

## **To Bury or not to Bury: That is the Question**

The decision to make cremation the mandatory form of disposing the COVID-19 dead in Sri Lanka was based on the premise that there was (i) insufficient evidence on the possibility of the virus leaking out of the buried bodies from the cemeteries, (ii) the possibility of the virus entering the water table, and (iii) as a consequent to (ii), transmission of the virus among the population. The cremation decision was based on precautionary principles, as the SARS-CoV-2 is a new virus with many unknowns.

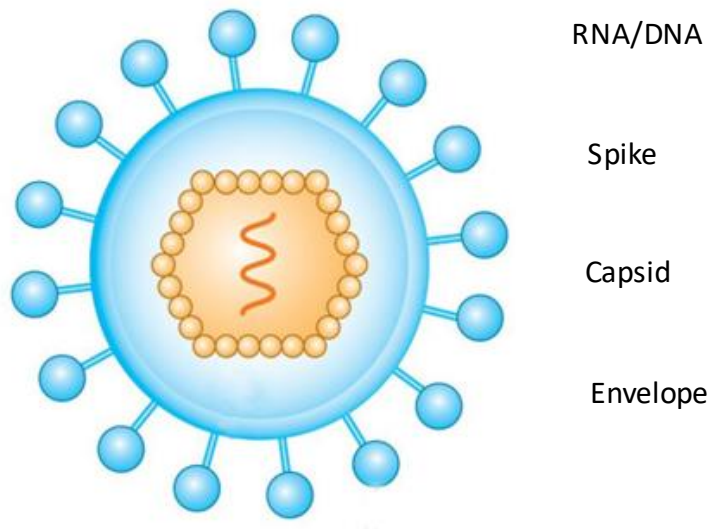
In the last few months, considerable scientific evidence has been published in international peer reviewed journals on many aspects of the novel coronavirus and its environmental impact. It is now time to lift the veil of ‘unknowns’ and move towards making informed decisions.

Viruses and virology is the domain of microbiologists, more specifically virologists. However, some basic knowledge in biology can help us understand the present pandemic and the various precautionary measures.

### **The virus**

Let us begin with the virus. The official name of the virus is SARS-CoV-2 and the disease it causes is called COVID-19. A single virus particle (called a virion) consists of an outer shell made of protein, enclosing and protecting the RNA, the genome or in layman terms the software that runs the virus. It is very tiny (20 to 400 nanometres) and cannot be seen through a microscope (see Figure). The genome is like an instruction manual for our cells and the entire body to function. Once the virus enters our living cells (called infection), it stops the normal function of a cell and hijacks the cell machinery to produce more copies of itself, causing the cell to eventually burst open, infecting new cells with virus particles and initiating a chain reaction. Thus, living cells are necessary for the virus to survive and make copies. The only mission of the virus is to make more copies of itself.

Viruses are broadly divided into Enveloped and Non-Enveloped viruses. The envelope is an outer covering on the virus composed of a fatty substance (lipids) and proteins (see Figure below). The SARS-CoV-2 virus is an enveloped virus.



**Figure: Schematic diagram of an enveloped virus**

The Corona virus that you see illustrated has knob-like spikes on the surface embedded in the lipid envelope. These spikes are vital for the virus to gain entry into our cells in the throat and lungs (respiratory tract): imagine this as the key (spikes) to open the door (cells in the throat and lungs). Fortunately, this envelope provides a soft target and is easily broken down by soap, detergents and other disinfectants such as alcohol. Without this envelope the virus cannot infect us – it has no key to enter our cells. Hence the emphasis on washing our hands with soap and disinfecting the environment with alcohol and detergents – this is sufficient to destroy the virus.

The Non-Enveloped viruses do not have this lipid layer. They have a hard protein coat resistant to common disinfectants, enabling the virus to survive in the outside environment. Examples are the Poliovirus and the viruses causing dysentery.

### **Stability of the virus in the environment**

In the past few months, scientists all over the world have looked at the potential risks of the SARS-CoV-2 virus entering wastewater and serving as a source of infection. Untreated waste (particularly from hospitals) and surface waters are a potential source of disease transmission and research done in these areas are at the initial stages. The virus is shed from patients who are under treatment in hospitals or quarantined at home, through their daily ablutions, sputum, and vomit, which can enter wastewater. Besides, faeces and urine from infected patients are also sources for the virus to enter sewage channels and seep into the water table. How stable are they in the outside environment?

A study on the stability of the virus on different surfaces under different environmental conditions simulated in a laboratory was done by the School of Public Health, Faculty of Medicine, Hong Kong and published in a leading medical journal, the Lancet Microbe (Chin et al. 2020). The major outcomes of this study were:

**Temperature:** The virus is highly stable at 4 °C (e.g. in the fridge) but sensitive to heat. When the incubation temperature is increased to 70 °C, the virus is inactivated in 5 minutes. At 22 °C virus is not detected after 14 days and at 37 °C it is not detected after 2 days. The last two are feasible temperatures in Sri Lanka.

**Stability on surfaces:** Infectious virus could not be recovered from printing or tissue paper after 3 hours, from wood or cloth after 2 days. The virus is more stable on smooth surfaces. Infectious virus could not be recovered from day 4 from glass and banknotes, and from steel after 7 days.

**Disinfectants:** The virus did not survive common disinfectants such as household bleach, ethanol etc. It survived soap for 5 minutes. It also tolerates a pH range of 3 to 10. i.e., it cannot tolerate very low (acidic) or high (very basic) pH. The RNA of the coronaviruses, in general, is extremely fragile and can be rapidly degraded by enzymes (called RNAses) abundant in the natural environment (Brisebois et al. 2018).

### **Can the virus leak into the environment?**

Theoretically virus particles can enter the soil environment after burial of a COVID-19 victim if the corpse is not isolated in the grave by a 'leak proof' plastic body bag, as decay and decomposition sets in gradually. However, what enters the soil environment is not an intact virus capable of causing an infection. Once the patient dies, the virus in the body cells cannot multiply and they begin to disintegrate. **Viruses need living cells within which they can multiply.**

We should remember that the virus is not an active living organism capable of defending itself and transferring to a new host. The decomposing body releases a range of chemicals and enzymes that would breakdown the virus. Other micro-organisms, either from the decomposing body or living in the soil environment, would consume these virus particles. Thus, they have a short survival time in the outside environment where detergents and other chemicals in the wastewater and enzymes produced by bacteria can damage the virus envelope (WHO 2020).

Consider the many patients who have died in the past from very infectious bacterial (Pneumonia, Tuberculosis, Typhoid, Cholera) and viral (Polio, HIV, Ebola) diseases. Cremation was never mandatory for these patients and there has never been any outbreak of epidemics attributed to cemeteries where these patients were buried. Disease causing pathogens are very specialized micro-organisms that can survive only in their living hosts. Once they leave their host and enter the natural environment, they cannot compete with the free-living microorganisms.

### **The question of the water table**

The water table is a huge body of water below the surface of the soil. You can find this out by looking into the nearest well. In low lying areas, such as in Colombo, the water table is close to the soil surface particularly during the rainy season. In the up-country regions or the dry regions, the water would be several metres deep in the well.

What is the risk of the virus entering the water table and infecting us? First, chances of finding a **complete virus particle capable of causing infection** are very small, due to reasons given above. Second, those living in urban areas do not consume ground water directly. The water we consume is disinfected at the Water Treatment plants of the Water Board and we also boil the

water at home. The WHO has indicated that the virus survives only 2 days in dechlorinated tap water and in hospital wastewater at 20 °C, and that there is no evidence that coronaviruses have caused infections through drinking water (WHO 2020).

Thirdly, drinking water is not a source of infection: the virus has to enter through our mouth, nose or eyes to enter the cells in our throat and lungs (respiratory tract), which is the main point of entry. Thus, infection of humans by the corona virus found in the water table is very unlikely. To quote Prof. Malik Peiris '**COVID-19 is not a water borne disease**'. Full stop.

## **Corpse handling during COVID-19**

Few peer reviewed papers have been published on handling and disposal of corpses of people who died from COVID-19. A publication by Nanayakkara et al. in October 2020 reviews practices worldwide and also the risk of infection after burial from bacterial and viral diseases. They conclude that due to inadequate knowledge available of COVID-19, it would be prudent to follow the safe corpse handling guidelines recommended by the WHO. They also state that because virus multiplication ceases as there is no living host, the virus can only spread to other humans by touching the corpse as COVID-19 is a respiratory virus spread mostly by respiratory secretions. The publication refers to WHO guidelines (WHO 2020), which states that graveyards of those who died from highly infectious diseases should be at least 30 metres from groundwater sources used for drinking water, and grave floors must be at least 1.5 metres above the water table, with 0.7 metre unsaturated zone and that surface waters from graveyards must not enter inhabited zones. Similar guidelines are also available from the Centres for Disease Prevention and Control of the USA (CDC 2020).

Rajanikanta et al. 2020, in an Indian perspective on handling the dead, emphasize the importance of handling the dead with dignity for the deceased and the surviving family. They also underline that more precautions need to be taken to prevent spread of the virus during handling the bodies, as SARS-CoV-19 is a new virus whose virulence and period of survival in the dead body is not yet entirely known. They suggest prevention of infection can be done by disinfection of the dead body with chlorine-based solution, enclosing it in a puncture proof body bag, minimal contact with the body and using airtight boxes for cremation or burial.

A recent article in the British Medical Journal, Global Health, where the authors reviewed the available literature to scope and assess the effects of specific strategies for the management of bodies of COVID-19 victims, stated, "There is scarce evidence on the transmission of coronavirus disease 2019 (COVID-19) and other coronaviruses from the dead bodies of confirmed or suspected cases" (Yaacoub et al. 2020).

Finally, internationally renowned Sri Lankan virologist, Prof. Malik Peiris has unequivocally stated, in an interview with the BBC Sinhala (<https://www.bbc.com/sinhala/sri-lanka-55348348>) that COVID-19 is not a water borne disease and the negligible chances of this virus entering the water table. In fact, in a three-minute video he provides a simple explanation to a layman on the period of infection of the virus, and transmission of the virus from a dead body. (<https://www.youtube.com/watch?v=K8ZYxZ-QajI&t=13s>).

## **So, what does the science tell us?**

- The SARS-CoV-2 virus is fragile in the external environment and has a very limited period of survival (Firquet et al. 2015).
- Detection of the virus in the environment by PCR is an indication that the viral RNA is present; to determine if this is viable and able to cause infection, the suspected sample should undergo a cell culture test.
- The virus is not water borne: The present evidence is that the infection route into the respiratory tract is through the mouth, nose and eyes. The global pandemic in almost all the nations and millions of infected people, has not shown evidence of other routes of infection, such as by consuming food or water.
- The virus does not survive common disinfectants such as household bleach, ethanol, and hand soap solution (Chin et al. 2020).

The current pandemic, unlike other localised occurrence of diseases, is being played out on the global stage: almost all the countries are involved, under all conceivable climatic conditions. One cannot imagine a better scenario to draw conclusions. Science is a process, that makes deductions from rigorous sifting of evidence. Science would immediately jettison an inference if evidence is presented to the contrary. Since the outbreak of the pandemic this year, literally hundreds of peer reviewed publications have been published – that is available on the web for anybody to access.

## **How can we offer safe burials?**

By taking the above into account, a safe burial protocol is suggested to prevent the virus from entering the environment.

- Immediately after death, the body is surface disinfected and then place in a puncture proof, body bag with a disinfectant. This can be enclosed further in another body bag.
- The body bags are transported from the morgue to the burial site in a plastic or aluminium box.
- Burial sites should be located at least one km away from human settlements, and in a region where the water table is very deep (e.g., in the dry zone). A large block of land is available in Oddamavadi in the EP.
- Finally, the grave could be lined with lime (calcium oxide- CaO), which would form calcium hydroxide in contact with moisture. This would provide an extreme basic pH, in which the virus would be destroyed.
- Further guidelines stipulated by the WHO and the Health Authorities in Sri Lanka should be followed.

The stigma associated with Covid-19 and the fear of being cremated is now forcing some sectors of the community to avoid PCR/antigen testing. This could lead to uncontrolled eruption of new

clusters. The cremation of Muslim deceased persons from COVID-19 has polarized and created resentment within the community. As this article shows, the science is out there as is the evidence, to show that safe burial can be accommodated for this epidemic.

Legal, social, cultural and emotional views have been expressed in these columns and elsewhere. Except for a few courageous voices from others, the aggrieved community seems to have been left by themselves to argue their case. To quote Rev. Martin Luther King Jr, “The ultimate tragedy is not the oppression and cruelty by the bad people, but the silence over that by the good people.”

One of our greatest attributes as humans is to empathise with fellow humans. Let us practice this.

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