DO INFECTIOUS DISEASES STOP WHERE LAND MEETS WATER?

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SUMMARY

Diseases, both infectious and noninfectious, have the potential to cross the land sea barrier. Whilst the focus of this topic has classically focused on diseases that could affect humans closely interacting with marine animals in a clinical or dietary setting, it is becoming apparent that some diseases also affect wildlife with important attendant conservation implications. Moreover, historically most work on diseases that cross land sea barriers have focused on marine mammals, it is now becoming evident that other marine animal groups lower in the phylogenetic tree are being adversely affected by factors originating from land, again with important conservation implications. There is a clear need for the veterinary profession to step up and lend their expertise to understanding disease process in those species that are less charismatic but likely have more ecosystem value than their more charismatic brethren. Veterinarians can also contribute significantly to wildlife conservation by educating their clients on proper management of invasive species to reduce their impacts on endangered native wildlife.

MARINE MAMMALS

Because veterinary medicine is a comparative science where professionals apply concepts and tools from one species to the next, it is probably not surprising that marine mammals are the animal group with the most available information given that our base of knowledge for this groups is the most complete. Clinicians and caretakers have a long history of interacting closely with marine mammals through rehabilitation, mortality investigations, or diet, activities that have afforded ample opportunities for exposure and documentation of zoonotic pathogens. Accordingly, several zoonotic pathogens have been documented in humans including viruses, helminths, and protozoa; of these, helminths appear to be the most important in terms of human prevalence.

Trichinella sp., a nematode that encysts in skeletal muscle causing fevers and myalgia. The parasite circulates in arctic polar bears where prevalence can reach 50% and to a lesser extent walruses where prevalence is lower (ca. 10-20%). Polar bears are thought to contract the parasite through predation of seals, scavenging, or cannibalism. Humans affected are those residents of artic habitats that consume marine mammals. The parasite is thought to be maintained among those species through cannibalism.

Viruses of marine mammals have caused isolated cases of disease in humans. Seal pox causes nodular lesions in the skin of various species of pinnipeds and cetaceans, and there have been isolated cases of humans caring for such animals developing skin lesions caused by this virus. Influenza A has caused periodic epizootic mortality in harbor seals in the Eastern US, and in rare instances, the virus has caused mild conjunctivitis in humans. Rabies circulates in arctic foxes and has rarely spilled over to marine mammals such as seals and polar bears, however, there are no known cases of exposure from marine mammals to humans. Caliciviruses infect pinnipeds and have been documented to cause vesicular exanthema in swine. One of these, San Miguel Sea Lion Virus 5 is a known zoonotic pathogen that has rarely caused fever and skin blisters in humans.

Various bacteria have crossed from marine mammals to humans. Seal finger, a painful inflammatory condition of the skin and joints has been variably associated with *Micrococcus*, *Staphylococcus*, *Erysipelothrix rhusiopathiae*, and *Mycoplasma* sp. Outbreaks of human *Salmonella* in arctic villages have been associated with consumption of marine mammal meat. Other bacteria circulate in wild marine mammals that seem to be adapted to those species but have the potential to cross over into humans. For instance, a marine mammal-adapted strain of Brucella circulates in seals and cetaceans causing lesions in the reproductive tract. On the West coast of the US, sea lions are periodically affected by epizootic mortality due to renal disease caused by Leptospira sp. Granulomas associated with Mycobacteria have been documented in marine mammals. *Coxiella burnetii* has been detected on serology and by PCR in harbor seals, harbor porpoises, and stellar sea lions. All these bacteria are potentially zoonotic, and rare cases with some have been documented, so it behooves practitioners with close contact with marine mammals to be aware of their existence.

Protozoa are also known to cross the marine land interface. *Toxoplasma gondii* infects a wide variety of marine mammals including pinnipeds, cetaceans, and sea otters. Seroprevalence to the parasite in certain arctic communities have been associated with consumption of seal meat. Exposure to *T. gondii* in marine mammals can be common depending on the species, however, clinical disease is rarer. However, the parasite does have important conservation implications for certain groups of marine mammals. In particular, *T. gondii* is an important cause of mortality in endangered Southern sea otters in California, endangered Hectors's and Maui dolphins in New Zealand, and endangered monk seals in Hawaii. Because felids are the only definitive host for the parasite, considerable work has gone into trying to elucidate the source of oocyst exposure in marine ecosystems. In California, oocysts from wild and domestic felids are thought to circulate from land to the sea where they are likely transmitted to otter by consumption of shellfish. Because New Zealand and Hawaii have no native felids, the source of oocysts to marine mammals in those

regions is feral and domestic cats imported to these islands. In those regions, then, burden of disease to endangered native species could be significantly reduced by managing cats in ways to reduce the chances of polluting of the environment with infective oocysts. *Sarcocystis neurona* is another protozoan causing disease and mortality in sea otters in the Pacific Northwest. In this case, the definitive host is the non-native opossum, again illustrating the indirect impact that non-native species have in spreading infectious diseases detrimental to native wildlife. Giardia and Giardia have been documented in grey seals and beluga whales in Eastern Canada, and given the close contact of some Arctic indigenous communities with marine mammals, the potential exists for transmission.

Intoxications to humans from marine mammals are rare and mostly limited to botulism outbreaks in Arctic communities associated with consumption of improperly preserved or deliberately fermented.

SEA TURTLES

Zoonotic diseases from sea turtles are rare. Salmonella, commonly transmitted from freshwater turtles to humans are also found in sea turtles, but human cases are rarely encountered. The only outbreak of Salmonella was in a village in the South Pacific where villagers got sick after consuming a dead green turtle. More recently, renal disease associated with a host adapted strain of Salmonella typhimurium was found in olive Ridley turtles both associated with epizootic mortality events and in the pelagic environment in the North and South Pacific. Interestingly, this bacterium recently colonized sea turtles in the last 50-100 years showing that potentially zoonotic bacteria can range far out into the open ocean.

Perhaps the highest risk to humans that sea turtles could pose would be the phenomenon known as chelonitoxicosis that occur chiefly in the South Pacific in indigenous communities that consume sea turtles. Some species of sea turtles, particularly hawksbills, eat invertebrates from which they appear to bioaccumulate toxins that are resistant to heat. People become poisoned after consuming meat from the affected turtle with symptoms ranging from neurological, oral and gastric ulceration, and death. In some cases, a significant proportion of villages can be affected, because consuming turtle is a shared event. Few attempts have been made to identify the actual toxins responsible.

FISH

The most significant zoonotic disease transmitted from fish to humans is Anisakis, a nematode acquired from consumption of improperly cooked fish. Multiple fish species can be affected, and infection in humans can lead to gastritis, urticarial, and nausea.

Toxicoses can also occur from eating certain types of fish. A prime example are pufferfish that are a prized delicacy, particularly in Japan. Preparation of this fish for human consumption must be done with care to avoid poisoning with tetrodotoxin, a potent neurotoxin that in sufficient dosages can kill a human. Ciguatera toxin produced by the dinoflagellate *Prorocentrum lima* can bioaccumulate in the flesh of some reef fish. The toxin is resistant to heat, and can cause significant short and long term neurological effects in humans that consume toxic fish.

SHELLFISH

Because of their ability to filter feed and concentrate large amounts of water, shellfish make great mechanisms for conveying illnesses to humans. Several diseases are transmitted to humans by shellfish. The most significant infectious disease is Vibrio bacteria that are bioaccumulated and transvectored to humans through consumption of improperly cooked shellfish. Symptoms of vibriosis typically include enteritis and sometimes death. Enteroviruses such as Norwalk and Noroviruses have also been documented in shellfish. Finally, potentially zoonotic protozoa such as Giardia and Cryptosporidium have been detected in shellfish.

A variety of marine algae (dinoflagellates and diatoms) produce toxins that bioaccumulate in shellfish that feed on these algae. The problem is sufficiently known that public health agencies discourage the consumption of shellfish at certain times of the year when it is known that shellfish are seasonally toxic. A variety of toxins have been isolated from shellfish including saxitoxin (paralytic shellfish poisoning), diarrheic okadaic acid (diarrheic shellfish poisoning), domoic acid (amnesic shellfish poisoning). These toxins act on voltage gated sodium, potassium, or calcium channels in the cell membrane interfering with neurotransmission leading to specific neurological clinical signs or death.

CORAL REEFS

Corals are a particular type of cnidarian in the class Anthozoa. Corals are small colonial creatures are animals with symbiotic algae that contribute to their vibrant colors. In spite of their small size, corals are responsible for massive structures known as coral reefs. Coral reefs in turn are important because they harbor some of the highest marine biodiversity on the planet, they serve as nurseries for coastal fisheries thereby driving much economic human activity, and they provide protection from storm surges to coastal communities.

In contrast to the aforementioned examples above, coral reefs are a great example of terrestrial activities impacting marine animal health. For instance, many coastal communities have lost significant percentages of wetlands that serve as the ”kidneys of the coast” filtering out harmful substances from terrestrial runoff prior to it reaching coral reefs. Land based pollution has in turn led to sedimentation and death of coral reefs. Another insidious problem facing coral reefs is overfishing which is leading to depletion of grazing fish, algal overgrowth of corals, disease, and mortality. Finally, global warming is taking a toll on and killing corals throughout the world. When the temperature is sufficiently elevated,

corals expel their symbiotic algae from tissues revealing the white skeleton under the transparent tissues. This phenomenon, known as “bleaching”, can at times be reversible if the coral recolonizes its tissues with algae in time. Otherwise, the coral succumbs to secondary diseases and dies. Proper human management of coastal ecosystems such as reduction of land based pollution, proper regulation of fishing, and abatement of global warming would go a long ways towards preserving coral reefs.