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Mini Review

ARE PANDEMICS ASSOCIATED WITH INTENSIVE LIVESTOCK PRODUCTION?

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Abstract

Covid-19 has awakened the world to the importance of infectious diseases. However, it also affected several people, including researchers, as well as some organizations to blame the pandemic on intensive livestock production. Several factors contribute to the fact that the next pandemic is less likely to come from intensive livestock farming than from wild animals and traditional small-scale livestock production. However, there are also the facts that support the role of intensive production in spreading of diseases. One Health - the interaction between the health of humans, animals and the environment has received a lot of attention. Livestock production plays a role in these interactions, but is not a primary driver for the development of new pandemics.

Key Words: Covid-19, livestock, pandemics, zoonoses

INTRODUCTION

Livestock for meat production is an essential part of the food supply in the world. Knowledge-based, rational and efficient production aims to keep costs down and

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make quality foods available to as many people as possible. It can be called modern knowledge-based livestock farming.

Civilizations arose because Man learned agriculture. A few plants had a high content of protein and energy and could be cultivated, and a few animal species could be tamed so that we could settle and build communities. The basis for the modern world is thus the cultivation of useful crops and the keeping of domestic animals.

The coexistence of domestic animals and the human population does indeed create some disease challenges. For example, salmonellosis has plagued us since the beginning of civilizations. But some developed countries, like most of the European, have well-developed systems to reduce this risk to a minimum. The fact is that European continent is one of the safest regions in the world in terms of disease from animals and food. Covid-19 does not change this. It is extensive travel and interpersonal contact that drives this pandemic. In addition to humans, a few other species such as cats, mink and ferrets can be infected with the Covid-19 virus, but they do not have a significant effect on the spread of the virus. Farmed mink may however play a role as multipliers and reservoir for the virus (Andersen et al., 2020; Wan et al., 2020; WHO, 2020).

HOW DO PANDEMICS OCCUR?

New disease problems can arise or come to the surface when abnormal closeness between wild animals, domestic animals and humans occurs. This may cause what in the technical language is called species-spill-over, where infectious agents are spread between species (Parrish et al., 2008), for example, from bats to pangolins and then to humans. This was one hypothesis on how the Covid-19 virus developed around the food and animal market in Wuhan, China (Boni et al., 2020; Wan et al., 2020). It has been shown that a Covid-19-like virus probably has been circulating in bats for decades, infecting humans and pangolins at about the same time (Andersen et al., 2020).

ZOONOSES - INFECTIONS FROM DOMESTIC ANIMALS, ARE RARELY PANDEMICS

Epidemics and pandemics can turn into regular occurrence and the disease is then called endemic. When the diseases occur beyond the endemic normal, it is called an outbreak of the disease. Epidemics are thus major outbreaks, and pandemics are worldwide outbreaks (Thrusfield, 1986). Several epidemics go in waves, such as childhood illnesses, or they show clear seasonal variations, such as the flu. There are not always clear boundaries, and an outbreak can develop into an epidemic or pandemic. Throughout history, there have been many pandemics. The most well-known is bubonic plague (black death), but outbreaks of, among other things, smallpox, measles, polio and influenza have taken millions of lives throughout history.

With Covid-19 as a backdrop, several people, researchers and organizations have blamed the pandemic on livestock production in the world. Among other things, reference is made to sources such as the American Center for Disease Control and Prevention (CDC), which among other things write that six-out-of ten infectious diseases in humans come from "animals" (CDC, 2019). This is true, and not unexpected, when one knows that man is one of over one million animal species in the world. What is important here is to distinguish whether the infection comes from domestic animals, wild animals or insects.

The CDC (2019) lists the 8 most important zoonoses from their point of view: influenza (birds, swine), salmonellosis (many species), West Nile fever (horses - transmitted by mosquitoes infected by birds), plague (*Yersinia pestis*; transmitted by fleas / lice and onwards by rodents), emerging coronavirus (bats, dromedaries, others), rabies (several species), brucellosis (goats, cattle), and Lyme disease (deer, ruminants, through infected ticks). What is striking with the lists of diseases that are transmitted from animals to humans is how rarely zoonoses in food-producing animals are the origin or reservoir of pandemics. Furthermore, most zoonoses that may be related to livestock production in CDC's list (for example salmonellosis and brucellosis) can be controlled with knowledge-based measures. Other countries will have other zoonoses they consider the most important in their country or region, and diseases such as bovine tuberculosis, Rift Valley Fever, anthrax and leishmaniasis are relevant in many areas.

One of the reasons why food-producing animals rarely are the origin or reservoir of pandemics is probably that we have cohabited with our domestic animals for thousands of years. Infectious agents in animals that can infect humans have to a large extent already had their pandemic phase. Zoonotic diseases that today exist all over the world may have once been pandemics, but today they are endemic. Every year, hundreds of millions of people worldwide are infected with salmonellosis, brucellosis, Q fever and anthrax, and approximately 60,000 people die each year from rabies (CDC, 2020). Of the zoonotic diseases we know in food-producing animals today, only a few flu variants in pigs and poultry have been pandemic zoonoses in recent times.

Pets can be affected by some of the same zoonoses as humans and outbreaks of disease can occur, and livestock can act as an amplifier in the event of a high burden of infection (Jones et al., 2013) - the larger the herds, the higher potential for amplification. Such situations have primarily led to animal disease and death, or reduced production that can threaten the economic livelihoods for inhabitants. Therefore, these diseases are often monitored, controlled or eradicated in animals with measures such as vaccination, quarantine and culling including stamping out. Sometimes this is not enough, and local outbreaks occur, but sometimes also major regional and continental epidemics. Pandemics occur very rarely.

INFECTIOUSNESS AND SEVERITY

There are large variations in the number of infected people, and the incidence of disease, due to zoonoses. Nipah-virus infection, which has been frequently mentioned, was first detected in 1998 in Malaysia. In that outbreak, 1,100 people died from the disease as a result of infection from pigs (Angeletti et al., 2016). The disease has not been detected in Malaysia since 1999, but 198 deaths have since been recorded in Bangladesh and 85 in India. In these countries, the infection has not been linked to pig farming, and the virus does not circulate among pigs. Hendra-virus infection, which is also frequently mentioned, has been detected in only 7 people who worked with Hendra-diseased horses on the East Coast of Australia between 1994 and 2016 (Broder et al., 2016). Although these are serious diseases for those affected, none of the outbreaks of these viruses have been more than local outbreaks of disease. The Covid-19 virus, like the swine flu virus, primarily has properties to spread rapidly. Mortality among those with detected Covid-19 infection is low (according to Worldometers (2021) arround 2% at the world level and, for example, approximately 0.5-1% in Norway and mainly in patients over 60 years of age). This compares with, for example, Ebola virus infections which cause high mortality - up to 20-90% (Kadanali and Karagoz, 2015). During the 2009 swine flu pandemic, an estimated 1 billion people were infected, and it is estimated that 300,000 people died (Kim, 2016). Only a few hundred people have been documented infected with highly pathogenic bird flu (H5N1 and H7N7), but many of these died (Peiris et al., 2007).

ZOONOTIC INFLUENZA – A PANDEMIC WITH A LINK TO DOMESTIC ANIMALS

Influenza is a viral disease that occurs in ducks, chickens, humans, pigs, horses and dogs. Normally, old, so-called "low pathogenic", varieties circulate within the same species over long periods. They have adapted to the host animal and typically give a milder course of the disease. Humans most often get sick from varieties that originate in wild waterfowl like ducks. These variants typically infect chickens, which in some relatively rare cases have infected pigs and humans.

In cases where new influenza viruses have been transmitted to humans, it is usually in densely populated areas where there is close contact with live ducks, chickens and pigs. Widespread small-scale subsistence animal husbandry in Asia provides the best conditions for the development of new varieties of influenza virus. In this cycle, humans also infect animals. Infections become pandemics because humans infect humans.

In January 2009, an outbreak of a new variant of influenza virus was detected in pigs in Mexico (Hsieh et al., 2011). The virus spread among pigs and humans around the world for a year and a half, and it is estimated that 15-20% of the world's population became infected. The virus was called swine flu - A (H1N1) pdm09. The infection

gave few symptoms in pigs, and also had a fairly normal course of seasonal flu in humans, except that it gave more disease than normal in younger people. As with other influenza viruses, the route of transmission was mainly droplet infection, but the infectivity of the virus was higher than usual. For example, Norway was one of the few countries in the world free of influenza virus in pigs until 2009, but the new virus spread rapidly among both pigs and humans. A vaccine for humans was taken into use in the autumn of 2009, and the pandemic was declared over by the WHO in August 2010. The swine flu virus is still circulating among European pigs.

Bird flu is a problem for large parts of the world's poultry production. This is mainly due to "old" low-pathogenic virus variants that circulate in poultry populations. This is most studied in industrialized countries where a decline in production is dramatic for the farmer's economy. Some highly pathogenic varieties have hit large flocks with very high mortality among the birds within a few days. This has been passed on by many as "industrialized production" is driving the development of new viruses and pandemics. This is not true, but large herds can multiply viruses in an ongoing outbreak.

WHAT ARE THE DRIVERS FOR VIRAL PANDEMICS?

Several factors contribute to the fact that the next pandemic is less likely to come from knowledge-based industrial production than from wild animals and traditional small-scale livestock production (Morse et al. 2012). Firstly, the traditional domestic animals and humans have been together for thousands of years, and it is empirically very rare that new pandemics have arisen from the domestic animals. The industrial production implies only a few contacts between different species, as well as relatively few herd-to-herd contacts both nationally and internationally. Furthermore, relatively few people have close contact with domestic animals in modern animal husbandry. Finally, established disease contingency plans, disease prevention measures including vaccination programs, health monitoring, disease control and, if necessary, drastic control measures, are well implemented in regulations by authorities and the industry.

In some cases, the preconditions for the outlined arguments are weakened. Systematically changed processes, such as the introduction of milder methods of rendering, caused scandal with BSE and new variant Creutzfeldt-Jacobs disease. Establishment of livestock, especially with new species, in new areas with rich wildlife and correspondingly rich occurrence of "new" infectious material, such as jungles and other tropical areas, has become a trend. Indirectly, European countries can also contribute by importing food and feed raw materials produced in areas where wild animals would be displaced.

When a new infection occurs, various factors are important for the spread. Large volumes, complex transport of goods and far-reaching distribution of products make the consequences of errors similarly serious; for example, global corporations that supply the world with breeding animals, and national and international supply of feed

and food products. Also, the larger the numbers of animals that have contact with the infectious agent, the greater the risk of spreading.

EMERGENCY PREPAREDNESS

Knowledge-based livestock farming counteracts infection with infection control and preventive measures, which also work in large scale productions. This probably means that the risk of new zoonotic diseases is lower per kg of meat or eggs in large-scale production.

Several factors affect the occurrence of zoonotic diseases in Europe. Nature given conditions are important disease obstacles in northern parts of the continent, i.e. Scandinavia. Cool climate there is unsuitable for many vector organisms needed to spread serious diseases common in temperate and tropical regions. Some parts, e.g. Great Britain, Ireland or Iceland, are geographically partially protected surrounded by oceans and seas. Many European, especially Western countries are well-developed societies. They benefit from and contribute to the preparedness of international organizations (WHO, OIE, FAO and the EU). Standard of living there is important for good sanitation and health systems including hygienic quality of drinking water that is finally reducing infection from humans to animals. This is also applicable to less developed European countries, such as Serbia. Also, surveillance and control systems for specific diseases are in place, veterinary competence and services are available while Competent Authorities insist on risk-based and cost-efficient food safety assurance systems. Furthermore, Europe is generally characterised by organized and knowledge-based measures in the industry and among consumers. The measures include, among other, heat treatment of feed raw materials for concentrate feed, movement restrictions on live animals and potentially contagious animal products, good manufacturing and hygiene practises, quality of the cold chain from production to consumers, organized preventive medicine and infection control programs for livestock, process control in the food industry, etc. Good livestock environment and safe supply of good feed provide animals with good conditions and resilience. The most important zoonoses nowadays, salmonellosis, campylobacteriosis, yersinosis and disease caused with pathogenic *Escherichia coli* (EFSA/ECDC, 2019), are prevented by good general hygiene measures.

WHAT IS THE CAUSE OF SPECIES-SPILL-OVER?

The next pandemic may have to originate either from a wild animal, a domestic animal or humans. Yet there are many prerequisites to be fulfilled for that an infection must jump from one species to another. First, a virus reservoir, and preferably exposure to "new" ecological niches with their own flora of virus is needed as well as the tendency of the virus to mutate or recombine. Also, the ability of the source host or a temporary host to become infected of several similar viruses simultaneously, and

close functional contacts between different species, including temporary hosts and vector organisms are needed. Then, high population or herd density in the recipient population is important prerequisite. The virus must be allowed to and have time to adapt to new host and environment. Finally, efficient spreading routes as human travel activity and trade, efficient movement of infected animals such as, for example, migratory birds, distribute the emerging infectious agent to new outbreaks, epidemics or pandemics.

ONE HEALTH – THE PROBLEM AND THE SOLUTION

The term "One Health" recognizes that human health, animal health and environmental health are closely tied together (Karesh and Cook, 2009). The world's population is growing and we live closer together and travel more. We need more food, keep more livestock, and seize areas which formerly were wilderness and sanctuaries for wild animals. The interaction between humans, animals and the environment affect the exchange of microorganisms between animals and humans. Sociological factors that drive people's behaviour are also important for understanding these mechanisms (Jones et al., 2013).

Nature's ability to adapt to genetic variation and evolution is a prerequisite for life on earth, and these biological processes can only to a small extent be controlled or predicted (Morse et al., 2012). This is most obvious for the infectious agents and occur more often the simpler they are. Therefore, there will continue to be new varieties of infectious agents that harm us, our domestic animals, or other species.

We can handle this with deep insight into the interaction between humans, animals and the environment using knowledge-based measures. We must maintain and renew competence, maintain preparedness and build societal structures and systems that ensure collaboration across disciplines and industries.

Authors' contributions

OA and TT designed the content and wrote the manuscript; BB participated in manuscript writing, translations and revised it critically. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests. The first popular version have been published in Norwegian (Alvseike and Tollersrud, 2020).

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DA LI SU PANDEMIIJE POVEZANE SA INTENZIVNIM UZGOJEM ŽIVOTINJA?

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Kratak sadržaj

Covid-19 virus je probudio svest ljudi o važnosti zaraznih bolesti. Međutim, uticao je i da više ljudi, uključujući i istraživače, kao i neke organizacije, okrive intenzivan uzgoj životinja za pandemiju. Postoji više faktora koji doprinose činjenici da je manje verovatno da će naredna pandemija proisteći iz intenzivog uzgoja nego od divljih životinja i tradicionalnog, ekstenzivnog uzvoja. Ipak, postoje i činjenice koje podržavaju ulogu intenzivnog uzgoja u širenju bolesti. Jednom zdravlju – interakciji između zdravlja ljudi, životinja i životne sredine, poklanja se sve više pažnje. Uzgoj životinja igra ulogu u ovim interakcijama, ali nije primarni nosilac razvoja novih pandemija.

Ključne reči: Covid-19, stoka, pandemije, zoonoze