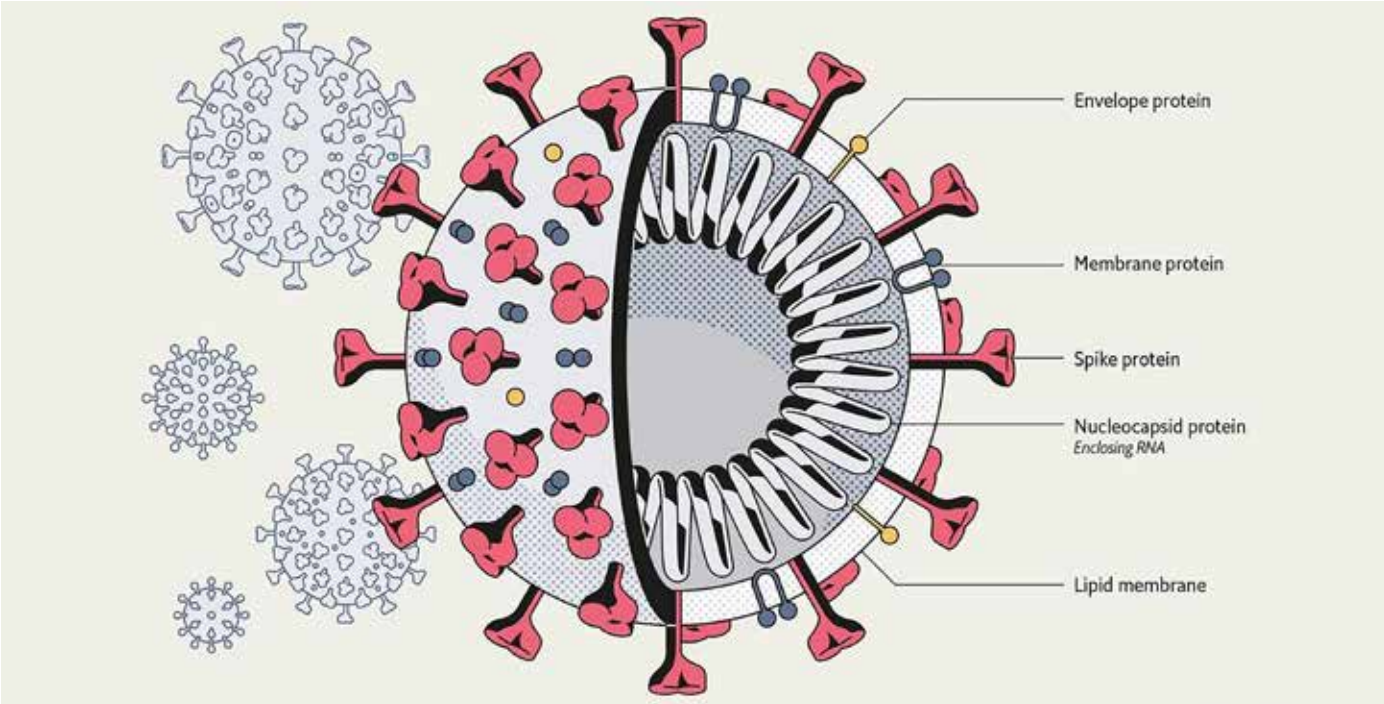

Figure 1: Diagram of SARS-CoV-2

https://www.economist.com/briefing/2020/03/12/understanding-sars-cov-2-and-the-drugs-that-might-lessen-its-power

SARS-CoV-2 is not the first coronavirus to 'spill-over' from animals to humans. Two other coronaviruses caused SARS-related diseases in 2002–2003 and 2012,[9] namely SARS-CoV-1, a bat coronavirus with a civet intermediate host,[10] and Middle-East Respiratory Syndrome coronavirus (MERS-CoV), that may have been transmitted to humans from Dromedary camels.[11]

Transmission

Respiratory viruses have three possible routes of transmission, namely through direct or indirect contact: either direct contact with an infected individual or indirect contact through a contaminated surface; or through contaminated droplets expelled through a cough or a sneeze, and lastly, via aerosols.[12]

SARS-CoV-2 is spread mainly through human-to-human interaction.[13] Human-to-human transmissions can occur through direct contact, such as shaking hands with an infected person. The second route of transmission of SARS-CoV-2 is by droplets. When an infected individual coughs or sneezes, they release droplets that contain virus particles which are either dispersed into the surrounding air or fall onto nearby surfaces and the floor. Another individual can inhale the droplets when they are in close proximity (within two metres) of the infected individual.[14]

A possible indirect means of transmission is through contact with a contaminated surface.[14] When contaminated droplets fall, after a sneeze or cough, or are transferred from an infected person's hand onto surfaces such as plastic, cardboard, or door handles etc., these surfaces could become another means of transmitting the virus to healthy individuals. Table I highlights the length of time the virus remains viable on certain surfaces.[15]

Although SARS-CoV-2 is a respiratory virus, there is much speculation around whether it is able to spread via aerosols (droplets of ~5 micrometres in size). A study conducted by Van Doremalen et al., showed that aerosols containing SARS-CoV-2 could remain airborne for three hours under certain conditions and stated that this knowledge could be used for medical staff to take extra precautions during aerosol-producing procedures (e.g. intubation) with COVID-19 patients, as these procedures could cause a fine mist of smaller droplets containing viral particles, which could increase the risk of infection in medical staff.[15] Therefore, all precautions should be taken into account, and medical and frontline workers have been advised to wear Personal Protective Equipment (PPE) when assisting COVID-19 patients and suspected cases.

Recently, emergency doctors from the Charlotte Maxeke Hospital in Johannesburg invented an innovative device called the 'intubox', which could be used by medical staff during any aerolising procedures on COVID-19 patients, to reduce the risk of infection of doctors and nurses.[16]

However, the stability of the virus in aerosols under natural environmental conditions still requires much research. Therefore, the general public is advised to wear masks when leaving their homes.

Table I: Stability of SARS-CoV-2 on surfaces[15]

Surface	Time (hours)
Plastic	~ 72*
Stainless steel	~ 48*
Copper	4**
Cardboard	24**

* Traces of viable virus were detected at this time
** No viable virus was detected at this time

Diagnostic testing for COVID-19

Chinese researchers provided the WHO and the international community with the genome sequence of SARS-CoV-2, in order to begin screening and detecting of patients who present with symptoms of COVID-19.[4]

Table II: Symptoms of COVID-19[20]

Mild	Severe	Critical
Non specific: Fever, cough (with/without sputum), sore throat, nasal congestion, shortness of breath, fatigue, malaise, muscle pain, headache	Pneumonia	Acute respiratory distress syndrome, sepsis and septic shock
Rare: Diarrhoea, nausea and vomiting		

Table III: High-risk patients with underlying conditions[22]

Affected organ	Condition
Lung disorders	Asthma COPD Emphysema or bronchitis TB* Cancer
Kidneys	Chronic diseases Dialysis Cancer
Heart conditions	Hypertension Heart failure
Liver disease	Hepatitis
Neurological	Parkinson's Motor neuron disease Multiple sclerosis A learning disability Cerebral palsy
Diabetes	
Spleen disorders	Sickle cell disease Spleen has been removed
Immunocompromised	HIV/AIDS* Chemotherapy patients As a result of steroid tablets Transplant patients
Others	Overweight – BMI of 40 and above Pregnant women

* TB and HIV/AIDS are an additional concern from the South African Government

The diagnostic test for the COVID-19 virus requires samples of nasal and throat swabs. These swabs are then screened for SARS-CoV-2 viral RNA by means of reverse transcription polymerase chain reaction (RT-PCR) assay.[17] A positive test result assists medical staff in initiating the correct and swift course of action and treatment for the patient, to prevent further spread of the virus in the community.

Symptoms

After an individual is infected with SARS-CoV-2, it has been reported that there is an incubation period of 2–14 days, with an average of five days before the onset of symptoms.[18] Patients can experience varying degrees of symptoms from mild to severe (categorised in Table II by the WHO), which may develop into severe pneumonia and could result in death, in some cases.

Recovery rates of patients vary depending on the severity of the symptoms and progression of the disease. The WHO reported recovery times of 14 days for mild cases, and 3–6 weeks for severe or critical patients.[19]

Who is most at risk?

China reported that the elderly, patients over 70 years of age, and those with underlying conditions, such as diabetes, lung disorders and hypertension were categorised as high-risk patients.[2,4,7,21] The British Government provided an extensive list of underlying conditions as listed in Table III.[22]

Safety measures

Non-pharmaceutical measures, such as social distancing and lockdown regulations, are put in place when the population has no immunity or effective treatment (drug or vaccine) to combat a novel pathogen during an epidemic or pandemic. These measures have been shown to reduce the spread of the virus within communities and prevent the healthcare system from becoming overwhelmed with patients.

Below is a list of the safety measures, recommended by the WHO,[23] Centers for Disease Control (CDC)[24] and governments around the world, which individuals can implement in their daily lives to reduce their risk of infection:

- Washing hands for 20–30 seconds with soap and water.
- Using alcohol-based hand sanitiser of more than 60% acohol.
- Sneeze and cough into a tissue or bent elbow.
- **Do not** touch your face.
- Practise social distancing.
- Wear a mask. If wearing a homemade mask, wash immediately after use in soap and hot water and dry in the sun.
- Quarantine of 14 days if
  - patients test positive,
  - showing symptoms,
  - were in contact with a confirmed case, or
  - travelled from a high-risk area.
- Self-isolation of vulnerable people is of utmost importance – no visiting from or contact with any persons.
- Wiping packaging of products with disinfectant.

Table IV: WHO drug trials[27]

Drugs	Treatment of known conditions/diseases
Remdesivir	Previously tested in an Ebola trial
Lopinavir/ritonavir	Approved treatment for HIV/AIDS
Lopinavir/ritonavir and interferon beta-1a	Used for the treatment of multiple sclerosis
Chloroquine/ hydroxychloroquine	Treats malaria and rheumatoid conditions, respectively

- Washing/wiping frequently touched surfaces with disinfectant/ soap and water.
- Cooking food properly.

Treatment

As of 6 April 2020, no effective drug regimen or vaccine has been approved for the treatment of SARS-CoV-2. Patients are given supportive treatment by medical staff based on their symptoms.[25]

However, the WHO is conducting a worldwide drug trial of four treatments,[26] in which South Africa is participating,[27] in the hopes of slowing the progression of the disease, reducing the severity of symptoms in COVID-19 patients and tapering the recovery period. These drugs include HIV antivirals, an anti-malaria drug, as well as a trial antiviral that was tested for the treatment of Ebola. Table IV describes the specific treatment regimens.

Vaccines are another means of treating a pathogen. Researchers have developed a third generation of vaccines that use DNA to induce an immune response. An example of this type of DNA vaccine has been developed by an American company – Inovio – which has developed a DNA vaccine candidate for COVID-19, that began its Phase 1 trail in April 2020.[28]

Conclusion

As of 6 April 2020, the global number of confirmed COVID-19 cases reached 1 210 956 infections with 67 594 deaths, since 31 December, when the first cases were reported by China. The total number of new cases and deaths reported, on 6 April 2020, was 77 200 and 4 810 – respectfully.[29]

With tens of thousands of new cases and thousands of deaths being reported globally each day, researchers around the world are racing, not only against time but also against SARS-CoV-2, to develop a safe and effective vaccine and treatment to protect the global population, especially those vulnerable individuals.

As with any novel virus, new information is always being discovered and reported on a daily bases. It is of utmost importance that, not only governing bodies and researchers stay informed, but medical staff, frontline workers and the general public keep up to date with current scientific knowledge of SARS-CoV-1.

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