

Corpse Plague Transmission

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Hello, I'm Sarah Gregory, and today I'm talking with Dr. Sophie Jullien, a pediatrician at the Barcelona Institute for Global Health in Barcelona. We'll be discussing the potential for plague transmission from corpses.

Welcome, Dr. Jullien.

[Sophie Jullien] Hi Sarah, thank you.

[Sarah Gregory] So give us a brief history of plague around the world.

[Sophie Jullien] Yes, sure. When I started working with plague and I was saying that to people, the disease actually sounded familiar to a lot of them, either because they read the book from Albert Camus, because they know about the plague pandemics that occurred in the past. And usually they were about to ask me like, so plague still exists? And the answer is yes. Indeed, plague has conducted three major historic pandemics. So the best known is the Black Death pandemic that occurred in the 14th century and this pandemic has killed, like, over 50 million deaths, which was like about one-third of the population of Europe. And then another pandemic occurred in the 19th century, which happened in China (went through Asia), and it actually was considered active until the late 1960s. So though yes, this is brief history of the plague around the world, and it is still considered disease of the past, yes, it remains a current threat in many parts of the world. And in the last, maybe, two decades most of the cases are now concentrated only in a few countries, many in Africa—and then these would be Madagascar...and they are seen in the Democratic of Congo, but also Uganda, Tanzania. But not only Africa, but also the U.S., Peru, and some other countries in Asia.

[Sarah Gregory] So WHO has listed it as an emerging disease. And that's frankly pretty scary. Do we know why it's increasing globally?

[Sophie Jullien] Maybe just let me say that, so a reemerging infectious disease is a disease that once was a major health problem (so we just mentioned that this was definitely the case of plague) and then it declined dramatically—so for example, for plague we had antibiotics and protected measures—but then it's again becoming a health problem. So why? For some diseases we may know it—so for malaria and tuberculosis unfortunately there is some antibiotic-based drug resistance. For plague, they think it's also the case, and as you said it is scary. It's probably because of environmental factors. So for example, there was major plague outbreak in Madagascar in 2017, and the plague outbreak hit the capital (so the capital where more than one million people live). So if you have an infectious disease there with all the movement going on, you can imagine how fast it goes.

[Sarah Gregory] Are there different types of plague syndromes? And if so, are there different symptoms for each of them?

[Sophie Jullien] Yeah, sure. So there are three main forms of plague, and they are defined depending on where the infection is. So we have the bubonic plague, which is the infection of lymph nodes. Then we have the pneumonic plague, which is the infection in the lungs. And then we have the septicemic plague when the infection is in the blood. And about the different symptoms, so yes generally for all of them would cause you severe symptoms—so they would cause fever, weakness, headache, body pains. And then depending on the form, so the bubonic

plague will cause sweating and painful lymph nodes (and they are called buboes). Then you have the pneumonic plague, which is actually like a very severe pneumonia—so they would present with cough, with shortness of breath, with chest pains, blood in the sputum sometimes—and the evolution would be very fast. And then the third form is the septicemic plague, and you have very sick people, and the disease would cause dysfunction of organs, the tissue may turn black. And yeah, that would be the different symptoms of these three forms.

[Sarah Gregory] And is one more contagious than the others?

[Sophie Jullien] So it's the ability of the disease to pass from one to another. So maybe I just need to say for that bubonic and septicemic plague they are spread by flea bites or handling infected animals, so they are not really transmitted from human to human. While the pneumonic form of plague...it's transmitted by the inhalation of infected droplets (so through air), so usually, yes, it's from human to human. So this would be definitely the more contagious form for humans.

[Sarah Gregory] I see. So what kind is most common? And does it vary geographically?

[Sophie Jullien] So bubonic plague is the most common form of plague. The pneumonic is probably the least, but it is the most severe form of plague. And I think what varies geographically is probably like not the disease itself, but like the health system and the conditions where the disease can be recognized and treated. So for example, in areas—so the first case of plague would usually start with like a flea bite or contact with an animal, so you would end up with bubonic plague, right? So if this is well recognized and treated early, the threat would stop here. So you won't have many cases, you'll have just a few cases of bubonic plague. But in some—so that would be for example cases in the U.S., right? When you have, like, cases every year. But I mean, in another scenario when you have cases started—even if it's bubonic plague that's started, let's say, rural areas—in some countries in Africa (for example, Madagascar) if the disease is not recognized early enough and it develops to a pneumonic plague and then you have transmission from human to human, then you would have an increased number of pneumonic plague if the preventive measures are not implemented early enough. So I think this is what actually varies geographically, if this makes sense.

[Sarah Gregory] Are the different types all treatable? And if so, what is the treatment?

[Sophie Jullien] So, yes. So plague is caused by a bacterium which is called *Yersinia pestis* and fortunately now we do have treatment for the disease. So it's with antibiotics—so with different types of antibiotics and the different, like, number of length of treatment for the different forms of plague.

[Sarah Gregory] What should clinicians be on the lookout for?

[Sophie Jullien] Right. So this is an important question because actually an outbreak is usually first detected by clinicians, right? I guess it depends on where you are. If you are in Spain, I mean, you shouldn't be much worried about it. But definitely when you live in an endemic area, you should be aware of it. I think raising awareness is probably the most important thing. And what they should look for is, like the symptoms I described. So whether you have, like, a very severe pneumonia and you're in an endemic area, you need to think about it. Or if you have like, these buboes (which are these painful and swollen lymph nodes), that is definitely something that clinicians should be aware of.

[Sarah Gregory] So your study looked into whether corpses or carcasses of animals could transmit plague. Why did you want to find this out?

[Sophie Jullien] Yes. So plague is a serious infectious disease with a high fatality rate. It's contagious, right, from human to human. I would say that the Ebola outbreak in West Africa in 2014 made people aware of how important safe burial is to prevent transmission from corpses. And this was not always well understood. So when WHO (the World Health Organization) and national governments turned to assure readiness for other outbreaks of dangerous infectious diseases such as plague, there was a concern about whether people that died of plague, in this case, were infectious and so what the right recommendation should be for handling corpses of people who had died of plague in this case. So a couple of years ago, WHO revisited their guidelines for the management of plague (which actually were recently published). And the concern of safe burial practices was identified as the priority to address. So this systematic review was commissioned to assess the evidence around the infectiousness of corpses to inform recommendations—that will inform evidence-based recommendations on the need of protective measures (formally personal protective equipment) for health workers or for whoever needs to deal with corpses of people who died from plague.

[Sarah Gregory] Are there more bacterial loads in corpses or carcasses?

[Sophie Jullien] So we know that bacterial loads are higher at the final stage of the disease. So when you get infected, you have low bacterial loads and then it gets higher as the disease evolves. So I would say yes, that at the time of death, there's probably—I mean, there is high bacterial loads at that time, yes.

[Sarah Gregory] About 35 hours seems to be the longest the pathogens have ever been seen to be viable. So, if someone was digging around in a plague pit from the 1600s, then it's unlikely they could catch plague?

[Sophie Jullien] So 35 hours seems to be the longest that plague was transmitted from a human or animal cadaver (actually in that case, a carcass) to a human. And then another point is that actually the plague bacteria (so *Yersinia pestis*) can survive in the environment, like in the ground around the corpse. And another point is that if we detect the bacteria in the ground or in these corpses, we also need to know whether these bacteria have the capacity to be infectious and to cause the disease. So yes, 35 hours seems the longest that we've seen that has caused the disease, but I would say that yes, it is very unlikely that you would catch plague by digging a plague pit from the 1600s. But we don't know for how long—so even...sorry if I'm not clear, but we...even if the bacteria live long enough in the ground, we don't know if *Yersinia* has the capacity to be infectious and to cause disease.

[Sarah Gregory] How did you conduct your study?

[Sophie Jullien] Alright, so this is a systematic review, just to be clear. So I did not conduct a study in the field myself, but I did gather all the literature—so all the studies, all the reports, all the descriptions that replied to the particular question that we are asking. And we do that in a very, like, organized and transparent way. So how did I do that? So the question actually is simple in a sense that we wanted to know whether human corpse can transmit the disease and if so, for how long a human corpse can transmit the disease. Even if it—so it sounds an easy question, but it's actually not easy and straightforward to find a reply because there is very little information that could straight to apply to this question. Probably first because we won't start

doing an experiment to have, like, people in contact with corpses or carcasses to see if they get infected (we won't do that for obvious reasons), and also because when you have an exposition to a cadaver or to a corpse, sometimes it's difficult to know if it was the only exposition. For example, if it's a family member, this person may have been also exposed to the same person when he was alive. So this is why this simple question is actually not easy to reply.

So on the methodological point of view, the way we conducted this study is that we divided this simple question into three categories (so three key questions). So we first tried to look at the transmission from living persons ill with plague to know, like, which body fluids can transmit the disease. And then we looked at data on transmissions from corpses, and we included carcasses because we anticipated that corpses—that we would have very limited data on corpses. And then finally, like the third condition is that we looked at the duration of infectiousness of the body fluids of the corpses and the carcasses.

[Sarah Gregory] So what did you find from looking at all of that?

[Sophie Jullien] So the key finding—to summarize the key findings, we found that actually the intense manipulation of infected corpses can lead to pneumonic plague through the inhalation of droplets. So, we have studies that are well documented and describe that. We also found that handling infected corpses can lead to bubonic plague by contact of body fluids (so mainly blood). We did not find anything on other body fluids like urine or sweating or other body fluids. But this probably requires skin cuts or abrasions, like small lesions on the hands, for the person to get infected. And the third point is that we actually don't know, so I mean the length of time that the bacteria survive in body fluids or that the corpse is contagious is actually unknown. So we have these 35 hours that we mentioned above that we have from one study which is very well documented, but there's nothing else on that so we don't know. We don't have a clear answer to this question.

[Sarah Gregory] What are the most important aspects of your findings?

[Sophie Jullien] At the end this systematic review gathered will bring information that's available on this topic, right, instead of having bits and pieces of different articles. So it's thought that plague is transmissible from cadavers and corpses although this seems to require close and prolonged contact. So for instance there were some cases in which they were describing people that were in contact with the same case of plague, but some would get infected and some others would not get infected even if they got like a very direct contact with the sick person. And finally, I think an important aspect of this finding is that it also highlights what we don't know. So we don't know for how long a human corpse can transmit disease after the time of death, and it is also important to know what we don't know.

[Sarah Gregory] Was there anything that surprised you?

[Sophie Jullien] I think I started mentioning that just in the above question that before starting to work on this review, I actually thought that plague was very contagious—or at least, I mean, pneumonic plague was very contagious. For me it was a learning experience to read and to explore studies showing that actually some people are exposed—that are very well exposed, that person's going to sleep on the same bed as the person with pneumonic plague even the day before the death and they did not end with the disease. So that was surprising to me. And then reflecting on the topic, maybe on a slightly different point of view, what surprised me is actually the lack of clear information on this topic. Nowadays we have, like, plenty of studies looking at

so many different things in health, in medicine. But these to me are very important and relevant questions and it was kind of still underreported, whereas, like...I mean, it's an important question, as I said, in the sense that depending on what we found it would lead to certain recommendations and that will affect lives of people—so it will affect whether depending on which kind of protective measures you will apply, it will affect both the lives of people but also the way the way the health system has to conduct and with economic repercussions.

[Sarah Gregory] What was the most challenging part of doing this study then?

[Sophie Jullien] To me, the most challenging I think is that our question did not have a straight reply. And so from a methodological point of view, we had to adapt the way of conducting this systematic review. And if including very old—I mean, some studies were very old studies, so some of them were very long which does not mean that they had lots of information and that they had the information that actually was very relevant to the question. So getting the details that we needed was not easy and actually very time-consuming.

[Sarah Gregory] And what do you consider the most important public health aspects of this review? And how will it inform public health?

[Sophie Jullien] So guidance on safe burial is actually...it's definitely needed in areas with plague outbreak—same as (or like) Ebola—and for all corpses of people who died from plague infection. So knowing infectiousness of corpses will tell us whether we need or not, for example, protective measures. And because, as I said earlier, recommendations on either way will have repercussions, we do need to have a rationale behind it. We need to base the recommendations on evidence. And the question here is relevant because in some countries the funeral rituals are very important to people and they actually involve the handling of the corpses. So an example is Madagascar, and during these funeral ceremonies people in this country—they bring the corpses out of the tomb and they will wrap the corpses in other fresh, new clothes and then they dance with the corpses and they carry over...the corpse over the heads by dancing. So this as you would imagine is a very clear and long exposure to the corpses of people who may have died from plague to the population. So because of plague, these practices have been forbidden for individuals who died of plague. It's a cultural problem, right? I mean, it's important that safe approaches are embedded in this traditional approach and we can ensure safe and dignified burials. So for doing that we need to be sure, we need to have evidence before making these recommendations.

[Sarah Gregory] I see. Yes, that's an important consideration.

Since the advent of COVID, people have heard a lot about PPEs (personal protective equipment). How should they be employed by people handling corpses and carcasses of plague victims?

[Sophie Jullien] Yeah, I remember two or three years ago when I started I first read PPE, I had to look what it means, and now everyone knows what PPE is. So there are different levels of PPE. Gloves for example, they are an element of PPE. So here we wanted to assess the contagiousness of corpses from people who died of plague to understand what level of PPE is required, and by looking at the findings that definitely plague can be transmitted by handling corpses of plague so during the meeting of plague experts that we had and looking at assessing other aspects, it was judged that yes, definitely people that have to handle these corpses need to wear full PPE and that includes gloves, gowns, goggles, and an adequate mask.

[Sarah Gregory] So Dr. Jullien, tell us about your job. You're a pediatrician, so how did you get from being a pediatrician to doing a review study of plagues in corpses?

[Sophie Jullien] I've always been interested in tropical medicine, so I went to the Liverpool School of Tropical Medicine in Liverpool to complete a master's in tropical pediatrics. And there I had the chance to work with Cochrane Infectious Disease Group, and this group is the reference for, like, evidence synthesis and systematic reviews in the field of infectious diseases, obviously. And there I learned to conduct systematic reviews, I got introduced to all these evidence-based practices and I got involved in a nice project where using the findings of the systematic review I was conducting at that time was used to develop evidence-based recommendations for guidelines for India on extrapulmonary tuberculosis. So that was a kind of a starting point. And then a few years later, the opportunity came to get involved in these other very interesting projects on plague. So WHO decided to revisit their guidelines on the management of this disease and they identified three key areas, and the topic we are talking about was one of the three. So, here we go. But it is a fascinating disease, I got the chance to learn a lot about plague. And, yeah, it is definitely a topic I never thought I would look at.

[Sarah Gregory] So has the pandemic required you to do your work differently and if so, how so?

[Sophie Jullien] Not really, to be honest in this sense that for this particular work, it's desk work, so working from home or working from an office did not make much difference. At the time that the pandemic started, I was finishing my PhD and so I could also do it from home. We got some delays, but yeah. I mean, nothing special that is worth to be mentioned.

[Sarah Gregory] So are you still a practicing pediatrician?

[Sophie Jullien] So I've been working at the hospital in last one year but not in the last two months, because of time restrictions I could not do everything. So I've been working at the hospital but after the big peak. I've been working at the hospital not as a pediatrician but involved in the clinical trials just when the pandemic started to look at the efficacy of hydroxychloroquine to protect health workers. So, yeah.

[Sarah Gregory] Well that was a pretty interesting outcome, huh?

Well thank you for taking the time to talk with me today, Dr. Jullien.

[Sophie Jullien] Thank you very much for your questions, Sarah. A pleasure.

[Sarah Gregory] And thanks for joining me out there. You can read the August 2021 article, *Plague Transmission from Corpses and Carcasses*, online at [cdc.gov/eid](https://www.cdc.gov/eid).

I'm Sarah Gregory for *Emerging Infectious Diseases*.

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