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Effectiveness of personal protective equipment (PPE) in reducing COVID-19 transmission to and from people, fomites and food

Report Number:	COV02
Author:	Kylie Horváth
Prepared For:	NZFSSRC Director
Reviewed By:	Catherine McLeod, Steve Hathaway, Roger Cook, Nigel French
ISBN Number:	N/A
Date	30 March 2020
Client Name/Logo:	PIANZ and MIA

New Zealand Food Safety Science & Research Centre
Hopkirk Institute, Massey University, Tennant Drive, Palmerston North 4442
Phone: +64 (0) 6 356 9099

RECOMMENDED CITATION: Horvath, K 2020. Effectiveness of personal protective equipment (PPE) in reducing COVID-19 transmission to people, fomites and food. NZFSSRC. Prepared for PIANZ and MIA. Pages 1-18.

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Scientific Executive Summary

On the 26th March 2020 New Zealand moved to Alert 4 status to reduce the potential for community transmission of severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2). An implication of this move is that best practice in minimising the risk of transmission requires a physical distance of 2 m. This poses logistical issues to workers within various primary food sectors, including the poultry, meat and seafood industries. A series of questions were posed by government and the food industry regarding the need for social distancing and other risk mitigation strategies in the food production/processing environment. This mini-review was undertaken to provide background information to those questions and support the government and industry in deciding on the most appropriate risk management strategies. It should be noted that the literature is scant with respect to best practice for managing COVID-19 transmission risk within the food sector, thus some learnings are drawn from the practices employed in the health sector. The key findings of this mini-review include:

1. As yet, we find no evidence of PPE being mandated in food production or processing premises in relation in COVID-19 globally.
2. Gloves and masks are considered to reduce transmission to health workers who are dealing with known infections.
3. The World Health Organisation (WHO) is strongly recommending that the use of face masks is rationalised as there is going to be a world shortage – they do not recommend the use of face masks for non-infected people. For people that are showing no signs of COVID-19, their recommendation is that PPE is not needed and that practicing good hygiene practices are all that are required.
4. Consistent with this, the USFDA (2020) recommends that personnel in food retail and service industry settings who are well should not wear a facemask. These people should use good hygiene actions and avoid close contact with people who are sick.
5. In contrast, the Occupational Safety and Health Administration (USA) recommends engineering controls and PPE for workers that need to be within 6 ft (1.8 metres) of each other and whose health status is unknown. This refers to workers that may be infected with SARS-CoV-2, but are not yet known or suspected as being infected.
6. For PPE to be effective (in the health setting), they must be worn correctly, particularly face masks – there can be issues with worker adherence to this.
7. There is some evidence of issues with doffing PPE and contamination of the surrounding environment and other people (in the health setting).
8. Individuals with beards and moustaches would not achieve the same protection as other individuals from a facemask or respirator due to leakage around the edges of the mask/respirator.
9. We have not found any specific scientific evidence of mitigations (the PPE aspects) that can be taken to ensure people working less than 2 m apart in abattoirs/processing plants can work safely. WHO note that a physical barrier may be useful (but this is specific advice to the health sector).
10. There are non-grounded suggestions that the use of such physical barriers, for e.g. screens and visors, may reduce the potential for spread via sneezes – however, it should be noted that people sneezing should be excluded from the workplace anyway, provided that the person is not suffering from hay fever.
11. We find some evidence that visors/shields do not provide complete protection as they do not always seal correctly.

12. The use of PPE in the workplace is recommended by the NZ Ministry of Health (MoH) for staff who are unable to maintain more than 1 metre apart from people who could possibly have COVID-19 symptoms.
13. Importantly, the first line of defence is always that people with symptoms or who are sick must not be working in food processing situations and there are industry mechanisms to ensure this is the case.

1. Introduction

This review was undertaken to answer operational questions about the current COVID-19 outbreak by the food industry. The questions addressed in this review were developed on the 26th of March 2020 jointly by industry and government in relation to the announcement that New Zealand would move to Alert 4 status. An implication of this move is that best practice in minimising the risk of transmission requires a physical distance of 2 m. This poses logistical issues to workers within various sectors, including the poultry, meat and seafood industries.

Our understanding of the disease and the virus is still in its infancy, and there are considerable knowledge gaps. Best practice for the food sector with respect to the questions posed in this review is not clearly documented internationally – there appears to be a lack of international consensus on many questions. We have provided information according to the current state of knowledge and within the short timeframe available for this review.

2. Objective

Undertake a review to inform risk management discussions on the need for social distancing and the correlated use of personal protective equipment (PPE) in food production and processing environments.

3. Methods

The primary sources of information that have been drawn upon for recommended PPE use are:

a) European Centre for Disease Prevention and Control (ECDC) technical documents and website (https://www.ecdc.europa.eu/en);
b) Ministry of Health (MoH) NZ (https://www.health.govt.nz/);
c) United States Centers for Disease Control and Prevention (CDC) website and documents (https://www.cdc.gov/);
d) World Health Organisation (WHO) website and documents (https://www.who.int/).

Search terms used included: coronavirus, COVID-19, PPE, personal protective equipment, food processing, transmission.

Other selected references have been used to provide supporting or additional information.

4. Background information on COVID-19

In December 2019, a series of viral pneumonia cases emerged in Wuhan, China, that were attributed to a novel coronavirus (Lake & Kingsbury, 2020). This virus was tentatively named 2019 novel coronavirus (2019-nCoV) and was epidemiologically linked to the Huanan Wholesale Seafood Market in Wuhan. By 11 February 2020, the number of cases had reached over 43,000 and the disease was named Coronavirus Disease 2019 (abbreviated to COVID-19), with the virus being officially named as severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2). The World Health Organisation increased the status of the COVID-19 outbreak to a pandemic on 11 March 2020.

Coronaviruses are spherical virions, measuring up to 170 nm in diameter, with an envelope and contain non-segmented, positive-sense RNA. They are named for the crown-like spikes on their surface. The family *Coronaviridae* contains 39 known species of coronaviruses and seven of these are known to infect humans. Of these seven, four species (human coronavirus (HCoV)-229E, HCoV-NL63, HCoV-OC43 and HCoV-HKU1) usually cause a mild self-limiting upper respiratory illness.

However, the other three species can cause severe disease in humans and are known as severe acute respiratory syndrome-related coronavirus (SARS-CoV), Middle-East respiratory syndrome-related coronavirus (MERS-CoV) and the newly identified SARS-CoV-2.

The disease, COVID-19, causes a variety of signs and symptoms with the most common being a dry cough and fever and can range from no symptoms to severe pneumonia and death (Lake & Kingsbury, 2020). The average incubation period is around 5-6 days after infection. Rare cases of asymptomatic infection (i.e. the patient has no outward signs of the infection such as coughing or sneezing) have also been reported, although most develop the disease at a later date. A further point should be considered when educating the workers in any setting around COVID-19 symptoms. Not every person that sneezes excessively is sick or contagious as some people suffer from hay fever and allergies and it would be unfair to exclude these individuals from work. Sneezing, in conjunction with a high temperature, might be a way of differentiating these individuals. Temperature checks of all employees could be a useful check of health status, bearing in mind that not all COVID-19 patients will manifest a fever.

Transmission of SARS-CoV-2 is considered to be via droplets produced by sneezing or coughing or through close contact between individuals (WHO, 2020a). These infectious droplets can contaminate skin and surfaces in the immediate vicinity. Infection by SARS-CoV-2 occurs through the mucus membranes either by direct contact with the droplets, or by contaminated hands carrying the virus to the mouth, eyes, and nose. Airborne transmission, whereby viruses travel in the air for large distances carrying the potential to infect new individuals even when the original host has gone, is not considered to be a significant infection route for SARS-CoV-2.

Viruses, such as influenza, SARS-CoV and MERS-CoV, can cause contamination of the environment. They have been shown to survive on dry surfaces for extended periods, and may require enhanced cleaning and disinfection to combat the spread of these viruses (Otter et al., 2016). According to Kampf, Todt, Pfaender, and Steinmann (2020), coronaviruses (including SARS-CoV and MERS-CoV) can persist for up to 5 days on surfaces like metal,

glass or plastic, with one SARS-CoV strain reported to survive on plastic for 6-9 days. However, some text does not appear to match with the table data so the results may not be accurate. Shorter survival periods were reported by van Doremalen et al. (2020) for copper, cardboard, stainless steel, and plastic for both SARS-CoV-1 and SARS-CoV-2.

Enveloped viruses are considered to be easier to remove or inactivate than non-enveloped viruses (WHO, 2004). Coronaviruses have been shown to be efficiently inactivated by 62-71% ethanol, 0.5% hydrogen peroxide or 0.1% sodium hypochlorite within 1 min (Lai, Shih, Ko, Tang, & Hsueh, 2020).

Best practice for protecting workers from hazards usually follows the 'Hierarchy of Controls' as seen in Figure 1 below. In summary, the most effective type of control is to eliminate the hazard. Other controls can be implemented with reducing effectiveness and PPE should normally be used as a last resort as it tends to be the least effective. In the case of COVID-19, physical removal of the hazard is covered by people staying at home if they are unwell. Engineering controls (e.g. physical separation) and administrative controls (e.g. personal hygiene and frequent handwashing) are extremely important steps to implement, before and even during the use of the final PPE control.

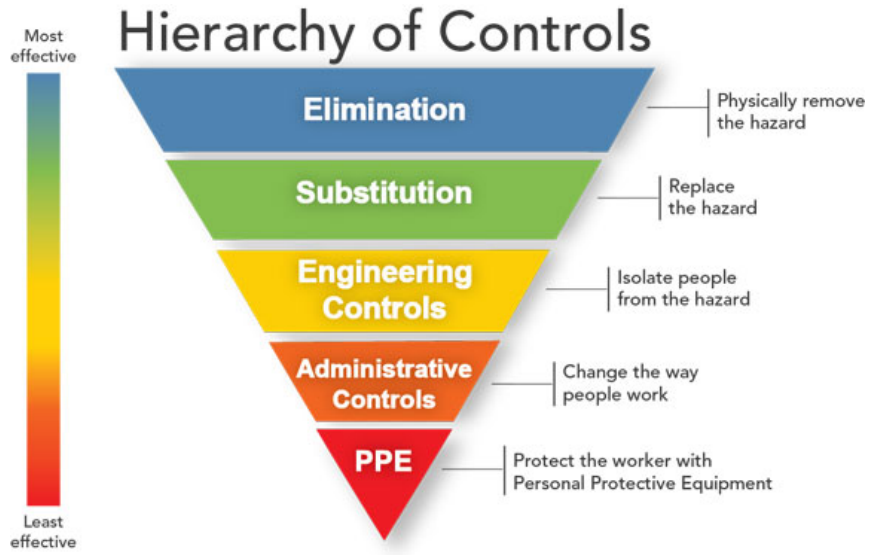

Figure 1. Hierarchy of Controls diagram from the National Institute for Occupational Safety and Health (NIOSH) webpage accessed on 4 April 2020. https://www.cdc.gov/niosh/topics/hierarchy/default.html

5. Overview of findings: Use of PPE for protection against COVID-19

The literature focuses on protecting workers in healthcare settings with an occasional mention of what the general public could do to protect themselves. The literature on protecting workers in the food production and processing industry is scant.

The use of PPE for healthcare workers for protection against infectious diseases of high consequence has been divided into two groups: the first assessment/contact group and the treatment/high aerosol exposure group. The ECDC (2014) suggests the use of first assessment PPE but with a distance of greater than 1.5m between patient and worker. The first assessment PPE would ideally comprise of double gloves, a surgical type of face mask with IIR rating (or a FFP2 respirator if available), a hair cover, an impermeable gown, a face shield or goggles, and shoe covers. This level of PPE is largely impracticable for workers in many food processing environments. However, this level is not deemed sufficient for the second group of healthcare workers who perform invasive diagnostic or treatment activities in close proximity.

Food processors need to work closer than 1.5m in some situations so may be at risk of transmission if they are working with an infected colleague, noting that if someone has obvious symptoms of infection (fever, coughing or sneezing) they are highly unlikely to be at work.

Asymptomatic carriers and infection routes may require more study, especially considering the severity of the disease. A family case study of COVID-19 in Anyang, China strongly suggests that one member, who had recently travelled from Wuhan, was most likely the carrier despite showing no symptoms (Bai et al., 2020). Only one real-time reverse transcriptase PCR (RT-PCR) on a nasopharyngeal swab showed a positive from this individual, which suggests that another route of transmission may have occurred. No faecal source was investigated in this study. Additionally, He et al. (2020) estimate that 44% of transmission could be occurring before an infected person shows their first symptoms because the viral load found in throat swabs peaked on, or before, symptoms began. Absence of fever in 12.1% and occurrence of unspecific symptoms in COVID-19 cases means that some food-processing staff might feel well enough to be at work (Yuen, Ye, Fung, Chan, & Jin, 2020).

The use of PPE in the workplace is only recommended by the NZ Ministry of Health (MoH) for staff who are unable to maintain more than 1 metre apart from people **who could possibly have COVID-19 symptoms** (MoH, 2020)**.**

The PPE recommended in this situation are facemasks and gloves. Surgical/medical masks are stated as being able to prevent the dispersal of droplets by a symptomatic person and also the inhalation of droplets if within 1 metre of a coughing person. This statement regarding surgical/medical masks protecting against the inhalation of droplets is not universally accepted.

In the United States, the FDA (2020) notes that it is not necessary for personnel in food retail and service industry settings to wear a facemask. These people should use good hygiene actions and avoid close contact with people who are sick.

OSHA (2020) defines jobs as medium exposure risk that require frequent and/or close contact with people who may be infected with SARS-CoV-2, but are not known or suspected as being infected. The close contact was defined as being within 6 feet (1.8m) of a person. The suggested plan for protecting the workers in this scenario was the following list:

- Engineering control
  - If feasible, install physical barriers such as clear plastic sneeze guards
- Administrative controls
  - Offer face masks to any ill employees and customers to contain possible respiratory secretions until they are able to exit the premises. If there are no masks available, then a reusable face shield that can be decontaminated might be an acceptable alternative
  - Consider strategies for minimizing face-to-face contact
  - Keep customers and employees informed about COVID-19 symptoms and the availability of medical facilities
- PPE requirements
  - Depending on the situation, some workers may need to wear some combination of PPE (gloves, gown, face mask and/or face shield or goggles)

A critical aspect to donning and doffing PPE is the avoidance of secondary disease transmission to the workers (ECDC, 2014). Both processes strongly benefit from active assistance by a trained member of the team. This helps to check for damaged equipment, regulates compliance, and reduces the risk of contamination of individuals and the environment.

During the donning procedure in a healthcare setting, the assistant should wear 'scrubs' and perform hand hygiene. (Note: in our current situation, the assistant also needs to consider respiratory protection of some sort, or full PPE for first contact perhaps, in the event they become contagious).

During the doffing procedure, again in a healthcare setting, the assistant would wear full-body PPE and perform glove disinfection and changes. The PPE user/worker leaving a contaminated zone would stand still and receive instructions from the assistant. The advantage is that the user/worker does not manipulate the potentially contaminated PPE on potentially contaminated body areas without having direct visual control. An additional qualified observer is required but, with no reason stated, the observer must not wear PPE.

6. Responses to specific questions

a. Does PPE reduce viral transmission amongst health workers and food production/ processing workers?

Evidence of reduced viral transmission for food workers through the use of PPE is scant. For health workers it is believed to help but it is dependent on how the PPE is used. PPE needs to be correctly fitted, handled in the best manner, and ideally needs assistance from a trained person to help remove the PPE to prevent contamination of the worker and environment.

Transmission of Severe Acute Respiratory Syndrome (SARS) in 2003 was reviewed by (Hugonnet & Pittet, 2004). There appeared to be a risk for nurses and doctors treating patients with SARS. However, this risk was mostly attributed to procedures that would only occur in a medical setting. Additionally, the authors recommended that correct use of PPE is important,

for example, performing mask fit-testing to avoid air entering the sides of the mask. Alraddadi et al. (2016) observed that healthcare workers who reported always using a medical mask or a N95 respirator had a lower risk of infection with MERS-CoV than the workers that didn't always, or never, covered their nose and mouth with a mask or respirator.

In the household setting, influenza transmission appears to be prevented when intensified hand hygiene practices and the use of surgical facemasks are implemented early after the index (first) patient shows symptoms and are used diligently (Cowling et al., 2009; Suess et al., 2012).

Examining the effectiveness of PPE for other pathogens in the meat industry, the following information was found. *Leptospira* spp. enter through skin abrasions or the mucus membranes similarly to SARS-CoV-2. Pittavino et al. (2017) found that PPE (facemask, glasses or gloves) did not show protection against Leptospirosis infection for meat workers in New Zealand. The facemask in this situation was a "mask with movable transparent protective shield covering the whole face", which suggests that it may have actually been a face shield. Literature relating to the same cohort study agreed that the use of PPE did not decrease the risk of new infection, nonetheless the authors recommended workers wear PPE once efforts have been made to improve the PPE and to educate the workers on how best to use the PPE safely (Dreyfus et al., 2015). One PPE aspect described that may increase the risk of infection is where users may sweat and use their hands more often to wipe their faces particularly when using eye goggles.

Careful manipulation of the PPE at all times is extremely important as this equipment can become a reservoir of infection. Washing hands before donning and doffing the PPE is highly recommended and avoid touching it during work practices.

b. What types of PPE (face masks etc) are most effective at reducing viral spread to other people, fomites[1] and food?

Facemasks, gloves and protective clothing, in conjunction with hand-washing are the key recommended PPE for reducing spread of viruses from droplet/airborne contamination.

All of the hospital staff that utilized all of these four things did not become infected with SARS-CoV during a case study in 2003 (Seto et al., 2003). All infected staff had omitted at least one of these key things. Facemasks were shown to be significantly associated with non-infection, as long as the masks used were N95 or surgical masks. Paper masks were not protective.

A guidance document prepared by the Meat Industry Association (NZ) regarding best practice for using face masks can be found in Appendix 1 of this document.

[1] Fomites are objects or materials which are likely to carry infection, such as clothes, utensils, and furniture

Respiratory protection

The literature can be mis-leading with the use of the term “face mask” as this can sometimes be used to describe one of four different types of face protection, including a face shield. ECDC (2014) have listed face shields with goggles as they are best suited for protecting eye mucosa. For respiratory protection, there appears to be four types:

1. Full face respirator, also known as a gas mask
2. Filtering face piece (FFP), also known as a respirator
3. Surgical face mask
4. Paper dust mask

The United States Center for Disease Control and Prevention (CDC) describes a respirator as a personal protective device that covers at least the nose and mouth and is used to reduce the user’s risk of inhaling aerosols. N95 filtering facepiece respirators are capable of filtering out all types of particles and this includes bacteria and viruses. The role of facemasks is for preventing contamination of the surrounding area by a coughing or sneezing individual. Alraddadi et al. (2016) reported that a N95 respirator gave better protection than a medical mask when caring for MERS-CoV patients. The ECDC (2014) document states that the main protection given by surgical face masks is to prevent exhaled droplets and they can also be splash-resistant for the user if they are marked ‘IIR’. These masks do not require fit testing. A respirator protects the user from the inhalation of droplets and particles but they require a fit test.

An additional note regarding masks/respirators is that individuals with beards and moustaches would not achieve the same protection as there would be leakage around the mask or respirator (ECDC, 2014; HPSC/HSE, 2020).

ECDC (2014) commented that sneezing inside the FFP respirator is possible but the user must not touch the respirator with their hands. However, there was no comment around the effectiveness of the respirator in holding the aerosol produced from that sneeze within the mask.

Evidence showing that surgical masks are not fully protective against aerosolized influenza virus was shown by testing the air in front of and behind each mask of several designs of surgical mask commonly used in the UK (Makison Booth, Clayton, Crook, & Gawn, 2013). The eight masks were individually placed on a dummy head fitted with simulated breathing. Results showed that viable influenza virus was detected in the air behind all the surgical masks tested but also showed that a surgical mask will reduce exposure, on an average up to 10-fold, depending on the design of the mask. The surgical mask that performed consistently better than the others had an integral visor, which was thought to possibly offer extra protection to the nose area that often tends to have leakage issues.

Many studies report some level of protection is provided by surgical masks. However, it is also important to note that not all surgical masks have the same level of protection. A study

with masks fitted tightly to a mannikin face showed that two different types of surgical masks produced by one company had very different penetration levels of MS2 virions (a non-harmful simulant virus) of 20.5% and 84.5% (Balazy et al., 2006).

Paper dust masks are not recommended for infectious diseases.

Hand protection

Choice of gloves would be determined on the basis of tactility and level of protection needed, but two pairs of gloves is recommended (ECDC, 2014). Ideally the first pair of gloves (in contact with the skin) should have a longer sleeve than the outer pair as it makes changing gloves easier.

Protective clothing

Single-use coveralls that are particle-tight and fluid-proof are recommended for workers that are exposed to infectious diseases of high consequence (ECDC, 2014). These would ideally have a splash-proof cover of the entry/exit zipper and an incorporated hood. Boots should be made from a chemical-resistant material to enable efficient decontamination and re-use.

Eye protection

Goggles with soft sealing edges would be the preferred item for protecting the eyes (ECDC, 2014).

c. Have there been incidences of viral transmission between workers wearing PPE?

Information on this aspect of the review was only able to be sourced for workers in the health industry, not the food industry.

The transmission of coronavirus between individuals has been reported in the scientific literature for Middle East Respiratory syndrome (MERS-CoV) but appears to be only between unprotected individuals in close proximity (Al-Tawfiq & Auwaerter, 2019; Al-Tawfiq & Perl, 2015). This includes healthcare workers and the main factors contributing to these cases is the delay in isolating coronavirus patients and the lack of PPE used in the first assessment of the cases.

Secondary contamination has been known to occur during the removal of PPE.

A study evaluating a PPE removal protocol designed by the CDC found that the removal of the PPE often resulted in the transfer of the non-pathogenic virus used in the study to hands and clothing (Casanova, Alfano-Sobsey, Rutala, Weber, & Sobsey, 2008).

During the 2003 outbreak of SARS, there were cases among individuals that used a N95 mask, which suggests that this mask may not be adequate for protection against SARS (Tambyah, 2004). However, the transmission may have been due to contamination and hand contact.

d. Are there significant issues with adherence for wearing PPE?

Ease of use and education may be the keys to gaining acceptance of PPE procedures.

Zamora J E (2006) compared two personal protective systems. The first system was an enhanced respiratory and contact precautions system and the second was more extensive with a full body suit, additional PPE and a powered air-purifying respirator (PAPR) system. Wearing the enhanced respiratory and contact precautions resulted in more contamination of skin and base clothing layer. However, those using the full body suit and PAPR tended to take longer to don the gear and more often did not comply with the donning procedures.

A questionnaire study looked at the usage of PPE among three groups of healthcare workers just after the 2003 SARS outbreak to ascertain if the appropriate PPE were used and to determine what factors would contribute to inappropriate use of PPE (Chia et al., 2005). Many of the healthcare staff (nurses, doctors and clerical staff) felt that a paper and/or surgical mask was adequate protection against SARS. This view was held despite the Ministry of Health, Singapore, manual stating that surgical masks may offer a certain level of protection and paper masks offer little or no protection.

Training healthcare workers on infection control specific to MERS-CoV showed a lower risk of infection (Alraddadi et al, 2016).

Lack of comfort/fit, and fogging and scratching of eyewear has been suggested as the most important barrier to protective eyewear usage in the food processing industry (Lombardi, Verma, Brennan, & Perry, 2009). Additionally, lack of safety training and younger age groups were factors that affected adherence to the use of PPE.

In a 2003 study assessing the wearing of facemasks by Chinese adults in Hong Kong to prevent SARS, almost 40% of the study respondents did not practice preventative actions despite the severity and rapid spread of the disease (Tang & Wong, 2004). The people less likely to wear facemasks tended to be male, single, and aged between 19-29 years. The reasons for this appeared to be around inadequate knowledge of the disease, influences of their peers, higher risk-taking tendency, and their perceived immunity/immortality to various diseases.

e. What is the basis of the proposed 2m physical separation between individuals?

The NZ government is requesting that essential businesses keep their employees apart by a 2m distance for their safety against COVID-19. This distance is unattainable for many food-

processing entities, or if attainable, this requirement will slow down processing lines considerably.

The distance for physical separation between individuals varies between authorities. ECDC (2014) recommends a distance greater than 1.5m for healthcare workers in first assessment settings, WHO (2020a) describes a minimum of 1m separation, and OSHA (2020) defines close contact as within 6 feet (equivalent to 1.8m).

In a study on SARS-CoV-2 transmission, there was significant contamination of the environment via respiratory droplets and faecal shedding that demonstrates the need for strict environmental and hand hygiene (Ong et al., 2020). The majority of PPE swabs and the air samples were negative. However, it is important to note that the air exhaust outlets tested positive. The PPE sample that tested positive was the surface of a shoe front.

An influenza study reported that healthcare workers could be exposed to infectious doses of influenza virus within 1.829m away from a patient with influenza (Bischoff, Swett, Leng, & Peters, 2013) and this was primarily in the form of small-particle aerosols. The authors commented that this finding questions the current information regarding localised droplet transmission for this illness.

The viability of SARS-CoV-2 in mechanically produced aerosols showed a minor reduction in infectious titre, with the virus remaining viable throughout a 3 hour experiment (van Doremalen et al., 2020). WHO (2020c) emphasizes that this type of aerosol does not reflect a normal cough or a normal clinical setting where aerosol-generating procedures may occur.

The literature regarding sneeze and cough distances are not in clear agreement. Nishimura, Sakata, and Kaga (2013) report a maximum direct reach of particles and microclouds given by sneezing and coughing were 84cm and 30cm from the mouth. A team under the leadership of Dr Lydia Bourouiba at the Massachusetts Institute of Technology (MIT) has worked on the fluid dynamics of coughs and sneezes and plans to incorporate microbial aspects in their next section of work (Lok, 2016). The fluid dynamic results have contradicted conventional thinking about sneezes where the larger droplets fall to the ground within 1-2m, and the smaller droplets would stay aloft as an aerosol. The results have instead shown that the respiratory liquid exits as a sheet of liquid, which changes to rings, these become stretched into filaments, which eventually break up into a range of droplet sizes. The large droplets were able to travel up to 8m for a sneeze and 6m for a cough, although environmental conditions can affect these results, and the droplets can stay airborne for up to 10min. Another group also caution that breathing and talking are important to consider as they have detected flu viral RNA in particles exhaled by patients (Lok, 2016).

Although there is potential for airborne contamination to occur, WHO (2020c) reports that airborne contamination has not been reported from the analysis of 75,465 cases of COVID-19 in China. As of 27 March 2020, WHO (2020c) continues to recommend that droplet and contact precautions for people in close contact (within 1m) with COVID-19 patients.

f. Are food producers/processors in overseas jurisdictions required to use PPE?

We have found no evidence of this to date.

The World Health Organisation (WHO) is strongly recommending that the use of face masks is rationalised as there is going to be a world shortage (WHO, 2020a). For people that are showing no signs of COVID-19, WHO recommend that PPE is not needed and that following good hygiene practice is all that is required.

WHO recommends medical masks for the general public for the individuals who are exhibiting symptoms and for those individuals caring for them (WHO, 2020b). Whilst WHO thinks that medical masks are sufficient in general settings, washing hands before and after handling masks is extremely important.

g. What equipment is most suitable?

It is assumed that this question refers to the food processing environment. The use of PPE has not been recommended for the general public or non-healthcare workers by the majority of authorities. As mentioned previously, the use of PPE in the workplace is recommended by many authorities only when staff are in situations that require them to work within 1m of individuals that could possibly have COVID-19 symptoms. The PPE most suitable for the majority of workers in this situation are facemasks and gloves. Ideally respirators (N95 or FFP2) would be the mask of choice, but surgical facemasks do offer some protection. Again, it is worth noting that training in the use of the PPE is crucial as some transmission of disease has occurred through incorrect handling of the PPE.

With the likelihood of a world shortage in face masks being a strong reality, alternative options are being investigated. A question was posed regarding whether tissues or rolled up hair nets might work, ostensibly to reduce the spread of COVID-19. There is no literature to support or reject this idea.

Cloth/cotton face masks were once used prior to the development of surgical masks, but these have been shown to be ineffective for influenza-like illness (MacIntyre et al., 2015). The suggested reasons were that the cloth/cotton masks retained moisture, give poor filtration, and were often reused and the end result was a higher risk of infection.

In support of masks in general, van der Sande, Teunis, and Sabel (2008) assessed both the inward and the outward transmission reduction potential of a FFP2 respirator, a surgical mask (1818 Tie-On 3M), and a home-made mask made of tea cloth. All three types reduced aerosol exposure, with the respirator being the most efficient and the home-made mask being the least efficient. The outward transmission (where masks are worn by infectious patients) was less effective than inward transmission (where masks are worn by healthy individuals). The authors concluded that any type of general mask is likely to reduce viral exposure and risk of infection, although children were less protected for all the masks, and this was thought to be due to imperfect mask fit on their smaller faces.

Assuming that visors and face shields are the same item, then the use of these items should be used with caution and education. Chen, Shang, Yao, Liu, and Liu (2020) says that face shields have some protective effects but does not offer complete protection against COVID19. Lindsley, Noti, Blachere, Szalajda, and Beezhold (2014) have also shown face shields to have some protective effects, particularly against the initial fluid burst of a cough, but they cannot be used as a substitute for respiratory protection. Perhaps if the shield is sealed around the user's face, then it might give similar protection to a respirator.

h. Can directional facing (for example have workers positioned back to back) reduce risk or the use of screens to separate workers?

WHO noted that shields may reduce exposure, but we have not found any scientific evidence supporting this statement to date (WHO, 2020a).

Evidence regarding directional facing of workers may be partially covered under the question regarding physical distancing and sneeze/cough dynamics. Literature supporting directional facing has not been found.

Engineering controls have been recommended by OSHA (2020) and the following options noted by OSHA on preparing workplaces for COVID-19 might be suitable for food-processing or servicing entities:

- Installing high-efficiency air filters
- Increasing ventilation rates in the work environment
- Installing physical barriers, such as clear plastic sneeze guards
- Installing a drive-through window for customer service

References

Al-Tawfiq, J. A., & Auwaerter, P. G. (2019). Healthcare-associated infections: the hallmark of Middle East respiratory syndrome coronavirus with review of the literature. *J Hosp Infect, 101*(1), 20-29. doi:10.1016/j.jhin.2018.05.021

Al-Tawfiq, J. A., & Perl, T. M. (2015). Review: Middle East respiratory syndrome coronavirus in healthcare settings. *Infectious Diseases, 28 (4)*, 392-396.

Alraddadi, B. M., Al-Salmi, H. S., Jacobs-Slifka, K., Slayton, R. B., Estivariz, C. F., Geller, A. I., . . . Madani, T. A. (2016). Risk Factors for Middle East Respiratory Syndrome Coronavirus Infection among Healthcare Personnel. *Emerg Infect Dis, 22*(11), 1915-1920. doi:10.3201/eid2211.160920

Bai, Y., Yao, L., Wei, T., Tian, F., Jin, D. Y., Chen, L., & Wang, M. (2020). Presumed Asymptomatic Carrier Transmission of COVID-19. *Jama*. doi:10.1001/jama.2020.2565

Balazy, A., Toivola, M., Adhikari, A., Sivasubramani, S. K., Reponen, T., & Grinshpun, S. A. (2006). Do N95 respirators provide 95% protection level against airborne viruses, and how adequate are surgical masks? *Am J Infect Control, 34*(2), 51-57. doi:10.1016/j.ajic.2005.08.018

Bischoff, W. E., Swett, K., Leng, I., & Peters, T. R. (2013). Exposure to influenza virus aerosols during routine patient care. *J Infect Dis, 207*(7), 1037-1046. doi:10.1093/infdis/jis773

Casanova, L., Alfano-Sobsey, E., Rutala, W. A., Weber, D. J., & Sobsey, M. (2008). Virus transfer from personal protective equipment to healthcare employees' skin and clothing. *Emerg Infect Dis, 14*(8), 1291-1293. doi:10.3201/eid1408.080085

Chen, X., Shang, Y., Yao, S., Liu, R., & Liu, H. (2020). Perioperative care provider's considerations in managing patients with the COVID-19 infections. *Transl Perioper Pain Med*.

Chia, S. E., Koh, D., Fones, C., Qian, F., Ng, V., Tan, B. H., . . . Lim, M. K. (2005). Appropriate use of personal protective equipment among healthcare workers in public sector hospitals and primary healthcare polyclinics during the SARS outbreak in Singapore. *Occup Environ Med, 62*(7), 473-477. doi:10.1136/oem.2004.015024

Cowling, B. J., Chan, K.-H., Fang, V. J., Cheng, C. K., Fung, R. O., Wai, W., . . . Chu, D. W. (2009). Facemasks and hand hygiene to prevent influenza transmission in households: a cluster randomized trial. *Annals of internal medicine, 151*(7), 437-446.

Dreyfus, A., Wilson, P., Collins-Emerson, J., Benschop, J., Moore, S., & Heuer, C. (2015). Risk factors for new infection with Leptospira in meat workers in New Zealand. *Occup Environ Med, 72*(3), 219-225. doi:10.1136/oemed-2014-102457

ECDC. (2014). *Technical document: Safe use of personal protective equipment in the treatment of infectious diseases of high consequence. A tutorial for trainers in healthcare settings.* Retrieved from

FDA. (2020, 27 March 2020). Food Safety and the Coronavirus Disease 2019 (COVID-19). United States Food and Drug Administration.

He, X., Lau, E. H. Y., Wu, P., Deng, X., Wang, J., Hao, X., . . . Leung, G. M. (2020). Temporal dynamics in viral shedding and transmissibility of COVID-19. *Preprint article.* doi:10.1101/2020.03.15.20036707

Hugonnet, S., & Pittet, D. (2004). Transmission of severe acute respiratory syndrome in critical care: do we need a change? *Am J Respir Crit Care Med, 169*(11), 1177-1178. doi:10.1164/rccm.2403004

Kampf, G., Todt, D., Pfaender, S., & Steinmann, E. (2020). Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J Hosp Infect, 104*(3), 246-251. doi:10.1016/j.jhin.2020.01.022

Lai, C. C., Shih, T. P., Ko, W. C., Tang, H. J., & Hsueh, P. R. (2020). Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. *Int J Antimicrob Agents, 55*(3), 105924. doi:10.1016/j.ijantimicag.2020.105924

Lake, R., & Kingsbury, J. (2020). *Foodborne transmission of COVID-19: Literature review*. Retrieved from

Lindsley, W. G., Noti, J. D., Blachere, F. M., Szalajda, J. V., & Beezhold, D. H. (2014). Efficacy of face shields against cough aerosol droplets from a cough simulator. *J Occup Environ Hyg, 11*(8), 509-518. doi:10.1080/15459624.2013.877591

Lok, C. (2016). The snot-spattered experiments that show how far sneezes really spread. *Nature, 534*(7605), 24-26. doi:10.1038/534024a

Lombardi, D. A., Verma, S. K., Brennan, M. J., & Perry, M. J. (2009). Factors influencing worker use of personal protective eyewear. *Accid Anal Prev, 41*(4), 755-762. doi:10.1016/j.aap.2009.03.017

MacIntyre, C. R., Seale, H., Dung, T. C., Hien, N. T., Nga, P. T., Chughtai, A. A., . . . Wang, Q. (2015). A cluster randomised trial of cloth masks compared with medical masks in healthcare workers. *BMJ Open, 5*(4), e006577. doi:10.1136/bmjopen-2014-006577

Makison Booth, C., Clayton, M., Crook, B., & Gawn, J. M. (2013). Effectiveness of surgical masks against influenza bioaerosols. *J Hosp Infect, 84*(1), 22-26. doi:10.1016/j.jhin.2013.02.007

MoH. (2020, 1 April 2020). Ministry of Health. COVID-19: Personal protective equipment for essential workers. https://www.health.govt.nz/our-work/diseases-and-conditions/covid-19-novel-coronavirus/covid-19-novel-coronavirus-information-specific-audiences/covid-19-personal-protective-equipment-essential-workers. Website accessed 1 April 2020.

Nishimura, H., Sakata, S., & Kaga, A. (2013). A new methodology for studying dynamics of aerosol particles in sneeze and cough using a digital high-vision, high-speed video system and vector analyses. *PLoS One, 8*(11), e80244. doi:10.1371/journal.pone.0080244

Ong, S. W. X., Tan, Y. K., Chia, P. Y., Lee, T. H., Ng, O. T., Wong, M. S. Y., & Marimuthu, K. (2020). Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. *Jama*. doi:10.1001/jama.2020.3227

OSHA. (2020). *Guidance on preparing workplaces for COVID-19. Website accessed on 28 March 2020.* https://www.osha.gov/Publications/OSHA3990.pdf.

Otter, J. A., Donskey, C., Yezli, S., Douthwaite, S., Goldenberg, S. D., & Weber, D. J. (2016). Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination. *J Hosp Infect, 92*(3), 235-250. doi:10.1016/j.jhin.2015.08.027

Pittavino, M., Dreyfus, A., Heuer, C., Benschop, J., Wilson, P., Collins-Emerson, J., . . . Furrer, R. (2017). Comparison between generalized linear modelling and additive Bayesian network; identification of factors associated with the incidence of antibodies against Leptospira interrogans sv Pomona in meat workers in New Zealand. *Acta Trop, 173*, 191-199. doi:10.1016/j.actatropica.2017.04.034

Seto, W. H., Tsang, D., Yung, R. W. H., Ching, T. Y., Ng, T. K., Ho, M., . . . Peiris, J. S. M. (2003). Effectiveness of precautions against droplets and contact in prevention of nosocomial transmission of severe acute respiratory syndrome (SARS). *The Lancet, 361*(9368), 1519-1520. doi:10.1016/s0140-6736(03)13168-6

Suess, T., Remschmidt, C., Schink, S. B., Schweiger, B., Nitsche, A., Schroeder, K., . . . Buchholz, U. (2012). The role of facemasks and hand hygiene in the prevention of influenza transmission in households: results from a cluster randomised trial; Berlin, Germany, 2009-2011. *BMC Infect Dis, 12*, 26. doi:10.1186/1471-2334-12-26

Tambyah, P. A. (2004). SARS: responding to an unknown virus. *Eur J Clin Microbiol Infect Dis, 23*(8), 589-595. doi:10.1007/s10096-004-1175-8

Tang, C. S., & Wong, C. Y. (2004). Factors influencing the wearing of facemasks to prevent the severe acute respiratory syndrome among adult Chinese in Hong Kong. *Prev Med, 39*(6), 1187-1193. doi:10.1016/j.ypmed.2004.04.032

van der Sande, M., Teunis, P., & Sabel, R. (2008). Professional and home-made face masks reduce exposure to respiratory infections among the general population. *PLoS One, 3*(7), e2618. doi:10.1371/journal.pone.0002618

van Doremalen, N., Bushmaker, T., Morris, D. H., Holbrook, M. G., Gamble, A., Williamson, B. N., . . . Munster, V. J. (2020). Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *N Engl J Med*. doi:10.1056/NEJMc2004973

WHO. (2004). *World Health Organization. Guidelines on viral inactivation and removal procedures intended to assure the viral safety of human blood plasma products WHO Technical report, series no 924, annex 4.* Retrieved from

WHO. (2020a). *World Health Organization. Rational use of personal protective equipment for coronavirus disease (COVID-19): interim guidance, 27 February 2020. World Health Organization. https://apps.who.int/iris/handle/10665/331215. License: CC BY-NC-SA 3.0 IGO Date accessed 27 March 2020.* Retrieved from

WHO. (2020b). *World Health Organization. Advice on the Use of Masks the Community, during Home Care and in Health Care Settings in the Context of the Novel Coronavirus (2019-nCoV) Outbreak Interim Guidance. 2020.* Retrieved from https://www.who.int/publicationsdetail/home-care-for-patients-with-suspected-novel-coronavirus(ncov)-infection-presenting-with-mild-symptoms-andmanagement-of-contacts Accessed date 27 March 2020.:

WHO. (2020c). *World Health Organization. Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. Scientific brief, 27 March 2020.* Retrieved from

Yuen, K. S., Ye, Z. W., Fung, S. Y., Chan, C. P., & Jin, D. Y. (2020). SARS-CoV-2 and COVID-19: The most important research questions. *Cell Biosci, 10*, 40. doi:10.1186/s13578-020-00404-4

Zamora J E, M. J., Simchison B, Day A G. (2006). Contamination: a comparison of 2 personal protective systems. *CMA Journal, 175 (3)*, 249-254.

Appendix 1. Recommendations regarding face mask usage[2] (Produced by Meat Industry Association, NZ)

With regard to use of face masks and visors: best practice[3] suggests

- Workers must be trained in the use of face masks and frequently reminded how to use them properly
    - They must be fitted properly – they do not work if they are not close fitting to face
    - Workers should wash their hands before and after donning and doffing
    - Must not touch the inside of the mask
    - Must not share masks
    - Must be stored properly if to be reused – with no possibility of touching contaminated surfaces between use
    - Only reused a limited number of times (this will depend on the manufacturer's instructions but one recommendation was up to 5 times maximum)
    - Must be replaced if damaged or hard to breathe through. Damage includes sloppy elastic straps that prevent fitting/holes in fabric, etc)
- Splash shields and visors need to be sanitised regularly (taking care around crazing/damaging plastic due to alcohol use etc)

Things to note:

- Experts believe the greatest risk for transmission is from the virus being carried in droplets when people sneeze and cough and from surface contamination. The virus is not thought to be carried around in the air by itself.
- There are two types of face masks that have different functions. These are "respirators" and "face masks".
    - A respirator is designed to filter virus particles from the air and it is recommended that an N95 or greater mask is worn when there is a risk of airborne contamination.
    - A face mask will not filter small virus particles from the air and therefore cannot protect you from airborne viruses but it can potentially protect you from droplets in the air, as these are bigger than the virus, as long as it is worn and handled correctly.
- The virus can survive up to 2-3 days on surfaces (stainless/plastic) and 1 or so on cardboard which is why surfaces must be regularly cleaned.
- The virus is very readily broken down by regular sanitisers/disinfectants.

[2] Please note this guidance is in draft and has been compiled from a limited review of credible websites. Further information may be forthcoming and manufacturers recommendations should always be adhered to.
[3] https://www.cdc.gov/niosh/topics/hcwcontrols/recommendedguidanceextuse.html