Contagious diseases

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Introduction

Contagious diseases are spread by direct contact between infective and susceptible individuals or exposure of susceptible individuals to infective material. Most of the highly feared diseases of humans and animals that sweep through populations as major epidemics, sometimes causing high mortality and invariably causing economic losses, are contagious diseases. They include influenza, measles and poliomyelitis in humans and foot-and-mouth disease (FMD), peste des petits ruminants (PPR), contagious bovine pleuropneumonia (CBPP), classical (CSF) and African swine fever (ASF), influenza (particularly equine and highly pathogenic avian influenza (HPAI)) and Newcastle disease (ND) in animals. Smallpox and rinderpest, two of the most feared contagious diseases in humans and animals respectively have been declared globally eradicated; smallpox in 1980 and rinderpest in 2011. Many, perhaps most, of the other diseases are less susceptible to eradication for various reasons related to their epidemiological and/or immunological characteristics.

How contagious diseases cause outbreaks

Whether a contagious disease will be able to invade a population and cause an outbreak depends upon the ability of the agent to spread within the population. This is determined by the infectivity of the agent, the length of the incubation period, the proportion of susceptible individuals in the population exposed to infection, and the density of the susceptible population. For highly contagious diseases factors that contribute to the high infectivity of the agent include shedding of the agent prior to the appearance of clinical signs, shedding of massive quantities of the agent during infection, multiple routes of transmission of the agent, a low infective dose, and extend survival of the agent in the environment. Thus FMD, which has a highly infectious agent and a short incubation period, will spread rapidly through a dense population containing a high proportion of susceptible individuals. The basic reproductive ratio (R0) is used to determine whether a pathogen is likely to cause an epidemic and the rate at which spread is likely to occur. It is computed by applying the formula $R0 = \beta \times d$ where β = number of contacts per unit time x transmission probability per contact and d = duration of infectiousness. In order for a micro-parasitic pathogen to invade a population, R0 must be >1, i.e. the conditions must be such that an infective individual will infect more than one susceptible individual in the population. The more individuals a single individual will infect, the higher the R0 and the greater the risk of a large epidemic. For example, within a particular farm experiencing foot-and-mouth disease, all animals will be infected after 2-3 replication cycles of the virus within 2-3 weeks.

Transboundary spread will occur when populations with large numbers of susceptible individuals that are continuous or migrate across international borders are invaded by a highly infectious agent such as FMD. It will also occur when infectious individuals, or infectious materials likely to be introduced into susceptible populations, travel to distant destinations within the

period of infectiousness. This occurred in recent times in human populations with severe acute respiratory syndrome (SARS) and pandemic H1N1 influenza and in animals with H5N1 HPAI, Type O FMD, CSF and ASF viruses.

Prevention and control

Prevention of contagious diseases depends upon reducing or eliminating the likelihood of contact between infectious and susceptible individuals. This can be achieved by hygienic measures that prevent the pathogen from being introduced into populations (biosecurity) and by reducing the number of susceptible individuals within populations. For example, although FMD is highly contagious, R_0 can be reduced to <1 by ensuring that a high proportion of individuals in a population have been effectively vaccinated and are therefore not susceptible to infection.

Biosecurity measures need to be taken according to the ways in which animals might be exposed to infection. Biosecurity can be defined as a management tool that creates an environment where infectious diseases are removed and prevented from spreading. It should ideally be part of any food animal production system. The components of biosecurity include farm layout, fences, sentinel animals, diligent testing for infection, quarantine, cleaning and disinfection of all equipment and clothing, pest control and immunization, and they directly affect productivity and profitability. It entails identifying the possible sources of infection for multiple diseases and finding the best way to prevent them from endangering the herd or flock. The most potent source of infection in most cases is the introduction of new animals into the herd, but semen, feed, water and fomites represent possible sources of infection as well as other animals such as other species of domestic livestock, rodents, wild birds, cats and dogs. Mechanical transmission of contagious disease agents by invertebrate vectors is possible. Older animals within the herd may act as a source of infection for younger animals, and for this reason intensive farming systems tend to operate on an all-in all-out basis to prevent mixing of different age groups or new groups entering pens contaminated by the previous group. Stringent hygienic measures are an important part of on-farm biosecurity and various routines for washing and disinfection have been tested for effectiveness against different pathogens.

Controlling outbreaks of high impact highly contagious diseases is challenging, particularly if the disease has spread beyond the initial focus before it is detected. Models have been developed to identify areas of high risk for outbreaks of important diseases so that advance measures can be put in place to avert the risk. For example, areas of dense pig-farming have been identified as having a high risk for CSF outbreaks. While a sufficient level of immunity in these populations can be achieved by effective vaccination, countries that are free of CSF prefer not to vaccinate and instead have to encourage pig farmers to maintain high standards of biosecurity to as far as possible eliminate the risk of infection. These measures focus on not introducing pigs or semen from infected countries or areas, under no circumstances feeding swill containing remains of pork that could have originated from an infected country or area, and strictly controlling the entry of people and vehicles to the pig facilities. To reduce contact between different herds in densely farmed areas, there are recommendations for the minimum distance between farms, based on the distance over which the CSF agent might be airborne. One of the more extreme pre-emptive measures is the elimination of poultry flocks in which low pathogenic H5 or H7 avian influenza viruses (LPAI) are detected, because mutation from LPAI to HPAI has been recorded. This often results in the destruction of large numbers of healthy birds.

Massive culling of infected and in-contact herds/flocks is frequently carried out in attempts to control outbreaks of contagious diseases, particularly when they appear in previously uninfected countries. For countries that export meat, it is the most attractive option as it enables more rapid reinstatement of OIE-recognised disease freedom and consequent resumption of trade than if vaccination is used as the control strategy. However, there are increasing ethical and environmental concerns about the massive destruction of animals, and in poorer countries where owners are unlikely to be compensated and resources are inadequate to maintain strict quarantine and movement control culling is more likely to spread than to control the outbreak. There are various initiatives to find alternatives to massive culling. One alternative is the use of vaccination to contain the outbreak. Technology to distinguish between vaccinated and naturally infected animals (DIVA) exists for some diseases and development is ongoing. This should help to eliminate the difference in time between resumption of trade after an outbreak and possibly for many diseases eliminate the perceived need for what is often unfortunately an inhumane exercise that has worse consequences for the livestock industry than the disease itself. Modelling indicated that control of the 1997 CSF outbreak in The Netherlands could have cost less than the culling of 11 million pigs provided that vaccinated pigs were not destroyed but were slaughtered commercially to return to the status of freedom without vaccination. It is clear, however, that for contagious diseases that have a high impact and potential for transboundary spread, prevention at farm level is the key to avoiding outbreaks and the involvement of producers in implementation of preventive measures is essential to ensure its success.

Find out more

Web-based modules on a range of contagious diseases are available on the veterinary HUB for CPD purposes and provide an in-depth look at how the diseases are transmitted, how to recognise them, their prevention, control and socio-economic importance, and where to look for further information

Web-based modules on animal health management and on the tools used for animal health management, including biosecurity, provide a broad overview of approaches to the management of high impact contagious diseases.