

7 Persistent Infectious Agents

7.1 Health concerns

There have been a number of outbreaks of infectious gastrointestinal disease on ships caused by persistent infectious agents (CDC 1986). For example, in 2002 the US Centres for Disease Control detected 21 such outbreaks (defined as affecting > 3% of the ship population) aboard ships arriving at US ports (CDC 2002). These diseases result from infection of the gastrointestinal system (digestive tract, intestines, stomach) and cause symptoms such as nausea vomiting and diarrhoea. Although often self-limiting or even asymptomatic, they can cause deaths, particularly in sensitive populations, and can infect significant proportions of the total ship population.

The subject of this chapter are the infectious agents that have the ability to persist in the environment long enough that an environmental surface, such as a door handle, (or even transmission through air), can lead to transfer indirectly from one person to another readily enough that an outbreak can occur. An infected person might, for example, be shedding an infectious agent *via* their faeces. After bottom-wiping or nappy-changing they, or their carer, might carry some of this material on their hands, unless thoroughly washed, leaving it on surfaces or in food or water that they touch around ship. When another person touches those surfaces or consumes the food or water they might pick up the infectious agent which can then be ingested when putting fingers in the mouth or through ingestion of contaminated food or water. Water and food borne contamination is considered in Chapters 2 and 3 respectively. This Chapter considers the risks associated with transfer of infectious agents *via* environmental surfaces, such as door handles, (faeces → hand → surface → hand → mouth) and also considers how these same agents can be transmitted via the air.

Many infectious agents can spread via environmental surfaces, including some protozoa, bacteria and viruses. However, to cause a detectable and significant outbreak aboard ship the agents also need to be highly infectious and be able to rapidly complete their incubation and begin replicating in their new infected host. For this reason, the environmentally persistent agents that cause gastrointestinal disease outbreaks aboard ships are generally viruses. Our knowledge of these viruses and their taxonomy is rapidly evolving. In any case, in general, the risk factors and control measures to be applied aboard ship are the same regardless of the taxonomic classification of the infectious agent. Therefore, only a very brief statement regarding the names and classifications of the infectious agents will be given here. One of the most common infectious agents, Norovirus, will be used for illustrative purposes.

Viruses belonging to the Calicivirus, Astrovirus and Reovirus families are commonly associated with diarrhoea, with the Calicivirus family including the genus most commonly associated with ship-borne outbreaks: Norovirus (NV) (which has also been known as Norwalk-like virus (NLV) and small round structured virus (SRSV)).

Because of the similarity between symptoms and control measures, NV will be used in this chapter to illustrate the risk factors and control measures to be applied on ship. NV is considered the leading cause of adult gastroenteritis outbreaks worldwide and is thought to be second only to Rotavirus in terms of all causes of gastroenteritis. Recent improvements in diagnostics and surveillance are likely to reveal even more outbreaks being detected aboard ships. The probable role

of international travellers as vectors is revealed by the similarity of strains between outbreaks across the world (White *et al* 2003).

NV can be transmitted by the aerosols liberated by projectile vomiting and, therefore, by airborne transmission (Marks *et al* 2001) as well as *via* ingestion, (both directly or indirectly via a surface) of infected vomit and faeces. Environmental surfaces can become contaminated readily and remain contaminated for some time (Cheesbrough *et al* 2000).

An outbreak can spread rapidly throughout a ship because NV has an incubation period of just 12-48 hr and an attack rates (proportion of those exposed that fall ill) can be high (often above 50%) in all age groups (CDC 2002). Symptoms often start with sudden onset of projectile vomiting and/or diarrhoea. There may be fever, myalgia, abdominal cramps and malaise. Recovery occurs in 12-60 hr in most cases and severe illness or mortality is rare, particularly if oral rehydration treatment is applied when needed.

Outbreaks may continue and attack passengers on successive voyages. Cohorts of new susceptibles are introduced on a regular basis and it is important to sanitise ships after an outbreak to reduce this risk. Virus densities peak at around 10^6 virions per g, reach around 1,000 virions per g three weeks from the cessation of symptoms in around 50% of cases and remain detectable for up to 7 weeks (Ball *et al* submitted). Therefore, even if ships are sanitised, bridging between groups may occur *via* a reservoir of infection in crew members.

Cruise-ship outbreaks demonstrate how easily noroviruses can be transmitted from person to person in a closed environment, resulting in large outbreaks. The continuation of these outbreaks on consecutive cruises with new passengers and the resurgence of outbreaks caused by the same virus strains during previous cruises on the same ship, or even on different ships of the same company, suggests that environmental contamination and infected crew members can serve as reservoirs of infection for passengers.

More recently, severe acute respiratory syndrome (SARS, (WHO 2004)) has been noted as a disease that might be spread by travellers or on ship. This disease, caused by a coronavirus, has symptoms that are typically different from the gastrointestinal viruses described above and is associated with respiratory tract infection and flu-like symptoms. However, although initially presenting rather like influenza, complications can include severe pneumonia and respiratory system failure which can be fatal. The risks from the person-to-person spread of SARS appear to be reduced by the same type of control measures applied for NV and similar agents.

7.2 Relevant Aspects of the International Health Regulation

Control of persistent infectious agents is not specifically covered management in IHR but there is a general overview of responsibilities for responding to and managing suspected or confirmed disease outbreaks on ships (see Chapter 9).

7.3 Risk factors associated with ships

Risk factors for infection from viruses such as NV are generally those that involve being in close proximity to an infected person (de Wat *et al* 2003):

- having another infected person in the same household;

- coming into contact with an infected person from another household;
- poor food handling hygiene;
- the significance of contact with other infected persons increases where the infected person is a young child; and
- contact with both faeces and vomit appear to be equally important.

Ships present a particularly high risk for extensive outbreaks for several reasons. Many outbreaks on land have been associated with situations in which many people are in close proximity to other infected persons for a period of time, such as parties, restaurants, schools and dormitories. These high-risk situations can all be present on one ship where the problem is compounded by them being in close proximity and by people sharing the same facilities for days to weeks. Cabins often include people living in close proximity, often with children, that might otherwise be better separated.

7.4 Controlling the risks

It is not possible to eliminate all risk of an outbreak resulting from persistent infectious agents on ship but risks can be reduced. Education of crew and passengers, such as through audio and written notices, signs and pamphlets is vital since both crew and passengers need to adopt basic control measures to reduce the risks and should always be advised to:

- Wash hands with soap and frequently, and always after using toilets and changing nappies and always before handling or consuming food;
- Avoid putting fingers in or near the mouth;
- Avoid placing objects that may have been touched into the mouth;
- Limit direct contact with others, even during greetings, such as the shaking of hands and kissing;
- Limit indirect contact with others, such as the sharing of drink containers and eating utensils;
- Remain in their cabins as much as possible during and shortly after illness or suspected illness to minimise contact with others; and
- Not take part in food handling duties or other duties that may readily lead to transmission of infection.

Concerned passengers or crew that wish to take extra precautions could adopt practices such as avoiding uncooked foods and unbottled water, including ice. Unpackaged foods, such as buffets, where people might well touch the food with hands, or with utensils that have been handled, dropped or put in mouths, or salivated on, could be avoided.

Additional systematic precautions that can be taken by ships include:

- Eliminating self-serve eating facilities, or at least supervising these facilities closely and preventing children from using them;
- Sanitizing items both between and even during voyages, this can include any environmental

surface that might be touched by one infected person and lead to indirect transmission to another (toilet and tap operating handles, eating and drinking utensils, door handles, remote control devices, switches on lights, radios and air conditioning units, chair, table and bedding surfaces and carpets);

- Maintaining a watching brief to detect early warning signs of an outbreak (requests for medication, visits to medical staff etc.); and
- The earliest possible detection of disease symptoms and management of patients, including isolation.

Additional details on these control measures are given below where they are discussed in a different context.

7.5 Controlling an outbreak

An outbreak of infectious gastroenteritis, such as that caused by NV, is often diagnosed presumptively on clinical grounds from characteristic epidemiological features. Outbreaks are often explosive in their onset with projectile vomiting a prominent feature. Attack rates may be as high as 50%. Criteria for suspecting an outbreak include:

- Short incubation of 12-48 hr;
- Illness duration of 12-60 hr;
- Vomiting in > 50% of symptomatic cases; and
- Both passengers and crew affected.

When an outbreak is suspected it is imperative to institute additional control measures immediately, without waiting for virological confirmation and without waiting for the results of bacterial cultures.

7.5.1 Containment levels at individual cabin level

Symptomatic passengers or crew are best advised to stay in cabin. Prompt cleaning and disinfection of areas contaminated by vomit and faeces should be undertaken (see below). Excretion of virus in faeces begins a few hours before onset of symptoms and can continue for up to 7 weeks with maximum shedding occurring 24-72 hours after exposure. Emphasis must be given to cleaning staff and crew regarding handwashing after contact with affected passengers or crew and objects, before handling food or drink and on leaving an affected area or cabin. Cleaning staff should wear gloves and aprons. Although there is evidence that airborne transmission is possible, the wearing of masks is generally not essential unless spattering or aerosolisation is anticipated.

7.5.2 Food and water safety

If the characteristic of an outbreak suggests a point source, epidemiological investigations should be undertaken to identify or exclude a food or water source.

Since food and waterborne outbreaks have occurred on ships, kitchen hygiene practices and water

safety management should be reviewed and monitored. Outbreaks have been associated with pre-symptomatic, symptomatic and post symptomatic food handlers and viral shedding can occur from asymptomatic, infected individuals. Infected food handlers should be encouraged to report symptoms and be excluded from work until at least 48 hours after symptoms have ceased. Exposed food that will not be cooked, such as fruit, can be discarded if it may have become contaminated. Water and food safety is considered in more detail in Chapters 2 and 3 respectively.

7.5.3 Environmental cleaning

Prolonged outbreaks on ships suggest that NVs survive well in this environment. In one outbreak, illness was associated with sharing bathrooms and having a cabin mate who vomited. The authors concluded that contaminated communal bathrooms and environmental contamination were implicated in the transmission of infection. Subsequent outbreaks were prevented by repeated and thorough bathroom cleaning and rapid cleaning of contaminated rooms. During an outbreak there is a need for a comprehensive and responsive cleaning and disinfection programme during and at the end of an outbreak.

Particular attention should be given to cleaning objects that are frequently handled such as taps, door handles and toilet or bath rails. The timing of the terminal cleaning process should be at least 72 hr post resolution of the last case. This takes into account the period of maximal infectivity (48 hr) plus the typical incubation period (24 hr) for the newly infected individuals. Affected areas should be rapidly cleaned and disinfected.

There is no direct evidence to support the use of particular agents for environmental disinfection as there is no viral culture system available for NVs. The related feline calicivirus is inactivated by heat at 60°C and by hypochlorite at 1000 ppm (0.1%), but not ethanol.

Contaminated linen and bed curtains should be placed carefully into laundry bags appropriate to guidelines for infected linen (such as soluble alginate bags with a colour coded outer bag) without generating further aerosols. Contaminated pillows should be laundered as infected linen unless they are covered with an impermeable cover in which case they should be disinfected with 0.1% hypochlorite solution.

Carpets and soft furnishing are particularly difficult to disinfect. Hypochlorite is not generally recommended as prolonged contact is required and many such items are not bleach resistant. Steam cleaning may be used for carpets and soft furnishings, provided they are heat tolerant (some carpets are "bonded" to the underlying floor with heat sensitive materials). However, this needs to be undertaken thoroughly as a temperature of at least 60°C is needed to be achieved to be confident that disinfection has been achieved and in practice, tests have shown that such high temperatures are often not reached in carpets during steam cleaning. Vacuum cleaning carpets and buffing floors have the potential to re-circulate NVs and are not recommended.

Contaminated hard surfaces should be washed, such as with detergent and hot water, using disposable cloth, then disinfected with a disinfecting solution, such as 0.1% hypochlorite. Disposable cloths should be disposed of safely, e.g. as clinical waste. Non disposable mop heads and cleaning cloths can be laundered as contaminated linen on a hot wash.

7.5.4 Separation and embarking and disembarking passengers

Embarking and disembarking passengers should be separated if possible. If an outbreak has

occurred on a ship, embarkment of new passengers should be delayed until the ship environment has been thoroughly cleaned and disinfected.

7.6 References

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