

Anthrax—Epidemiology of an Outbreak

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I hope the title of “epidemiology” did not scare anyone away. And if you came in because of the word epidemiology, you can get up and leave now, because I am going to talk about some characteristics of an anthrax episode and some little things about it that are sort of interesting and not too much in the science of epidemiology.

Let us take an anthrax episode sequentially and jump around a little bit and see how things happen.

So it is 8:30 in the morning. It is Thursday, August 17, 1976, and you are Dr. Frank Sims. You are the general practitioner in the little town of Vernon, Texas. Vernon is on the highway that runs from Fort Worth, north and west towards Amarillo. It is about as close to the corner of Oklahoma as you can get without being in Oklahoma. So, your phone rings and it is a rancher client of yours who is about 30 miles to the west and he says, “Hey, Doc, this is Joe. I have an old dead cow I have found this morning and she is dead out by the tank and half-way in it. I dragged her out and the buzzards and coyotes haven’t got to her yet. I thought you might want to take a look at her. Could you come out?”

Doctor Sims says, “Well, I’m busy this morning, as I have some dehorning and castrating lined up. Why don’t you load her in the gooseneck behind your trailer or pickup and drag her over to the rendering plant in Vernon. At one o’clock or so I will be over there. I’m interested and we will cut her open. Besides, that will save you the cost of my trip 30 miles out there and 30 miles back. Anything unusual that you can say about her or anything we should think about, Joe, before we bring her in?” He said, “Well, she is just fresh dead, and I thought we would look at her and, really, I have been seeing a few buzzards over my neighbor’s ranch and he must be losing some and so I thought I ought to check this one out.”

It is one o’clock in the afternoon. It is a local used-cow dealer in Vernon, Texas, at the rendering plant and Joe is there with his trailer and Dr. Frank Sims meets him there. The gooseneck trailer behind the pickup, he backs her up behind the plant and you notice that there is quite a bit of blood running and dripping off the back end and down onto the street and there is a little old dead cow in the back. She has been dead for nearly 24 hours, probably. This blood kind of smears across the bottom of the trailer as you drag her out and onto the rendering plant floor and you tell the man at the plant to go ahead and chop her open and skin her out like he usually does before you look to see what lesions she has.

You do not have any reason to think that this is anything different from any other cow that you have posted at the rendering plant for Joe or for any one of your clients. But, as things go along, you notice you are pretty wide awake and I think you, as Dr. Frank Sims, are to be complimented for your observances here. The blood is not very well clotted in this dead cow. You see some lesions in the lung that look a little bit like pneumonia, but not very dramatic. The lymph nodes are a little bit blown up and juicy, a little bit red, but nothing too dramatic there. You are thinking about a nutritional deficiency problem in the background some place because of the condition of the cow initially, but there is a little bit of free blood in the lumen of the spiral colon and the cecum. The mesenteric nodes are a little enlarged, darker and a little bit swollen. Again, not really dramatic but just enough to be noticeable. Then you find the spleen, and it looks like an anaplasmosis spleen and you think about anaplasmosis, because it is a little bit enlarged and a little bit bloody when you cut across it. It is not really highly dramatic.

You have been out of school for about 25 years. There has never been an anthrax case in this territory before. You have not seen one since the year after you got out of school and that was down in south Texas and you sure have not seen one in this area. You do not want to mention the word anthrax to him and so you hedge a little bit and you say, “Well, it could be pneumonia. It has some lung lesions and we really have not ruled out blackleg. It does not have any real dramatic muscle lesions but it could be blackleg or another clostridium. The spleen looks a little big. Tell you what, Joe, I am going to take some stuff back to the lab and we will see if we can figure out something. I think we need to run a few lab tests on this cow.” This is all you tell him.

Joe says, “Let me know as soon as you can, Doc. I am a little bit worried. After I talked with you this morning I did check with my neighbor and Bill says that he has 20 cows that he has lost over there in the last two weeks. That is the reason for some of those buzzards in the air. This is really the sixth one that I have lost and I would like to know what is going on. Hurry up as much as you can, Doc.”

So we have 25 dead cows and this is number 26. Also the first time you have got a call, but now the monkey is on your back as Dr. Sims and Joe wants you to hurry. It is three o’clock by the time you get back to your office and you have a spleen in an OB sleeve and you have a syringe full of blood. Again you

are to be complimented because you do have a microscope and some glass slides. You also have some stains and you make a few smears and you stick them under your microscope. You look at them under a low power and you see a lot of rods!

You start adding a few things together. You have a little higher death loss now mentioned to you. You have seen some interesting lesions and you see a lot of bacteria and you cannot really look with great detail to see spores and square ends and capsules and absence of spores and the presence of capsules. But you are concerned enough that you do call Joe and you are afraid that he has got something interesting. You tell him to think about lining up some help to get some of those cows rounded up in the morning to either go through them with some antibiotics or some vaccination for blackleg or something. You have your assistant wrap this OB sleeve and this spleen and some of the blood and the syringe and get it off to the bus station to get it on the bus to the diagnostic lab because you would like to have a confirmation of what this is. You have some suspicions.

You call back to the rendering plant and tell Harry over there that he posted this cow barehanded. You ask him to change his clothes and wash his hands because you are worried a little bit about what he was into. You ask him to check out the cuts on his hands and if he sees anything interesting in the next day or so, he had better get to the doctor.

Here is one mistake you make. You have Harry come over to your office and after he has his hands washed you have him soak his hands in Novalsan for about 1/2 hour. Really, if you think about it, the spores and anthrax organisms that he has on his hands are not going to be taken care of by any chemical disinfectant. So, it is a good maneuver but not very effective.

One thing you do right is not to tell anyone in town and you warn your office girl to keep this quiet. She knows you are expecting something a little bit unusual, but you do manage to tell her that anthrax is a scary word and not to let too much information get out until it is confirmed. That is where we are in Vernon temporarily.

Let us leave Frank Sims' office and go to the next day to a feedlot. This is a feedlot in Heart, Texas, this is near Dimit. You have a 10,000-head feedyard in Dimit, or in Heart, which is near. The veterinarian that is a consultant for that feedyard is Dr. W. J. Hill from Dimit and about 9:00 on Friday morning he comes up to Heart Feeders. This is his regular day to be there and he makes sure he is there today, specifically because they received some new cattle yesterday and he wants to look at them. He would be there anyway on Friday.

But the manager says, "Hey, W. J., we have a couple of animals out here for you to post today and sure glad you are here this morning because we had three loads of heifers in yesterday afternoon. They are native calves and they are short-haul calves, less than a hundred miles over at Crow. They looked good off

the truck yesterday. They were a little bit hungry because it has been dry over that way. But despite how good they looked yesterday, we are thinking about getting ready to process them this afternoon but we have two dead in the pen this morning.

"We pulled them out there over to the dead pile and we would like for you to post them before you do anything else in the feedyard this morning. They are on receiving ration and they mainly had hay last night and they are bloated up. They might look like acidosis, but pretty obviously they are not, and the rest of the pen looks okay this morning." So, W. J. goes to work and finds a few things in the cattle. He finds some interesting things and some things that do not look like a post-arrival respiratory disease or pneumonia. He gets on the phone and he calls the diagnostic lab in Amarillo. About 10:00 in the morning my telephone rang and it was W. J. and he said, "We have these two heifers and we have a rumen pH of 6½ to 7 and they are bloated up and their lungs are pretty clear. There are no injuries anywhere, the spleen is a little bit big and the carcass is not yellow like an anaplasma carcass. The lymph nodes look interesting and they are sort of big, generally like a septicemia."

We discuss a little about feed, how long they had been in, how long a haul they have had, what the rest of the pen looked like and whether they had been processed or dipped yet. We came to the same conclusion and we did mention the word anthrax over the phone, and we said let's get some tissues in here this afternoon. We would like to check them and rule out anthrax in this feedyard. So we left it at that and W. J. was going to get somebody dispatched from the feedyard to bring some tissues in. We had a phone call back from him at 11:00 in the morning that the pen had been ridden at 9:00, everything looked fine, at 11:00 another heifer was down and was about to die. He asked if somebody could come out to pick up the specimens and be out here when we post the other heifer.

We said, "Sure. I cannot go but I have two people who could come. We will meet you there at 1:00 this afternoon." The same sort of situation—a bloated animal and large, pulpy spleen, large lymph nodes, hemorrhages into the gut. I got back that evening to the diagnostic lab. We initiated some cultures. We made some smears. We strongly suspected anthrax. We inoculated some mice and by 8:00 on Saturday morning we gave the feedyard a call. We could not get W. J. at his office. We called the feedyard and said, "We have probably confirmed anthrax. The organisms are encapsulated and they are non-sporulated and also a gram-positive rod. The blood from those cattle killed the mice. We are going to phone in a presumptive diagnosis to Austin and we suggest that you get on this thing right away." He said, "What do you suggest we do?" I said, "What do you have in the way of antibiotics? Do you have penicillin or terramycin?" They said that they had terramycin. I said, "Go out to that pen of cattle, pull

them, run them through the chute this morning, temperature them, but go ahead and give a pretty good dose of antibiotics. This is Saturday at about 10:00 in the morning. Plan on pulling those calves and treating the whole pen again tomorrow morning. In the meantime we will try to round up some anthrax vaccine. And what happened to the carcasses that W. J. posted yesterday?" He said, "The rendering truck has already picked them up, they are gone and the area is still contaminated where we posted them and our dog ate about half of that first one! Is he going to get sick?" I said, "I do not know. Let's watch him."

That is about the extent of the discussion that we had. So it is 11:00 on Saturday, August 19, and you as Dr. Frank Sims are in your office back in Vernon again and it has been a day and a half since you sent the specimens to College Station. The telephone rings and it is Howard Whitford. He calls up and says, "Frank, I have some bad news for you on those specimens that you sent in. We got a confirmation of anthrax and we will call Austin for you and let them know."

So, that is the beginning of the story and this is sort of how it goes from there on. The feedyard did go through the cattle on Saturday morning after we called. I learned later that although none were visibly sick on Saturday, there were five or six that had temperatures of 106° and 108°. It was 10:00 in the morning so it was not hot enough that we are looking at much environmental influence on that. They were definitely febrile. They gave 30 cc of terramycin to the group on Saturday morning and worked them again on Sunday morning and they were able to get vaccine to them on Monday. There were no further deaths in that pen of cattle and there is no further illness. It looked like anthrax in the feedyard. There is apparently no spread to the other 20,000 head of cattle. They ended up without having any quarantine beyond the 8-day period. They were able to go ahead and sell their fat cattle and I think they lucked out for a couple of reasons that Dr. Hill was there on the morning that the first two died. They did get a necropsy on them, otherwise they may have had 200 head of dead cattle in the first pen and they may have had some pretty good spread and they may have had some fat cattle that did not get sold when they needed to be sold.

The dog that ate the tissues from the carcass was confined for a period of 10 days for observation and for curiosity. The dog was never treated and never got sick and to this day the feedyard people think there never was an anthrax outbreak there. They think the lab was erroneous in their diagnosis and they based it on the fact that the dog did not die. Either you get hyper-excitable about it, or when you really see it and it is all over, you forget you ever had it and possibly do not even believe it.

In the cow-calf area in the ranch, we ended up with a spread of the disease problem. We ended up with 581 cattle and six horses dying. Interestingly, three of

the horses that died were horses that were ridden by cowboys that rounded up the heifers that went to the feedyard. There were a lot of flies that morning, biting the cattle and the horses, and possibly this was one of the means by which horses became exposed and infected.

About the same time the heifers were dying in the feedyard, the horses were dying back at the ranch. The anthrax outbreak apparently was not spread by the blood that was dripping off that gooseneck trailer that drove halfway across Ford County. It did not spread in that direction. Why, I do not know. One thing interesting about the spread of anthrax is that apparently we can get magnification of an episode for this reason: A cow is infected with anthrax, she does not feel good, but becomes febrile. She has a lot of other aches and pains. As much to cool off as anything, to offer some self-treatment for her febrile condition, she gravitates toward the open farm pond or tank and you will find her near there or wading in any water she can get to. They tend to move in the direction of a body of water. In two episodes that I have been associated with since I have been in Texas, death of a cow in an open tank has resulted in a release of anthrax organisms into the water supply and, I think, magnifies and intensifies an epidemic and makes it an epidemic rather than an individual case.

There is an old wives' tale that buzzards and coyotes can tell an anthrax carcass from a blackleg carcass or a nutritional deficiency or one that is run over by a train, and they will easily gobble up anything but an anthrax case. An anthrax one they will leave alone. This is not true really, and it is probably an old wives' tale because the buzzards and the coyotes are not any smarter than we are, but are probably more resistant to anthrax.

Dr. Frank Sims reports that the anthrax carcass in the field confirmed his anthrax by the lab. As they drove up as close as they could and walked the rest of the way across an open field to get to it, thirty-two buzzards took off from that carcass. So we do get quite a congregation of predators in an area where we have an anthrax outbreak.

What does a cow look like with anthrax? She is depressed. She is off feed and she tends to gravitate to a source of water. If there is an open tank, she will wade in it. She is weak and lethargic and reluctant to move and she will have a temperature of 106 to 108° and above. She is usually not down, but at this stage is standing there looking depressed. If you can catch her at that time with antibiotic therapy, you get a tremendous response. Within 24 hours it will be effective and you need to redose. Dr. Sims used pen-strep intramuscularly on cows like this for about three days in a row with good success. If he caught a cow that was still standing, he would get good therapeutic results.

The Stern vaccine was used and there were no more sick cows appearing four to five days after using it. Apparently we were getting relatively rapid onset of

immunity. It is the vaccine product which does replicate and it appears to be quite effective in stopping an outbreak. Horses appear to be more susceptible. The vaccine takes longer to produce an immunity and we are looking at something like 8 to 10 days before it is safe and we can predict that we are not going to have any death loss in vaccinated horses.

I have a question for you now. You have the cow-calf herd out here and you have decrepit cows and you have young, healthy, vigorous cows. You have cows in good shape and cows that are a little short on feed. You have cows nursing that are not eating very much and you have newly weaned calves. Which ones are going to die more quickly if we turn anthrax loose in that herd? Which is most susceptible? Momma or the kids? The old or the young? The healthy or the nutritionally deficient? Does it matter? It is kind of interesting. Decrepit old cows without any teeth and a little short on feed and so forth are the first to go. They are grazing close to the ground and picking up a little more dust, maybe inhaling a little more dust. The young weanling calves that are newly weaned, replacement heifers, they are number two. The young adult cows and the bulls are third in susceptibility and, of course, the nursing calves that are not grazing are healthy, happy and content. They are not inhaling much dust and they are the least susceptible to anthrax. Is that the way you would have answered it? Would you have predicted it that way?

Here again, you are Dr. Frank Sims and he is out vaccinating a bunch of cows. There is an anthrax epidemic in the area and the cow kicks at the wrong time and you stab yourself in the hand and inject about 2 cc of Stern vaccine into your finger. Ouch. What else? Are you worried about the effects of this live anthrax organism that you have injected subcutaneously? Is this going to cause any trouble? What should you do? Any suggestions? Well, in actuality, if it had been Strain 19 brucella vaccine you should be more worried. Stern vaccine is avirulent. Other than the mechanical effects and a little pain, you can squeeze out a little bit of the blood and put a band-aid on it and go home and sleep well tonight, because Stern vaccine strain will not produce anthrax in you. If you had been using one of the older spore vaccines made up of virulent organisms that are encapsulated when they grow, you should be very, very concerned. You should get some antibiotic therapy and do all you can and still be a little bit worried about the dangers of having anthrax yourself.

You have a herd that you know has been exposed to anthrax. You have had one or two deaths. Let's take this herd where there has been six cattle dead. You ask Joe to round up his cattle and you are Dr. Frank Sims and you are going to go out there tomorrow morning. What will you tell him to do? Should you vaccinate those cattle? Should we wait six to eight days for immunity to develop and let those die in the meantime prior to the six- to eight-day period. Or should we rush in and use antibiotics and treat these cattle with the idea that they have been exposed and

what will antibiotic treatment do to the efficacy of vaccine? Now, I had one practitioner tell me that the new Stern vaccine was not any good because you do not get any immunity out of it. He mixed antibiotics and steroids with it in the syringe and even gave it to the cows and it still did not produce any immunity. You have a live organism and you want it to grow in the cow, yet it needs to cause an antigenic mass in order to produce immunity. You do not want to mix antibiotics and Stern vaccine together in the same syringe. You probably will interfere with immunity if you give Stern vaccine in one side and antibiotics on the other and so the recommendation here is to resort to the trusty thermometer and temperature these cattle as they go through the chute. The recommendation is, to those cattle that are not yet exposed and are not yet incubating or not yet running a fever, to go ahead and vaccinate. Do not give antibiotics. Turn them out. Those that are febrile this morning, you run them through the chute and go ahead and give a good dose of antibiotics. Plan to get them back tomorrow and treat with antibiotics again and on the third day vaccinate. So, cut those out and segregate those that are febrile from those that are not and vary vaccination or treatment on that basis.

A couple of other notes. What are the clinical signs of anthrax in a horse? Are they different from cattle? Well, not really. Horses are lethargic, depressed, off feed, they hurt all over. That is the description that you could give. They have a fever of 105° or better and they are likely to respond less well to antibiotic therapy than a cow. They seem to be less resistant in general to anthrax.

The disease outbreak did not spread along the direction that Joe took with his trailer as he drove into town. The disease outbreak spread in a different direction. I do not know why it specifically went in the direction it did. Now, we know that an outbreak of anthrax can be magnified by releasing the organisms into the water supply and the outbreak did go downhill and follow the drainage patterns in general. And so, drainage and contamination of water will sure influence the direction of spread of an anthrax problem.

Dr. Sims also suggests a spread in the direction of prevailing winds. He maintains that the procedures that are used for burning the carcass and making fire with rubber tires and igniting them and incinerating them does a very good job of warming up anthrax spores and getting them up into the air where the currents can catch and distribute them.

Dr. Sims is concerned that it may have spread anthrax spores in the direction of wind drift and dust and probably burial would be a better method of getting rid of carcasses if at all possible.

Why did anthrax start in the area that it did? Why did anthrax start in this place where it had never occurred as far as we know? Why did it start when it did? When could you expect to see anthrax cropping up in your area?

I do not know if it ever will in your area. We have

some endemic areas of anthrax in south Texas. There are some thoughts that buffalo were infected with anthrax on occasion and areas that had high buffalo population are now endemic anthrax areas. The ranch in north central Texas was on a location that was on a trail drive route for longhorns from south Texas that were brought north. They were taken out to Oklahoma to graze in Indian territory. When the Indians got to causing too much trouble, they brought those cattle back across into Texas. It is an area of some of these ranches that are heavily infected now. Eventually they got them to Dodge City or some place north to the railhead for shipment back east for beef. So we are not necessarily looking at a congregation point for buffalo, but probably a congregation point for cattle that were driven from south Texas endemic areas through this area on the way to Dodge City.

In those areas close to the area of the trail drive, those ranches now do consistently vaccinate every year for anthrax and a few others that they need to. This area is adjacent to it and west of there, had not had anthrax before, and it represents a new area. But there was something that was different, as far as Dr. Sims is concerned, about the area—that it was exceptionally dry in the summer of 1976 with short grazing and a lot of dust. He feels it was responsible for the exposure of cattle and inhalation of anthrax spores from vegetation covered with dust.

You are again Dr. Frank Sims, and you are faced with an anthrax episode in your practice. You diagnose one—you have suspicions of one first and then you confirm one. Dr. Sims is pretty smart, really, in not making any firm pronouncements until he had a confirmed anthrax episode, and until he had some help from the lab and regulatory people to tell him where to go and what to do.

The idea of making sure that the word “anthrax” is not spread around too widely is a good one because people are afraid of the word anthrax for some reason. They get excited and it makes television reports and the telephones are clogged from old ladies and school teachers and people who really have no concern about the problem.

The approach to use is one he used and is a good one—to warn the people you know have the problem that they might have it and go ahead and get it confirmed, get the message back to them, to the areas and ranches where help can be provided, then go to your neighboring practitioners. Make sure they know about it and hear about it by telephone. Let them spread the word to their clients. They know where the cattle are and they know where livestock is in a given area. If necessary, do what they did in Ford County and call a meeting through the veterinarians of livestock producers. They all met in Vernon. At one place and one time they discussed the problem and described its extent, informed the people what was going on and what to do about it, and got right to the people that were specifically involved. Rather than go

onto a general news broadcast like a T.V. station and put out word through the news media, especially to everyone that is not concerned. That approach was used two years before in another outbreak in Texas and it severely crippled the regulatory efforts and it crippled communications among regulatory people and practicing veterinarians. That approach caused more trouble than it did good. So, go through the channels, your professional channels, and go back to the producers and get information to them that way and get on with it. Dr. Sims did a lot of things that were right. One of the things that he did was that he had on his gloves when he took the specimen to the packing plant and so that is another reminder. Regardless of anything else, regardless of what the guy at the rendering plant does, when you are posting a carcass, put some gloves on. It looks more professional and you have a lot fewer anxieties when you find out that it really was anthrax.

What specimens do you submit to the lab and how do you get them there in good shape and what can you do for presumptive diagnosis? You see a dead animal and you are concerned about the possibility of anthrax and you have reason to suspect it. Just draw an unclotted blood sample from the jugular. Chances are it will sneak up on you. Chances are that you are going to have posted that first animal, or done a more routine approach, and in that case take some lymph nodes, take part of the spleen, take nearly any tissue for submission to the lab. But do not do what we sometimes heard was taught—the ear chopped off and sent to the lab. They cannot get much out of them. Do not chop off an ear and send it in. I had eight ears that came in last summer and I could tell that they were infected as they had plenty of maggots on them, but they sure did not have any blood in them, let alone anthrax organisms.

Remember when we look at blood or a smear from an anthrax organism, that if you can look at a slide and see about one organism in a high power microscope field, that means that the tissue or specimen that you smeared on that slide, if it was a fluid, had about one hundred thousand bacteria per milliliter. So, with an anthrax case when we take a blood sample, smear it on a slide, look at it, and we can see about one hundred or greater organisms, we are talking about 10 million organisms per milliliter of blood in that animal's body. Blood is a pretty good thing to avoid spreading around, and if you want to control things, try to keep from spreading blood around any more than you need to.

As far as the differential diagnosis is concerned, I have posted anthrax carcasses without the raspberry jam spleen. I have posted a carcass that turned out to be anthrax and it just had hemorrhage into the cecum. I was surprised to find it was anthrax. The spleen lesion is nearly always there, but not always. What is most heavily relied upon in differential diagnosis is the fact that it is a septicemia and the lymph nodes throughout the body will be enlarged, reddened and inflamed.