What do we know about viruses, coronaviruses and their impact on food safety and food supply chains?

Q1. Why be concerned about viruses in the food supply chain?

Many viruses are of concern in food chains because they can either produce illness in humans or problems for animal health and welfare. Viruses often considered in food safety risk assessments include norovirus, Hepatitis A and Hepatitis E. Water and some foods have been known to act as vehicles for viral transmission e.g. sewage contaminated water sources often linked to norovirus contamination of food sources such as oysters, and handling of live animals in food preparation being linked to avian influenza outbreaks in humans (1). These infectious diseases are often termed zoonotic i.e. they are transmissible between animals and humans, and alternatively humans to animals (1, 2).

“Emerging viruses” is a term used to describe the appearance of viruses whose presence has increased over the past twenty years or whose presence threatens to increase in the years to come (3). H5N1 (causing avian influenza) SARS-CoV, MERS-CoV and SARS-CoV2 (causing COVID-19) are all emerging viruses.

Robust food hygiene controls are needed to prevent foodborne illness through presence of pathogenic viruses. For more details see also IFST Information Statements on Foodborne viral infections (4), Avian influenza and food (5) and HIV/AIDS and the food handler (6).

Q2. What are coronaviruses?

Coronaviruses are a large family of viruses that can cause diseases in humans, ranging from the common cold to Severe Acute Respiratory Syndrome (SARS). Coronaviruses, as with some Hepatitis viruses, Influenza, Herpes, Newcastle Disease and Orthopox viruses, are enveloped viruses. Enveloped viruses are viruses that possess an envelope or outer coating that is composed of a lipid layer (fat-like substance that is water insoluble). The envelope is needed to aid in attachment of the virus to the host cell. Loss of, or damage to, the outer envelope results in loss of infectivity.

There are hundreds of different coronaviruses in this large family of viruses which are named for the crown-like spikes on their surfaces (7, 8). They circulate in certain animal populations and can cause illness in those populations. Some of the animals associated with coronaviruses include bats, camels, cats and pigs (7).

Coronaviruses can cause diarrhoea in cows and pigs and upper respiratory disease in chicken (8). These viruses can in certain circumstances transfer from animals to humans as can many bacteria e.g. Salmonella, Campylobacter and so on. Whilst some animals may be the reservoir hosts e.g. bats, other animals can act as an intermediary host and it may be these animals that humans are more likely to come into contact with (9). In the Wuhan situation some sources have suggested pangolins as a potential intermediary host and advise that they should be removed from wet markets (9).

Q3. Which coronaviruses are a human health concern?

There are 7 known coronaviruses, 3 of which can cause severe illnesses such a pneumonia. The other 4 cause mostly mild infections such as the common cold.

The three of greatest health concern are Severe Acute Respiratory Syndrome (SARS-CoV); Middle East Respiratory Syndrome (MERS-CoV), and the novel virus we are most concerned about right now SARS-CoV-2 or COVID-19 (7).

COVID-19 is the disease caused by SARS-CoV-2 which emerged from China in December 2019 and was declared a global pandemic by the World Health Organisation (WHO) on March 11 2020. (7)

Q4. What is COVID-19?

COVID-19 is 'the name of the **disease** caused by the novel coronavirus, SARS-CoV-2 and is short for 'Coronavirus Disease 2019', as opposed to the name of the **virus** itself.

This new virus, SARS-CoV-2 and disease (COVID-19) were unknown before the outbreak began in Wuhan, China, in December 2019.

COVID-19 spreads primarily from person to person through droplets of saliva or discharge from the nose when an infected person coughs, sneezes or speaks. People can catch COVID-19 if they breathe in these droplets from a person infected with the virus. Therefore, it is important to stay at a 2-metre distance away from others.

These droplets containing the virus can land on objects and surfaces around the person such as tables, doorknobs and handrails. People can also become infected by touching these objects or surfaces, then touching their eyes, nose or mouth. Therefore, it is important to wash your hands regularly with soap and water or clean with alcohol-based hand rub if there are no handwashing facilities nearby.

The probability of exposure to SARS-CoV-2 via the consumption of food or the handling of food contact materials or packaging for food produced in the UK is considered by UK FSA to be Negligible to Very Low (i.e. between 'so rare that it does not merit to be considered' and 'very rare but cannot be excluded') (12).

WHO and ECDC currently agree that there is currently no confirmed case of COVID-19 transmitted through food or food packaging (13, 14).

At this time, there are no specific vaccines or treatments for COVID-19. However, there are many ongoing clinical trials evaluating potential treatments and vaccines.

Q5. Influenza viruses have also been linked to concern over human pandemics, why?

The main concern about influenza viruses in general is their ability to cross species barriers.

The 1918 influenza pandemic (Spanish Flu) was the most severe pandemic in recent history and was caused by an H1N1 virus with genes of avian origin. The origin remains unclear, but it spread worldwide and infected an estimated 500 million people or one-third of the world's population. The number of deaths was estimated to be at least 50 million worldwide.

Influenza H5N1 virus was first noted in birds in 1996, and it was only a year later that the first human cases were seen (3). In 2009 A(H1N1) which contained a unique combination of gene segments from North American and Eurasian swine lineages emerged to be a concern for human health (14).

Note: Classification of influenza A type viruses, such as avian influenza or swine influenza is determined by the two surface glycoproteins, the hemagglutinin (H) and neuraminidase (N). Thus, the numbers associated with the H and the N proteins gives rise to the names of the individual influenza A viruses of concern in humans such as H1N1 or H5N1.

Q6. What do we know about SARS and MERS?

Severe Acute Respiratory Syndrome (SARS) caused by the SARS-CoV coronavirus emerged in China in November 2002 and was a public health concern through to 2004 (7). Understanding around the epidemiology and ecology of SARS coronavirus infection remains presently incomplete and the risk of re-emergence is unpredictable. However, there have been no new reports of SARS infection in humans worldwide since 2003.

Following its emergence, transmission of SARS-CoV occurred person to person, mostly via droplets (inhalation). It causes a high fever initially with pneumonia, which in some cases progresses to produce fatal respiratory failure (overall death rate has been about 10% but exceeded 50% for patients aged over 60 years). The natural reservoirs of SARS-CoV have not been identified, but several species of wildlife (e.g. civets, ferrets) consumed as delicacies in southern China have been found to be infected by a related coronavirus. Domestic cats living in the Amoy Gardens apartment block in Hong Kong (which was heavily hit by the outbreak) were also found to be infected. More recently, bats, ferrets and domestic cats were experimentally infected with SARS-CoV and found to efficiently transmit it. These findings indicate that the reservoir for this pathogen may include a wide range of animal species.

Middle East respiratory syndrome (MERS) is a viral respiratory disease caused by a novel coronavirus MERS-CoV. MERS was first reported in Saudi Arabia and was believed to have been transmitted from camels (7, 8) It was first identified in September 2012 and continues to cause outbreaks but on a very localised scale (7).

Typical MERS symptoms include fever, cough and shortness of breath. Pneumonia is common, but not always present. Gastrointestinal symptoms, including diarrhoea, have also been reported. Approximately 35% of reported patients with MERS-CoV infection have died.

Although most of human cases of MERS-CoV infections have been attributed to human-to-human infections in health care settings, current scientific evidence suggests that dromedary camels are a major reservoir host for MERS-CoV and an animal source of MERS infection in humans. However, the exact role of dromedaries in transmission of the virus and the exact route(s) of transmission are unknown. The virus does not seem to pass easily from person to person unless there is close contact, such as occurs when providing unprotected care to a patient. Health care associated outbreaks have occurred in several countries, with the largest outbreaks seen in Saudi Arabia, United Arab Emirates, and the Republic of Korea.

Q7. How are these types of coronaviruses spread?

Initially SARS-CoV, MERS-CoV and SARS-CoV-2 (causing COVID-19) must have transferred from their animal host to humans. Once in the human population there can be direct transmission i.e. person to person spread mainly via droplets (from sneezing, coughing etc.) or indirect transmission via surfaces and hand contact with those surfaces (10,15) These droplets can be inhaled or cross-transferred from surfaces to hands and then eyes and nose where hands are the vehicle of transmission (10).

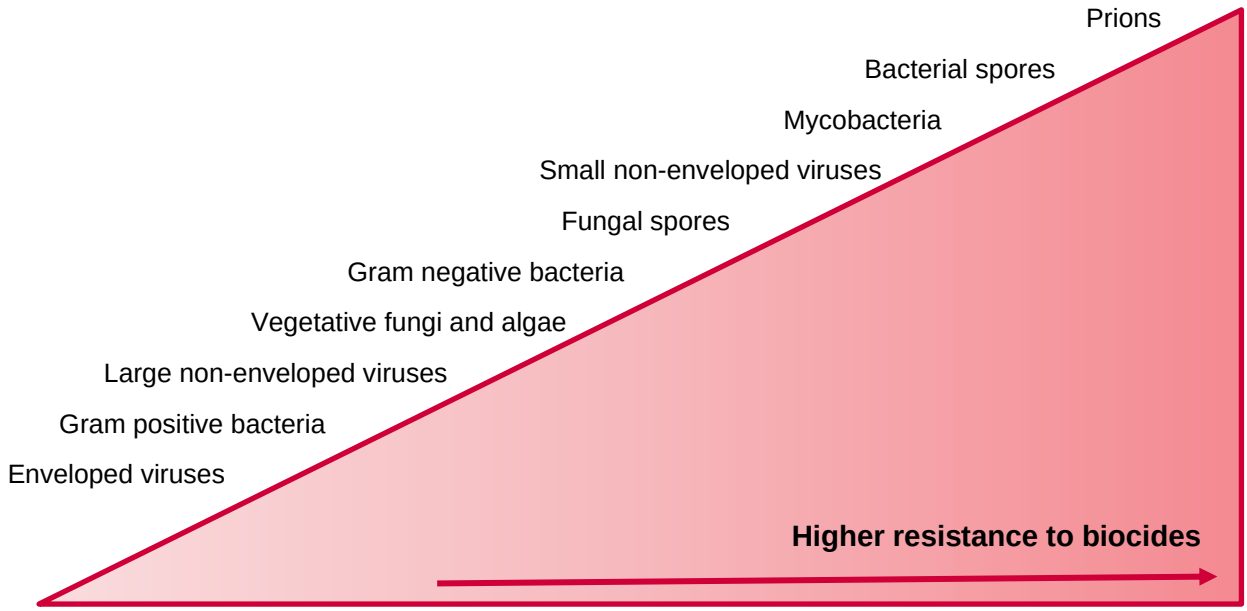
There is some suggestion that SARS-CoV and MERS CoV have the capacity to survive on surfaces for extended periods (15). The capacity to survive can vary according to the material that the surface is made of (15). Veterinary coronaviruses have been shown to remain on un-sanitised surfaces for 28 days, whereas some human coronaviruses have bene found to remain on such surfaces at room temperature for up to 9 days (14). Sanitation and hand hygiene are thus essential to control the spread of the virus. SARS-CoV can also survive in water, on foods and in sewage (15).

Research is continuing into survival of SARS-CoV-2 causing COVID-19 on various surfaces and in different types of medium e.g. water, sewage, Initial results indicate a range of findings including that SARS-COV-2 can remain viable on hard surface for up to 72 hours (15) and no infectious virus could be detected from treated wood and cloth on day 2 or from treated smooth surfaces on day 4 (glass and banknote) or day 7 (stainless steel and plastic) (16).

Factors influencing the survival of these coronaviruses on surfaces include: “strain variation, titre, surface type, suspending medium, mode of deposition, temperature and relative humidity, and the method used to determine the viability of the virus” (15).

Different classes of microorganism susceptibility to biocides varies, with enveloped viruses being the most susceptible based on the removal of infectivity following the disruption of the envelope as shown in Figure derived from (17).

Figure 1. Susceptibility of different microorganisms to biocides, adapted from [17]



Q8. How can viruses impact human health?

The viruses discussed here can have a significant impact on human health.

Some details about various influenza and coronavirus related illnesses have been included in Table 1.

Table 1. Key facts about viral pandemics and outbreaks including SARS and MERS (Sources: 6, 18, 19, 120, 21, 122, 23, 24, 26)

Year	Virus / Disease	Number of countries affected	Number of confirmed cases	Number died	Main route of disease spread
1918	H1N1 Influenza	Worldwide	-	25-40 million (18) 17.4 million (19) 50-100 million (23)	Travel - person to person
1957	H2N2 Influenza	Worldwide	-	1-4 million (23)	Travel - Person to person
1968	H3N2 Influenza	Worldwide	-	1 million (23)	Travel - Person to person
1997 onwards	H5N1 Influenza		455	861 (up to 2019)	Bird to human contact – little person to person transmission
2002	SARS-CoV severe acute respiratory syndrome	26	8096	774 (20)	Travel - person to person
2009	H1N1 Influenza	214	-	18,449 (16) 200,000-400,000 (23)	Travel - person to person
2012	MERS-CoV Middle East respiratory syndrome	27	2494	858 (up to 2020) (21)	Travel - person to person
2020	SARS-CoV-2 COVID-19 (as of 10.04.2020)	212	1.43 million	85,711 (22)	Travel - person to person

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