



Brucellosis: Understanding an Important Arctic Infectious Disease

Center for Climate and Health

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This bulletin describes brucellosis, an infectious disease caused by bacteria found in some land and sea mammals, including Arctic species that are important subsistence foods. We discuss the history of brucellosis in Alaska, explain climate change connections, and describe some of the implications for consumers of these wild foods.

Background

Brucellosis is considered one of the most important Arctic infectious diseases and frequently affects wildlife including land and marine mammals that are important subsistence resources for Arctic people. Brucellosis is a “zoonotic disease”, meaning that people can become infected by coming in contact with the same bacteria that causes the disease in animals. Ten species of *Brucella* are recognized in animals and some of these *Brucella* species include different biovars (i.e., different strain types).

Three *Brucella* species are known to cause disease in humans, *Brucella abortus* (mainly infecting cattle and bison), *Brucella melitensis* (mainly infecting sheep and goats), and *Brucella suis* (mainly infecting pigs, caribou and reindeer). *Brucella suis* “biovar 4” is the strain found in caribou and reindeer. Less frequently it can be found in dogs, moose, sheep, muskoxen and predator species. These are “spill over” hosts, meaning that the infection is usually not sustainable in the absence of a bacterial reservoir in the caribou or reindeer.

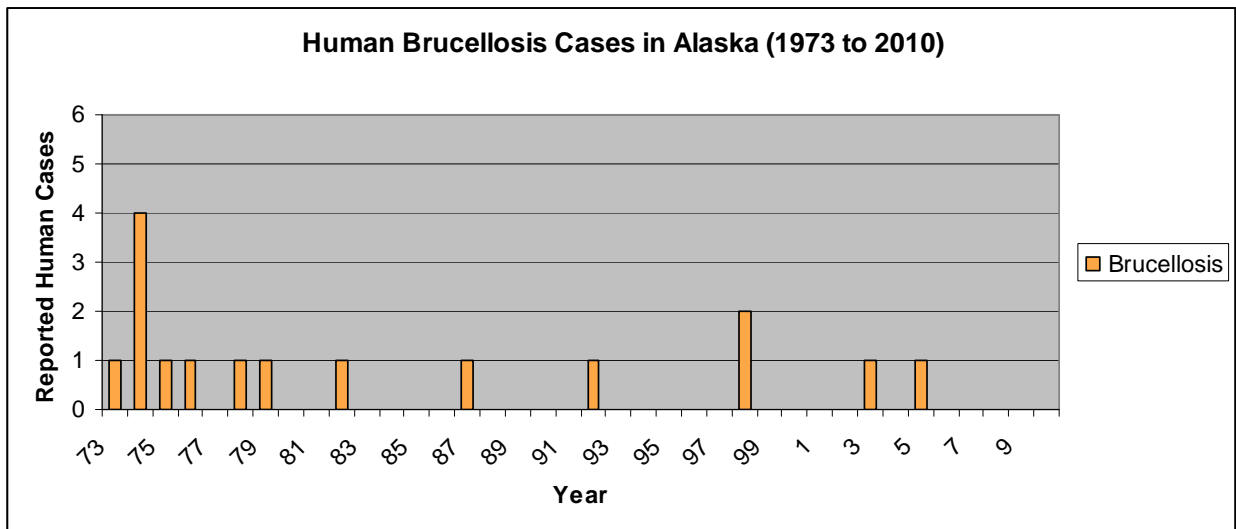
In Alaska, caribou are hunted mostly in spring, fall and winter. In the spring and fall, meat is air dried on racks and saved for later consumption. This is an efficient and economical way for preserving wild meat, as well as a traditional practice. Part of a freshly killed caribou is sometimes eaten raw, including the bone marrow and some internal organs. This can expose people to the *Brucella* bacteria. Another route of exposure is through a cut in the hand during butchering.

It is not known how frequently the infection occurs in people; although brucellosis has only rarely been reported to public health. Since 1973, there have been 17 reported cases in Alaska (DHSS). But the fact that brucellosis is difficult to diagnose may mean the disease is under reported, and that the rates are actual higher.

The *Brucella* – Caribou Connection

Brucellosis is a very old disease, and yet it has only recently been associated with wildlife in the Arctic. Up until the 1950s, reported human cases in Alaska were largely attributed to drinking

unpasteurized milk, as was common on small farms¹. Cattle and pigs sometimes are infected with *Brucella abortus* or *Brucella suis* biovar 1, but in the 1950s, the disease had not yet been associated with Alaska wildlife. This changed in August of 1959 when an otherwise healthy, nineteen year old Alaska Native woman from Barrow fell ill (Edwards, S. 1959). She was admitted to the Barrow Native Hospital with flu-like symptoms, including fever, diarrhea, vomiting, and stomach pain. The following week, she was transferred to the Alaska Native Hospital in Anchorage under the care of Dr. Stan Edwards. After months of tests she was diagnosed with an uncommon type of brucellosis; not the variety found in farm animals, but rather *B. suis*, biovar 4 which had, never before been identified in Alaska. The woman was treated successfully with antibiotics, but the source of her *Brucella suis* remained a mystery.



Source: State of Alaska Department of Health and Social Services

Dr. Edwards had a strong suspicion that the young woman had received some unique exposure to *Brucella suis*. Prior to her illness, she had never been more than 120 miles from Barrow. Fresh dairy products were unheard of in Barrow, and people routinely consumed dry or canned milk. There was however, an interesting recent event in the patient’s history. In August of 1958, three months prior to her illness, she had participated in a seal hunting trip. During the trip, a caribou was taken and the woman and two others from the party ate the bone marrow raw.

Dr. Edwards and Dr. Robert Phillips of the U.S. Public Health Service’s Arctic Health Research Center traveled to Barrow to investigate. They were able to collect blood samples from 480 people. Of those tested, only one person was positive for anti-*Brucella* antibodies, an eighteen year old boy from Wainwright who was also a member of the seal hunting party and had eaten the raw caribou bone marrow. The third person who had eaten bone marrow was a 50 year old man. He also had been ill three months after the hunt, and had been treated with antibiotics. His tests came back negative for *Brucella*.

¹ Forty-nine cases were reported between 1939 and 1953 (Huntley et al. 1963).

Edwards and Phillips provided initial epidemiological evidence for an Alaska reservoir of *Brucella suis* in caribou. Human cases had also been described in other parts of the Arctic, including Canada in 1953 and in 1955, where caribou was also considered a possible source (Matas 1953, Corrigan 1955), and in Siberia, (Pinigin and Petukhova, 1962). More evidence of the caribou – human *Brucella suis* relationship was soon to follow.

In 1960 the 1st and 2nd Scout Battalions, of the Alaska National Guard, were mustering for their annual encampment. There were 795 members from 55 villages throughout southwest, western, northern and the interior of Alaska. It was an opportunity to assess exposure to *Brucella suis* statewide. Blood samples were collected from all guardsmen as well as from the general population of residents in the communities of Anaktuvik Pass, Barrow, and Wainwright. Additionally, bone marrow for culture and blood samples was collected from 145 caribou around Anaktuvuk Pass (Huntley et al., 1963). Up to 10% of the Guardsmen tested positive for anti-*Brucella* antibodies, indicating past exposure. In Anaktuvik Pass 14 people were positive, suggesting an exposure of 10 to 20% of the population.

In 1961, two more cases of brucellosis were identified, one from Anaktuvuk Pass and a second from Kivalina (Huntley et al., 1963). People in both villages rely heavily on caribou in their diet. The strains isolated in these patients resembled the strains isolated in caribou, suggesting that the *Brucella* among caribou may also cause illness in humans. By 1966, the relationship had been firmly established. The strain of bacteria isolated in caribou and in people were the same (Brody et al. 1966), it was *Brucella suis* biovar 4 (Meyer, 1964).

Between 1961 and 1965 samples were collected from 763 residents in seven Arctic villages that rely heavily on caribou for food. These included Anaktuvuk Pass, Arctic Village, Fort Yukon, Kiana, Kivalina, Noatak and Shungnak. Chevak was selected as a control (unexposed) community since caribou was not commonly used there for subsistence (Brody et al. 1966). Blood samples were acquired from between 20% and 95% of the population and represented all age groups with the exception of children under five years of age.

No one tested positive in the control community Chevak, but in the others between 5% and 21% tested positive for anti-*Brucella* antibodies, showing that they had been exposed but were not necessarily experiencing illness. During the same period however, eight active infections were identified among men and women: one case in Anaktuvuk Pass, two in Kiana, two in Kivalina, one in Kotzebue, one in Wainwright, and one in Barrow. All suffered from similar flu-like symptoms and recovered after receiving antibiotics. All cases were in people who commonly ate caribou, both cooked and raw. So even though many residents had *Brucella* antibodies in their blood, it was uncommon for people to develop the disease.

During almost the same period, analysis of caribou from across Alaska identified an epidemic of brucellosis in both the Nelchina (Southcentral Alaska) and Arctic caribou herds (Neiland et al., 1967). Speculation was made about a potential caribou-dog-human connection, similar to other dog-human zoonotic disease pathways in rural Alaska; such as rabies (fox-dog-human) and echinococcus (vole-dog-human).

Brucellosis serology in 7 villages above the Arctic Circle (Brody, 1966)

Village	Number Tested	% Positive Male	% Positive Female	% Positive Total
Anaktunuk Pass	98	7	10	8
Arctic Village	45	24	13	18
Fort Yukon	174	20	21	21
Kiana	174	4	8	6
Kivalina	64	3	11	6
Noatak	131	4	7	5
Shungnak	77	14	14	14
TOTAL	763	9	13	11

A later blood survey by the State of Alaska Department of Fish and Game, suggested that the disease was present in all caribou herds in Alaska, but with a high prevalence in the Northwest, and a low prevalence in southern part of the state (Zarnke, 2001). Similarly, in Canada, caribou continued to be identified as carriers of *Brucella suis* biovar 4. Arctic people were considered at particular risk for infection because of the raw caribou meat in their diet. As advised in a 1989 report on brucellosis among Canadian Inuit, “physicians should consider brucellosis in these individuals who present with persistent fever or hepatosplenomegaly (an enlarged liver or spleen)” (Chan et al., 1989).

The *Brucella* – Marine Mammal Connection

In 1994 a new *Brucella* species was described; the first case of brucellosis in a sea mammal, a captive dolphin in California (Ewalt et al. 1994). The fact that the animal had an aborted pregnancy (a common outcome of brucellosis in animals including caribou) suggests that this new *Brucella* species was not only present but was also causing disease. Two different marine mammal *Brucella* species *Brucella pinnipedialis*, infecting preferentially seals, and *Brucella ceti*, infecting preferentially whales and porpoises, have since been isolated in a variety of marine mammals.

Marine mammals strains were different than any of the terrestrial strains of the bacteria. A survey from the North Atlantic found that 38% of surveyed hooded seals were sero (blood) positive for *Brucella* (Tryland et al, 2005). Brucellosis was also found to have high prevalence in 49% of tested common seals and 33% of harbor porpoises on the Scottish coast (Foster et al., 2002). Anti-*Brucella* antibodies have also been detected in 10% of ringed seals tested in the Barents Sea (Tryland et al., 1999). In Alaska, a 2006 study in the Gulf of Alaska, Prince William Sound, Kodiak Island and the Southeast, described 46% sero-positivity in Harbor seals (11% for pups and 54% for non pups), the highest of any species tested in Alaska (Zarnke et al., 2006).

Climate change may be increasing the opportunity for *Brucella* and other infectious agents to spread throughout the Arctic. Whereas some Alaska sea mammals were once geographically isolated, the opening of ice-free routes across the Arctic Ocean are increasing opportunities for interaction and the spread of infectious disease. The social behavior of seals, sea lions and other pinniped species, especially during haulout periods, provides added opportunity for

transmission of infectious disease (Zarnke et al. 2006). Transfer may occur through prey species, from mother to calf (or pup), or through a parasite such as lung worms that were reported to have infected a Pacific harbor seal (Garner et al., 1997).

But can marine *Brucella* also affect people? The occupational acquired infection of a laboratory worker suggested that the marine *Brucella* may also be contagious to humans. The lab worker had headache, sinusitis and fatigue, and had bacteria in his blood (Brew et al. 1999). Marine *Brucella* species have also infected people in a community setting. Two incidents of community-acquired human infections from marine *Brucella* were reported in Peru, both resulting in neurobrucellosis, a rare, severe form of systemic nervous system infection. Neither of the patients reported consuming or having contact with sea mammals, despite the fact that the strain of *Brucella* they acquired, *B. pinnipedialis* is associated with seals. This raises questions about the possible routes of human exposure to marine *Brucella* (Sohn et al, 2003).

Because each *Brucella* species has distinctive characteristics of infection, the complexity of the interaction between the bacteria, the animals and humans has increased (Godfroid et al., 2005). At least two newly identified species, *B. ceti* (infecting cetaceans like whales, dolphins and porpoises) and *Brucella pinnipedialis* (infecting different seal species) are now present in the Arctic (Godfroid J, 2002) and new *Brucella* strains or species may emerge as existing *Brucella* adapt to a changing environment. Marine *Brucella* species may utilize non-mammal species such as fish or round worms as intermediate hosts. Marine ecosystems may add complexity to the marine *Brucella* life – cycle, and may pose additional possible sources of human exposure. It is not known whether antibodies developed to *Brucella* from caribou will protect against infection from marine forms of *Brucella*, or to what extent standard tests for infections in humans exposed to terrestrial forms of *Brucella*, will also detect antibodies to marine *Brucella*.

Conclusion

In Alaska, little is known about the prevalence of brucellosis in humans. Although rarely reported, it may be diagnosed and treated more frequently than is apparent. Surveillance and reporting systems to improve understanding about this disease are needed, both in wildlife and for the people who depend on these animals as a staple in their diet.

Caribou as well as reindeer are the reservoir of *Brucella suis* biovar 4 brucellosis infection in people. This can be a severe disease and requires prompt diagnosis and treatment. There is also a possible reservoir of *Brucella ceti* and *Brucella pinnipedialis* in Arctic marine mammals. However, to date no human infection with marine *Brucella* has been described in the Arctic. On the basis of the blood tests available, a determination of the origin of the *Brucella* infection, marine versus terrestrial, is not possible.

The extent of exposure and infection by marine *Brucella* in humans is currently unknown. Worldwide, only three naturally acquired human cases have been described, for which the route of transmission is not known.



Alaska Natives depend upon traditional foods to provide a healthy, affordable, sustainable, and culturally meaningful diet. Sea and land mammals used for food are often eaten raw (such as bone marrow), dried, or raw after freezing. These practices are known to carry more risk for food-borne illnesses than eating food that has been cooked, which effectively kills most bacteria and parasites. The risks are highest for people who are susceptible to infection, such as pregnant mothers, the elderly, or people that are immune suppressed due to illness or cancer therapy. But how great is the risk, what benefits would be lost, and do the risks justify changing behaviors and traditions that have been passed down for generations?

More information is needed to answer these questions, and to help us understand the risks and benefits associated with different methods of food preparation. With better information, consumers of traditional foods can make choices based on sound science and their own personal and cultural priorities. In the meantime, some basic precautions such as wearing protective gloves during butchering can help consumers protect themselves from brucellosis while continuing to use and enjoy these important subsistence resources.

The bulletin entitled ***Brucellosis – Answers to Frequently Asked Questions***, provides information for subsistence food consumers and some basic guidelines on how to prevent exposure to *Brucella*. The fact sheet is available at the ANTHC Center for Climate and Health website. Google us with: “Center for Climate and Health.”



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