

CDC Ebola Response Oral History Project

The Reminiscences of

Jordan W. Tappero

David J. Sencer CDC Museum

Centers for Disease Control and Prevention

2015

Jordan W. Tappero

Interviewed by Samuel Robson
December 30th, 2015
Atlanta, Georgia
Interview 2 of 4

CDC Ebola Response Oral History Project

Q: This is Sam Robson here with Dr. Jordan Tappero. Today's date is December 30th, 2015, and we're here at the CDC's [Centers for Disease Control and Prevention] Roybal Campus Clifton Campus audio studio. This is our second interview as part of the Ebola [Response] Oral History Project. In our last session which got cut short, we had been talking about Dr. Tappero's background, his youth, early interests in National Geographic and public service. I think we were moving in the direction of tracing essentially your path to medicine and to public health. Where I thought we could start—and we'll have to do this unfortunately briefly in order to get to the Ebola stuff—but kind of talk about what your interests were at the end of high school, what you thought of your future going into college.

Tappero: I think probably the things that most influenced me to think about medicine were a couple of things. I had a wild crowd that I ran with in my junior high school years, and so that little man on my shoulder said, you need to break from this crowd. I had a new kid move into the neighborhood the summer before I started ninth grade and happened to have a last name that also started with a "T," so I made a new friend and this guy showed me that, hey, if you actually do your homework and show up to class on time, you can actually get pretty good grades. Before that I never thought I was really a

smart kid or a potentially good student. I had no knowledge of that. I just was running with a wilder and wilder crowd that never took a book home. And it was kind of transformative and all of a sudden I was doing well in school and had a biology teacher who kind of stimulated me in a very positive way, and then I found that I liked math for the first time because if you're doing your homework it's actually not that hard. Things like that made me think, hey, maybe I should think about something academic, and maybe college for the first time was something that I should think about. By the time I got to high school, I really had a passion for math and sciences, and by that time I'd established enough foundation by being a good student that was excelling, exceeding. So I really enjoyed my chemistry and advanced chemistry experiences and my pre-calculus experiences in high school. Went off to college as a chemistry major and a math minor. I was doing pretty well in school and was thinking, okay, either a chemistry degree and doing sort of laboratory research—so I had a project the summer between my sophomore and junior year where I did a lab project all summer. At the same time I learned that it's a pretty lonely place in a laboratory and I felt like more of a people person. So all of a sudden the medicine side of some of the classes I was taking, physiology and biology, started triggering that nurturing side of what it would maybe be like to be a doctor. So I applied my junior year and was accepted in my home state University of Nebraska as a junior before my senior year and I went off to medical school at the end of my junior year.

Q: And where did you go to college?

Tappero: I went to my home state University of Nebraska. I was an undergraduate on a scholarship and then in medical school the same, University of Nebraska Medical Center which is in Omaha. The university is in Lincoln and the medical center is in Omaha, so that's where I spent the next four years. I had a really unique experience in medical school in that if you look back in the seventies, a lot of the Midwestern schools were seeing that their need was to have primary care physicians out in their rural counties, and increasingly medical students were going on to sub-specialize and look for jobs more in urban areas. So in the seventies they had an experiment where they would allow you to finish medical school in three years, the idea being that after your first year of sort of didactic classroom anatomy, those biochemistry, etcetera classroom work, the next couple of years you would do your required courses but you would do your twelve months of required things, your standard obstetrics and gynecology, psychiatry, internal medicine, surgery, etcetera. You would do those and then you would pick something as a primary care practice and get out after three years of medical school and stay in a primary care setting. But it didn't work out. Students ended up pursuing careers in sub-specialties anyway and only doing three years of medical school. So my year was a transition year back to the four-year program, so we had our first year on the old three-year program where we did our didactics in one year instead of two years and then we had three years left even though we only had two years of required classes but they wouldn't let us graduate until the end of four. They had to have that transition year. So I pretty much went from the didactic year and the two years of the required stuff straight through and then I had my fourth year to do something more adventurous.

Most people I think were either starting a family or something like that but I was really young for my age in medical school, I think the youngest guy in my class, and I signed up for electives all over the place. So I did family practice in Sitka, Alaska, and I did cardiology in Emerald, Scotland, I did radiology in San Francisco, I did emergency room in New York City. So I set up this incredible year where—

[interruption]

So I set up this incredible year where I finally got to pursue those global aspirations that we talked about earlier where I really saw this world through National Geographic and I wanted to see more of it. I had great experiences, especially the experience in Sitka, Alaska, was pretty amazing. It was in Sitka at the Edgumbe Hospital which was an Indian Health Service hospital, so you got to see a lot of the Native American Indian social issues, health issues, and at the same time you had opportunity because of the docks there to go salmon fishing, go clamming, spend weekends hiking. Of course, I didn't have to be doing anything medical. I had this year—I had to do three years in four; I did my three, so then I sort of did like a month on, month off, and so I went up to Denali or Mt. McKinley and went backpacking for a month there. It was a really, really fascinating experience.

Q: So after the fourth year, what happens then?

Tappero: So then I applied to internal medicine. That's what I seemed to enjoy the most. I enjoyed the complex sort of pathophysiology and physiology of how the body works and I enjoyed the experiences of critical care in the intensive care units, enjoyed working on really complex organ failure problems that you see in internal medicine, everything from infectious diseases to heart attacks or arrhythmias to cancer. I was drawn to those complex medical problems, so I applied for internal medicine and I ended up going to the University of Arizona in Tucson for my internal medicine and I did three years there in the standard residency and stayed on for a fourth year to do the chief medicine year. And the chief medicine year provided an opportunity for me to, again, pursue the global health side of things. That year there were two hospitals that we rotated in but there were three chief medical residents. So out of the year of twelve months we had four months where you could do anything you wanted and then the other two blocks of four months you were at one of the two hospitals.

So my elective four months I went with my infectious disease professor-mentor to Sudan, and in Sudan worked on something called visceral leishmaniasis, and there were two laboratory projects that were under my assignment. One was to work with immuno-gold staining and look for the parasite in lymph nodes through a kind of gold staining procedure, and that one was probably maybe 20% of my responsibility and that project worked. The other one, the more complex one, required that you do tissue culture, and in the tissue culture I spent a lot of time under the hood and then putting it in the incubator and waiting for cells to grow and things of that nature. That one turned out to be very frustrating. I had never worked in a biochemical, biochemistry laboratory, infectious

disease laboratory environment. This was before the internet and Sudan is far away and mail isn't good and telephone services were nearly nascent. I kept having a fungal overgrowth in the incubator but I didn't know how to solve that so my solution was just to keep doing the experiment over and over and over, and getting the same frustrating results. What I enjoyed most about that project was there was a large Eritrean refugee population from Ethiopia on the Sudanese border and that was the place where there were a lot of refugee doctors asking for assistance with diagnostics. They would have unexplained febrile illness. If they didn't see malaria parasites on a malaria smear they really were stuck, and one of the endemic diseases there was this disease which we were studying, visceral leishmaniasis, and so we would often go out to the refugee camps and see if we could offer some diagnostic services. This is in the early days of institutional review boards where I think if we were to do this kind of work now, it would almost be considered like research in some kind of consent. Even though we were providing a service we were also receiving biological specimens that in addition to helping them with diagnostics, if we found leishmaniasis we could use the specimens for the laboratory work.

So we're talking 1985 here and the interaction with the refugee physicians there I found more fascinating and stimulating than the laboratory experience that I was having back in Khartoum where my experiments weren't working out. These several docs that I met, several of them had become sort of international refugee displaced person physicians as their career path. So imagine yourself like Médecins Sans Frontières, that kind of environment. I asked who they worked for and one thing led to another, got some

references and came back from my experience in Africa saying, you know, I don't want to pursue this infectious disease track that I thought I did that would lead me to laboratory work studying infectious diseases, but I hadn't really learned or been informed about the public health side of infectious diseases. I hadn't seen it, didn't know about Centers for Disease Control, the EIS [Epidemic Intelligence Service] program and those kind of things and so I had to kind of figure out, okay, what am I going to do? If I'm not going to do this infectious disease pathway, what would I do?

Anyway, when you're a chief medical resident and you're back at the main campus, you also have the opportunity—you spend about half the day working with the internal medicine residents, their cases, helping on complex consultations that they get on their services, and the other half of the time you have time for creative learning to sort of round out your experience as an internist in your residency program as a chief resident. And I decided I needed to really build my skills in dermatology because I had never taken that elective, and sort of at the time thinking this is easy and simple, I'll have some extra free time, but I actually really enjoyed it and found that the diagnostic mix of using your eyesight to help you discern descriptive lesions of the skin and then also, when needed, a biopsy of the skin, learn the tissue pathology part under the microscope and use your eyes again in see complex patterns there to put together with what you'd seen with your eyes. I also enjoyed the rapidity with which you would see large numbers of people, have a brief but also interactive social dialog with someone. Most of the time you could quickly give them an answer of reassuring but some of the times they were really complex and required some deep thinking.

Also at the same time my internal medicine residency was informed by the AIDS [acquired immune deficiency syndrome] epidemic. AIDS really hit the United States sort of in the early eighties like '82, '83, and so my internal medicine residency, we were seeing the first AIDS cases in the US and we saw a lot of pneumocystis pneumonia and Kaposi's sarcoma, the two first AIDS-defining illnesses. Later we learned that there was a virus called human immunodeficiency virus that was causing this, but at the time we really didn't know that and we didn't have a cause for what was leading predominately gay men to come down with pneumocystis carinii pneumonia or to come down with Kaposi's sarcoma. So the Kaposi's sarcoma part was part of the diagnostic services of the dermatology department and the professor there who was the head of the dermatology department suggested, "Hey, since you're not going to pursue this infectious disease fellowship, maybe you should think about dermatology and studying Kaposi's sarcoma." He said, "Dermatology used to be called dermatology and venereology, and there's a lot of work that dermatologists that are interested in infectious diseases can do around sexually transmitted diseases like gonorrhea, for example, or chlamydia."

So I thought about it and also applied for a job as a refugee doctor on the Thai-Cambodian border. I had a real passion for what was my [unclear] youth, the Vietnam War, and now there was this conflict between the Vietnamese and the Khmer Rouge and other Cambodians that resulted in the Killing Fields and a displacement of several million Cambodians onto the Thai-Cambodian border. So I decided I wanted to be a refugee doctor there. I didn't end up making the visits to the medical centers for infectious

disease fellowships. I withdrew from that for the reasons that I explained from my African experience with the laboratory and on a whim applied to a few dermatology programs that were linked to a lot of AIDS patient populations. One of them was University of California San Francisco, and then while working in the refugee camps I was accepted into a dermatology program at UC San Francisco and after a little over a year decided to come back and pursue that, and that's how I sort of found my way to San Francisco.

The time in San Francisco was, the first couple of months, tough I'll say. I went from this bamboo dirt floor hospital setting with really sick, predominately children under five years of age with malaria and pneumonia and meningitis and adults, mostly women with complicated deliveries with no operating theater in which to deliver challenging complex maternal births, and also in this environment a lot of Khmer soldiers would go back into Vietnam or back into Cambodia and fight the Vietnamese occupying troops that would come back with landmine injuries or gunshot wounds. So you come back from that kind of environment to a university hospital in a major metropolitan area and you're seeing a lot of bread-and-butter infectious disease problems, acne for example, or seborrheic keratosis, and I thought oh my goodness, I've made a mistake here. But after the first two months, then I got my rotation down at San Francisco General Hospital, which is the county hospital. It was truly sort of the nexus of the AIDS epidemic and the patient population—probably four out of five people hospitalized had HIV [human immunodeficiency virus] infection and the amount of dermatology was just overwhelming. And back then it was pre- the antiretroviral drug treatment era and so it

was nearly certain that people that had HIV infection would eventually die of their HIV infection and a lot of the diseases of the skin were the AIDS-defining diagnosis and you could literally see through the skin the problems of the deteriorating immune system, and it was I guess in many ways the informative experience of my career about epidemics. This HIV epidemic was massive in scale, undefined, but clearly blooming, and the passion that I had for working with HIV, even in the dermatology setting, became how I again launched my infectious disease career.

So I began thinking I don't want to work in a laboratory for the reasons I've already explained and decided to really think about working on studies around risk factors. There were a couple of population-based studies in the Bay Area that were being done around HIV. One was called the San Francisco Men's Health Study and that was run by Professor Warren Winkelstein at the University of California Berkeley. And then there was another one at San Francisco General Hospital, a gay men's cohort study. So I wanted to study Kaposi's sarcoma and see, what is behind this, could it be an infectious disease?

At the end of my first two years of my residency, the department supported me to go get a master's in public health at Berkeley. My advisor, a guy named Art [Arthur L.] Reingold, had spent eight years at CDC in the meningitis and special pathogens branch and sort of told me about the Epidemic Intelligence Service program and sort of knew about my background and said, "I think this is really something you should look into." And I decided to at least explore it and put in my application. In the meantime, started

using some of the tools I was learning in epidemiology. One was while I was doing my master's in public health, I also continued three days a week to see patients at San Francisco General and we were seeing this new disease that looked like an unusual type of Kaposi's sarcoma, sort of weeping red lesions on the body that kind of looked like what we call exophytic Kaposi's sarcoma. But under the microscope they didn't look at all like Kaposi's sarcoma, and when we looked with special stains, you could see that there were bacterial organisms there. So we started a case control study with patients with bacillary angiomatosis, this Kaposi's sarcoma-imitating lesion, but it was something different. We weren't able at first to grow the organism and identify what it was. You could see that under the microscope and electron microscopy that these organisms looked like something called—organisms of cat scratch disease, and those organism had been purportedly identified by the Armed Forces Institute of Pathology and they were named *Afipia felis*. They were thought to be a soil organism that was really hard to grow, but had been published on that it can be grown. But the clinical picture of these gentlemen didn't look at all like children with cat scratch disease which is fever with swollen lymph nodes, usually in the area where you'd been purportedly scratched by a cat or bitten by a cat.

So we started looking in the literature, and I scrubbed through some literature at something called *Bartonella bacilliformis*. There was something called Oroya fever that was described in South America and Peru in the early 1900s, and that disease was a disease of railroad workers who were working high in the Andes Mountains putting in railroad tracks. These men of mostly Spanish decent would get afebrile illness with hemolytic anemia. Most of them would die. Those who survived, six weeks later or so

would develop these lesions that looked clinically just like bacillary angiomatosis. So we thought, we wonder if there's a relationship between these. It had also been in I think the 1920s a Harvard group led by a guy named Barton went down to South America and were able to culture the organism from these individuals and it was named *Bartonella bacilliformis*. So also interesting history there as well with this Oroya fever, there was a medical student in Peru named Daniel Carrión who had the hypothesis that the hemolytic anemia and febrile illness that killed so many of these railroad workers was also part of the disease spectrum for these people with what was called verruga peruana, these skin lesions that looked a lot like what we were seeing in bacillary angiomatosis. Those lesions, he took some, chopped them up and convinced his mentor that if he injected them into him, he might get hemolytic anemia and show that this was in fact a late manifestation of Oroya fever. Well, he and his professor did that. He did get hemolytic anemia and sadly he died. I guess his reward was that he proved himself right. He got the disease Oroya fever, also named after him, Carrion's disease. Many years later we used this clinical picture of people with verruga peruana to inform our case control study about asking questions about hypothesis generation for looking at risk factors. So we asked about questions of cocaine, cocaine exposure, insect bites, all kinds of things, and although we didn't find a direct link with South America, we did look at what Dr. Barton, who had discovered how to grow the organism in the case of verruga peruana, and he used a lot of umbilical cells from cows to generate a media upon which he was actually able to culture the organism.

So I found a laboratory partner at UC San Francisco. Her name is Jane [E.] Koehler, and she used some of those types of cell lines, and our next cases of bacillary angiomatosis she was able to recover the organism and grow the organism. So we looked at the organisms that we were trying to grow and then successfully grew and we looked at their 16S gene sequence, and to our surprise they were a very close match to *Bartonella bacilliformis* but different. They were also a close match to *Rochalimaea quintana*, the cause of World War I trench fever, and they were also identical to something that was being recovered in Oklahoma in patients with unexplained febrile illness that were just with bacteremia or fever and bloodstream infection. And when we looked at the epidemiology of the risk factors of our patients, we found that about two-thirds of the bacillary angiomatosis patients that had a 16S gene sequence for their organisms matched what was being seen in Oklahoma in these febrile patients, and the other one-third were growing what was World War I trench fever. That was really surprising to us. And we also found that the risk factors for those who had the 16S gene sequence like those patients in Oklahoma had cat exposures and the one-third that didn't were homeless patients without any exposure to cats at all. So we ended up tying up this whole story together that the cause of bacillary angiomatosis was two organisms, *Rochalimaea quintana*, the cause of World War I trench fever in the homeless patients, and *Rochalimaea henselae*, which was the organism named that was found in Oklahoma, and that that organism was actually the cause of cat scratch disease and the organism that had previously been purported to be the cause of cat scratch disease was a soil contaminant. They got it wrong. And then the genus *Rochalimaea* had to be eliminated because the first organism in that genus that had been identified had been identified in South

America, the cause of *Bartonella bacilliformis* or the organism *Bartonella bacilliformis*. And so World War I trench fever got its genus renamed from *Rochalimaea quintana* to *Bartonella quintana* and cat scratch disease got renamed from *Rochalimaea henselae* to *Bartonella henselae*, and *Bartonella bacilliformis* is the first organism in that species identified from Carrion's disease or Oroya fever.

Q: Wow, these are some fundamental changes in these diseases. How did it feel to be making these kinds of discoveries?

Tappero: Well, I finally found my niche. I loved the hypothesis generation of epidemiology, the sleuth work. That was an eight-year body of work to figure all these things out, and it didn't end with just identifying the organism and the cause and the risk factors for. There were other things that needed to be solved like, okay, cat scratch disease, two-thirds of our patients have cats. Those are the ones that had *Bartonella henselae* infection. How were they infected and what is the relationship between cats and humans? So we also looked at how that might be and our epidemiology told us that cat fleas were as much a problem as cat bites and scratches. So we got permission from predominantly gay men who owned cats to bleed their cats. So one of my veterinary friends taught me how to bleed cats and I bled the cats and tried to grow them in the same media that we grew the organisms from the lesions of bacillary angiomatosis and found that about 40% of cats owned by these gay men who had this disease were bacteremic at any one time. So then we said, how big a problem is this in the cat population? So we looked at homeless shelters for cats or PAWS or those kinds of shelters and got

permission to bleed cats, and we found that in homeless shelters not only in San Francisco but almost anywhere in the country about 40% of cats at any one time have this organism in their bloodstream. So we found the reservoir and then we wanted to know, how do cats infect each other? And it turns out that it really has nothing to do with scratches and bites, it has to do with cat fleas. So if you have two cats, one in a cage next to the other, and you have *Bartonella* infected in one and not the other and you let them play and scratch and bite, they don't transmit. But if you introduce a flea into the environment where these two cats don't get to play with each other but they're side by side, then infection is transmitted from the cat with bacteremia to the one without. So it's a vector-borne disease. We also showed that cat scratch disease in children is actually caused by *Bartonella henselae* and that the reason you see a different clinical picture in AIDS patients relative to children is that children have pretty good immune systems. For the most time, they get exposed to what is the organism purportedly called cat scratch disease and they never get an infection. Some small percentage of children do, they do get swollen lymph nodes. When you look for the organism in a biopsy of the lymph node, it's hard to find it. Usually you don't. Sometimes you can find just one or two of these organisms, but then if you look at men with autoimmune systems because of HIV infection or chemotherapy for a terrible malignancy or something like that, then people have this disease bacillary angiomatosis or if it gets into a large organism it's called peliosis hepatis like the liver or spleen, there you see lots and lots of organisms and they are the same organisms that cause cat scratch disease in children.

Q: That's crazy. So remind me of the timeline here.

Tappero: Sorry, I got carried away.

Q: No, it's good.

Tappero: So the timeline was medical school, then internal medicine, discovering after four years of internal medicine maybe not infectious disease laboratory kind of track but maybe refugee medicine, something like that, and doing dermatology as an elective and really being fascinated by the AIDS epidemic problem that took me to pursue the dermatology fellowship. During the fellowship, discovered the science of epidemiology and public health through my master's in public health, put it to practice in studying bacillary angiomatosis and discovering not only the causes but the risk factors for and the reservoir for cat scratch disease. And then thinking about that my professor, who was a mentor for me in public health, strongly suggested that I think about the EIS program. So I applied to EIS and I was accepted and about ready to move to Atlanta, and then the Gulf War started. My mentor at San Francisco General, the head of the department there who took me on as a young faculty, was Army Reserve and he was brought out of the reserves for the Gulf War. So I had to ask CDC if I could defer for one year so that I could be the head of the dermatology department at San Francisco General Hospital while my mentor, Dr. Tim [Timothy] Berger, went off for the Gulf War. And during that year I really learned how to step into some big shoes and run a dermatology department in a big inner city county hospital with lots and lots of HIV infection patients. But the war fortunately

ended and Tim came back, and then I pursued the next year after deferral the EIS experience that I came to CDC for and started in 1992 instead of '91.

Q: When you think about your EIS experience, are there certain diseases, certain cases you were on that you think you learned quite a bit that you were able to apply to Ebola? What are some that stick out in your memory?

Tappero: I think there are two things about my EIS experience. I think out of my twenty-four months in EIS I spent something like thirteen or fourteen of them overseas and something like fifteen or sixteen total away from Atlanta doing outbreak investigations, and they were all extremely informative and pursued or added to my passion for this working in public health and working in global public health. And then things around Ebola that also touch on it were that I did have the opportunity to work with a group at CDC that is responsible for the organisms like Ebola virus, like Marburg virus. That collective group of infections is known as hemorrhagic fevers. There's also another big outbreak that happened during my EIS experience, was the hantavirus or Four Corners outbreak, and that is also—the hantavirus is one of those organisms that is also managed by the Viral Special Pathogens Branch group. So that was probably the big epidemic of my two-year EIS experience that I got to work on. There were also other experiences in my own experience with meningitis in the Special Pathogens Branch. One was meningococcal disease or meningococcal meningitis and I had some remarkable experiences with that organism as an epidemiologist as well. My first outbreak was going to Butte, Montana, and working on an outbreak of meningitis among young children. We

wanted to see if the vaccine that was for adults had any benefit at all in young children, so we did an immunogenicity study and learned that young children can actually develop some antibodies in response to the vaccine. So because this outbreak was happening in younger children, that community was vaccinated.

Another outbreak that was fascinating that happened during my time was after my work on hantavirus I had an opportunity to go look at an outbreak of meningococcal meningitis in the Los Angeles County jail, which is the largest county jail in the country. It has over twenty thousand inmates at any one time. It turns out that five years before, the LA County jail had an outbreak of meningococcal meningitis serogroup C in the jail and that the community also had rising rates of meningococcal disease but didn't quite reach that threshold for what we would call a meningitis outbreak. And then the very next year it went down in the jail and it went down in the community. Now, fast forward five years into the future when I'm an EIS officer and we're seeing the outbreak in the jail again and we're also looking at the surveillance data telling us that meningitis is also rising in the community. So I was sent out to investigate why this is happening in the jail and what is the relationship, if there is one, between what's happening in the jail and the community.

So there were a couple of things we did. One was a case control study of meningitis in the community. When you look at meningitis in America back in the 1990s, there were two predominant serogroups that were the cause of it, serogroup B and serogroup C, and serogroup C tended to be clonal, meaning if you looked at the 16S gene sequence of the

organism and some other kind of biochemical variables, you would find that they were truly a clone; whereas if you looked at the serogroup B organisms, they really weren't that closely related. They were a scattered group of B's that were different, not clonal in nature. So we looked at the surveillance data for all the cases of meningitis in Los Angeles county and it turned out that if you are an adult or a child, if you get bacterial meningitis, you get high fever, you get really sick and you almost always in the United States end up in a hospital that does a spinal tap and gets the organism or does a blood culture and gets the organism. So when we say meningococcal meningitis, it's because we have laboratory confirmation and usually the serogroup for that organism. So we looked at the neighborhoods where bacterial meningitis was occurring. They tended to be in poor neighborhoods, South Central LA lots, that kind of a thing, and we did a case control study where we went door to door. Going door to door, you would ask for permission for those who had survived meningitis or for those unfortunately that had passed away, a surrogate like a parent, to ask a number of risk factor questions. And then you would use a control, and the control we used as a neighbor, not someone in the same household but a matched neighbor. So what we found was that in this match case control study that it was in fact a risk factor for bacterial meningitis to have exposure to someone recently released from jail, which was a real surprise for us. And then we looked at it by serogroup. We knew that the outbreak in the jail was a serogroup C clonal outbreak and that there really wasn't any serogroup B meningococcal meningitis happening in jail. But when we looked at who had B and who had C in the community and their risk factors for exposure to someone recently released from jail, the risk factor was just as strong for those with serogroup B disease as it was for serogroup C disease, so we said, how can

that be? There's no B outbreak in the jail. So then we had a hypothesis that maybe the carriage in the pharynx or the throat is high among people released from jail and so we did a carriage study at the Los Angeles County jail looking with a throat swab of people coming into jail, people going out of jail. Not only inmates coming into jail but inmates upon release from jail, but also staff members who worked in the jail, you know, the police corrective services people in the jail.

What we found was that there was a very high carriage prevalence of serogroup B in the pharynx of men in the jail of all these different B's and there was almost no C found in the carriage, and that matched what we'd seen for clonal serogroup C outbreaks across the United States, that we don't see a lot of high carriage in communities around a serogroup C meningitis outbreak. But we also found by also looking in the literature from World War I where there were a lot of meningococcal outbreaks in GI soldiers who were in training camp together and in close quarters, that there was a lot of disease in that, and we found that the overcrowding in the Los Angeles County jail system was so high that it explained the high carriage rates among all these B's. So the way we hypothesized and put together the story is that serogroup B, even though not clonal, is in such high carriage rates relative to the regular community that it is a risk factor for serogroup B disease in communities, and that so many men being released from jail with serogroup B are exposing their communities to serogroup B organisms and eventually it gets sporadic non-clonal meningococcal B disease in the community and that the serogroup C in the jail was clonal. Then we left some recommendations for how to address that problem

there as well, and then fortunately the next year the rates went down again as they had five years before.

Q: By that time were you still in EIS?

Tappero: Yeah. That was just a six-week investigation, believe it or not. That's why it's so much fun to be a disease detective for CDC. Not only do you work on problems of significance to the public, not only do you hopefully solve the problem and save lives, not only do you get to pursue the intellectual challenge of solving a complex puzzle, but you're working on problems that are meaningful and that ultimately will save lives and protect communities, and that's what I wanted to be a doctor for. It just took me a long time to figure out how to put that passion into practice.

Q: It's really cool to be able to look back and keep track of the places you worked and the things you worked on and what's happening now, to be able to say, cases are down a year later. Are you always able to do that?

Tappero: I think one of the things about epidemic disease is that there's always some type of bell-shaped curve, that eventually things get better. The question is, how can you dampen the height of that epidemic curve and how can you squeeze the duration into something as short as possible? So there are many new tools that we have that have really dampened the height and shortened the timeline for outbreaks. Or in other words, outbreaks are inevitable because there's always going to be a new emerging infection or

there's going to be a community that isn't vaccinated properly, or you could go on and on down the line of emerging infectious disease, but can you investigate quickly and can you put in an intervention that dampens the height and the length of time of which communities experience the epidemic or the outbreak—hopefully if you're able to keep it an outbreak and not let it become an epidemic.

Q: I like that. It's a very useful description of what you're trying to do. I've kept you talking for a good forty-five minutes and I try and keep little breaks in here. Is it okay if we take five?

Tappero: Sure.

[break]

Q: So I think we were just getting finished with EIS and actually, let's talk about setting up the Botswana office after EIS. So what happens after EIS?

Tappero: Well, what happens after EIS is I do the preventive medicine residency, and that's for CDC. If you already have your master's in public health, which I did have, and you've completed EIS, then one more year makes you eligible to sit the preventive medicine residency boards, and it just so happened that during my second year of EIS I pursued an outbreak of meningococcal meningitis in Santiago, Chile, that resulted in a two-year long study in evaluating two meningococcal serogroup B vaccines head to head.

One produced by the Norwegian Institute of Public Health, the other one produced by the Finlay Institute of Health in Cuba. So we have a Cuban produced vaccine and a Norwegian vaccine and in order to see that project through, which I really wanted to see through, I needed to extend my EIS experience by another year. So it kind of just all worked out that by doing the PMR [preventive medicine residency] program and being eligible for the preventive medicine residency board, I could also complete my two-year project in Santiago, Chile. So I also had to do my PMR assignment in a place different from where I did EIS and so I was based in Atlanta for EIS. I went back to the University of California San Francisco Berkeley environment where I'd come from. I worked with Professor Reingold again on a *Bartonella* project in the Bay Area as well as finishing up my project in Chile. So I probably spent about, out of that twelve months, three months in the Bay Area and eight months or so in Santiago, Chile, doing that vaccine trial.

Q: Can you tell me about Art Reingold and your relationship with him?

Tappero: Yeah. So Art Reingold is still a mentor and close friend. He did EIS, I think, in the state of Connecticut is where he did his and afterwards came to Atlanta and worked in the meningitis and special pathogens branch with one of the famous epidemiologists of CDC, Dr. Claire [V.] Broome. She was the branch chief of meningitis and special pathogens branch and Art became the epidemiology section chief under Claire, and he was there seven or eight years. He ended up falling in love with an EIS officer and pursued her to the Bay Area after she finished EIS. Her name is Gail Bolan. She's currently the STD division director for the [Division of] Sexually Transmitted Disease

[Prevention] in NCHHSTP [National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention]. Anyway, Gail had finished EIS, gone back to do her infectious disease fellowship at Stanford [University] and Art and Gail were a couple and Art got a job at UC Berkeley for a one-year assignment that has since turned into his full professional career. So he left CDC in pursuit of love and yet has remained CDC West, if you will, sending so many young people from the Bay Area who are interested in epidemiology to pursue the EIS experience, and then he's done a lot of projects with CDC from the School of Public Health at UC Berkeley over the many years. After his three children went off to college, completed college, his wife decided that now it's her turn to be a full-time epidemiologist although she worked with the state health department in California on STDs when the division director job opened up here and she was free from family responsibilities to pursue that. She's been here about two years now and Art is in Berkeley and frequently comes to Atlanta for not only work but to also spend time with Gail.

Q: That's great that you can continue to have that.

Tappero: Yeah, and I frequently get back to the Bay Area for work-related things somehow or another. There are several cities in the country that if you're in global health you tend to find yourself getting back to—one is obvious, Washington, for obvious reasons. I find myself in Washington, DC for global health security or other reasons with some relative frequency, and then periodically I'll find myself in the San Francisco Bay Area and always hook up with Art. I think I spent seven years at UC San Francisco.

Because of that connection I'll often get invited out to give talks and things in the Bay Area as well as other places and always catch up with Art.

Q: So after that second stint in the Bay Area, what happens?

Tappero: Well, I was about ready to go back to UC San Francisco with the epidemiology department and sort of a dual appointment where I would also do some clinical work with the department of dermatology but have my office with the epidemiology program at UC San Francisco. Then I was going to finish around June 30th of '95, but that March or April, CDC decided it wanted to open a country office to look at the relationship between HIV and tuberculosis in sub-Saharan Africa. It was because early in the AIDS epidemic, if you call those years early still, it was clear that there was some association between TB and HIV but it wasn't really well understood. And so CDC decided to open, I think, its fourth overseas country office in Botswana, a country of about one and a half million people in a land mass the size of Texas, and a country that throughout the 1960s was a major success story in TB control. They had really done a good job in bringing TB rates down and all of a sudden within the span of about four years, they went from being one of the better TB control programs or one of the lowest reported incidence rates of new TB cases to being the highest in all of sub-Saharan Africa and it just turned out that sero [serological] surveys of HIV infection in sub-Saharan Africa also found Botswana to have the highest HIV prevalence rates in the world. It was around 35-39%, somewhere in that range, in this country with only 1.2 million people. So that was the place that CDC decided that it wanted to study the relationship between TB and HIV.

So I was asked if I would open the country office there in 1995 and it was a really tough decision for me. Probably the most difficult decision I think as a professional epidemiologist I had to make. My love for the San Francisco Bay Area, my reintroduction as PMR back to that community and being offered a job and really thinking this was going to be my path back to academics and grant writing and all of that. Then all of a sudden out of nowhere I get the call from the division director for the Division of TB Elimination, Kim Castro, saying, would you really consider being our field epidemiologist, you've got a lot of international experience, you clearly have a passion for the HIV problem, TB is also a fascinating problem. Anyway, in the end I took the job and opened the country office in a little house on the streets in sleepy little Gaborone, and I remember my first challenges were getting the first computer and trying to get a phone line hooked up so we could have dial-in modem internet and all the headaches that come with being a small fish in a big pond.

Q: That's a good question. When we talk about a country office, what are we actually talking about?

Tappero: I think if you look at CDC's global experience over the past twenty-five to thirty years, it's been transformative. If you look back into when I started EIS in '92, I think we had a small country office in Kenya which was largely to support malaria research, looking at what became evidence for using insecticide-treated bed nets to prevent malaria in households for adults and more importantly children. And also we

were able with that country office to start looking at the questions of HIV because we had a physical presence there. We also had opened in what was then called Zaire, now Democratic Republic of Congo, had opened a country office to look at HIV there. That office had to be closed down because of political unrest. I think it was probably around 1991 or so and they opened a new country office in West Africa in Côte d'Ivoire, or Ivory Coast, and Kevin DeCock was the first country director there. We also, because of the HIV epidemic, opened a country office in Thailand. That, I think, was right around 1990, if I remember, '89 or '90, and that was because HIV exploded among injection drug users and sex workers at that time. So if you look at the time we opened the CDC country office in Botswana, we had a country office in Ivory Coast, we had one in Kenya, we had one in Thailand, and this was the fourth CDC country office. Traditionally throughout the eighties and nineties, CDC did global work but we did it by being seconded to the World Health Organization or the Americas region of WHO [World Health Organization], the Pan American Health Organization. And when we seconded, we continued to use all the tools and experience and connections that CDC can bring to public health, but you leave your hat at the door and as a secondee to the organization you're largely supporting the work of the organization and bringing the technical skills and assets that the agency can bring to it when WHO calls for it.

When we get into the late 1990s, the discovery that highly active antiretroviral drug treatment for HIV, or three or more drugs in the treatment of HIV, has a pretty substantive impact on health. That became sort of the transformation of how CDC and the global community responded to the HIV epidemic. And in 2003, after a couple of

years of looking at the prevention of mother-to-child HIV transmission interventions with antiretroviral drug treatment for newborns born to HIV-infected pregnant women, President Bush in 2003 announced the President's Emergency Plan for AIDS Relief that would not only include addressing on a grand scale in sub-Saharan Africa and parts of Asia the problem of mother-to-child HIV transmission, but also the widespread scale-up of programs for providing antiretroviral drug treatment for adults as well as HIV-infected children. And with that, the number of country offices that CDC needed for implementation of our program grew substantially. I think throughout 2003 to about 2008, during that five-year period—I could be accurate about the figures and look into it but I think we opened something like thirty or forty country offices. In addition, because having a CDC country office provides the infrastructure and the relationships with the US Embassy, the host government also provides the opportunity for CDC to hire locally employed staff that really become the continuous memory for CDC in-country because we tend to go out on two-year assignments with a six-year maximum deployment to any one country and then we rotate the local staff. The CDC country offices really are that permanent memory for us. And so we generally as well, unlike other US government agencies that work in the health spectrum, most of our country offices are co-located with ministries of health where we actually sit side by side with our Ministry of Health counterparts to work in partnership. Most US government agencies work at the US Embassy, have their offices at the US Embassy and they work through a non-government or local indigenous NGO organizations to implement their programs; whereas, as you know from working here, we like to be very technical and hands-on and we do fund some partners to assist us in our work but we are the principle technical partner that sits with

the Ministry of Health rather than having another group provide that technical expertise on behalf of the US government. We are that source of information in technical support.

Q: When a country office is started, and I'm sorry, we're getting a little bit away from your specific experience, but it's interesting to me, this development. Is it the host government which invites the CDC to come or WHO? What are the mechanisms there?

Tappero: Generally speaking, our reputation as an agency is respected and appreciated around the world, so most every ministry of health has called on CDC subject matter experts at one time or another to help them with an outbreak or an epidemic or an immunization program or controlling malaria or trying to explain an unexplained illness. So we're fairly well known and in that scenario when we are approached to open a country office, usually unless there's security issues in that country we are usually invited to co-locate and when that happens, we don't pay rent. We literally sit side by side. We are usually given space in some countries, adequate space in some countries, because there isn't adequate space even for their own staff. We work in a very tight shoebox-like environment but it varies around the world and we are always first and foremost pursuing the opportunities to work side by side with the Ministry of Health because we think that that is in the long run the greatest contribution that we can make. If we sit side by side and train as many people as possible to be disease detectives, to be field shoe leather epidemiologists and laboratorians that can support national public health reference laboratories with a tiered infrastructure for laboratory support over time, then we are able to make the biggest impact. And it's only by working with ministries of health that you

can actually develop that national capacity. I think that it's very valuable to work with a variety of partners who can address urgent needs in different geographic locations, but sitting with the Ministry of Health, working side by side, providing an evidence base for problems and being able to work side by side with national government public health leaders, you actually can provide data that influences policy changes, guidelines and regulations at a national level. Resources, of course, need to be available, but eventually provide guidance that is national and can reach the whole population.

Q: How did you see that take place or not take place in Botswana while you were there?

Tappero: I think it took place in dramatic fashion. My time in Botswana preceded the identification of highly active antiretroviral drug treatment as a cure for HIV. But one of the many things that we were able to do in Botswana from 1995 to 1998 was to document that children that lived in households with someone with tuberculosis were at very high risk of getting tuberculosis themselves, and that the adults that were largely becoming infected with active tuberculosis were HIV-infected adults, and so a couple of things came from that. One, we were able to show that even in HIV-infected communities that treatment of tuberculosis, even in the setting of HIV infection, decreased the risk of TB transmission to others in the household. So even though it's sad news that at that time pre-antiretroviral drug treatment, the adults would eventually succumb to their opportunistic infection, it didn't need to be tuberculosis, or if it was tuberculosis, they didn't need to put others in their household at risk for acquiring TB themselves. It also helped us to identify, again, predominately children who were exposed to TB, and

consider the question of: does preventive therapy for TB in someone who clearly is exposed and has become infected but does not yet have active TB disease; is there a value in that? And it turned out that yes, there is. So if you look at tuberculosis infection in general in a non-HIV environment, about 10% of people that get infected will eventually come down with the disease, and that risk of 10% throughout your adult life is usually at two ends of the bell curve of your lifespan. If you're infected as a child, you're more likely to get active TB disease in your youth. If you survive that period without coming down with active disease, throughout your teens, your twenties, your thirties, your risk of having active disease is very low. Then as an adult in your seventies, as your immune system starts to fatigue, as we say in aging, that's where most of that 10% lifetime risk of after infection you come down with active disease occurs.

HIV changed everything. All of a sudden active disease was in sub-Saharan Africa, in San Francisco and New York and LA, an explosion in TB incidence among people in their teens, twenties and thirties, and that was because of co-infection with HIV. We know now that before the identification of highly active antiretroviral drug treatment for HIV, that you could still treat the TB and prevent transmission to others. Then with the discovery of multi-drug treatment for HIV or highly active antiretroviral drug treatment, HAART, three or four drugs that are specific to HIV infection, that that alone would decrease the risk of tuberculosis incidence as well. And that happened because your own immune system then kicks back in and controls HIV, but we can also give preventive therapy to those who are HIV-infected and decrease their risk of tuberculosis even with HIV. And those are the kind of things that we learned in Botswana.

I would say the year 2000 was sort of the transformative year of the annual international AIDS conference. We saw that in '98, the discovery of HAART being used widely throughout Europe and North America had a transformative impact on saving lives in these high-prevalence HIV-infected communities in the developed world. And by the year 2000 in Durban, South Africa, the global community started demanding access, and at that international AIDS conference which was presided over by former president Bill Clinton, by Nelson Mandela who had just stepped down from being president in South Africa, and by many other luminary figures in public health, that the international world, the international community was saying, we need access for all, not just for people living in the First World. And I think that call to action by the HIV-infected global community was also joined by a large spectrum of influential organizations and people, one of which was the faith-based organizations who had been doing missionary work in sub-Saharan Africa for years. They really were a strong voice in saying, we want access for our missionary work, and I think by the time President [George W.] Bush is well along the first term of his presidency, he is hearing from many of his faith-based constituents that the epidemic in sub-Saharan Africa needs to be addressed, that the tools are now available and that this conservative compassionate approach to—his worldview led to the President's Emergency Plan for AIDS Relief in the announcement in 2003 that the US government would commit to spending \$15 billion over five years to impact this terrible scourge that was affecting sub-Saharan Africa and parts of Asia. And that program, PEPFAR, by 2008 was really meeting its targets, saving lives, preventing new infections, and it had bipartisan support. It was reauthorized in 2008 for another five years. It was

reauthorized again in 2013 for another five years, and I think will continue to be a big part of the US government commitment to the AIDS epidemic and a big part of the global contribution to dampening the AIDS epidemic that we've seen as we've learned that treatment of HIV also leads to prevention of new infections in HIV.

I think in the next few years we'll find out how the global community will address the problem of—there are still two out of every three living HIV-infected people in the world who are not yet sick enough to need treatment, but the resources that are available right now are meeting the demand of those who are infected who need lifesaving treatment, but as the other two-thirds come into a lowering CD4 cell count and need for treatment, that the dollars right now are sort of at that tipping point of there aren't any additional dollars to address the next two-thirds in need. And we'll see how the global community responds to that. We've demonstrated through PEPFAR, the Global Fund [to Fight AIDS, Tuberculosis and Malaria] and other global contributions to the HIV epidemic that there is a way forward but there will probably need to be more resources. I think the American people have clearly made their contribution to demonstrate—the vast majority of resources for PEPFAR and Global Fund and this demonstration of success in the HIV epidemic have come from the kind contributions made through US taxpayers. There needs to be more than just a US taxpayer solution to this problem, but there is a solution and hopefully the world will, again, step up and address this ongoing epidemic that now is sort of in the background. People don't talk about it so much because those who need HIV access to care in the US and in Europe are getting it and those who need it today in

sub-Saharan Africa are getting it but tomorrow there will be an unmet demand and we will see where it goes.

Q: Yeah, that two-thirds, that's amazing. So back to you specifically. After starting up the country office in Botswana, what happens?

Tappero: I think it was my first opportunity to be a mentor for the EIS program and that's why I decided not to take a full-time job in Botswana. The EIS program requires that your mentor is Atlanta or state-based. One day I hope we change that, but I continued to live in our project house in Botswana probably eight to nine months out of the year but had my supervisory responsibility for two EIS officers and those officers spent roughly, like me, eight months a year in Botswana. And then after my first two EIS officers finished their two-year program, towards about eighteen months into their EIS experience I was approach by the branch chief where I had done my EIS in the meningitis special pathogens branch to be the epidemiology section chief there, to take the job of my public health mentor, Art Reingold's position, that he had had in working with Claire Broome. I decided to take that opportunity, and then from 1998 to about October of 2000, I was epidemiology section chief. It also allowed me to spend time with the woman who is now my wife and she was sort of an outdoor recreation instructor and Olympic kayak racing pursuant from the Nantahala Outdoor Center. When I moved to Atlanta to do EIS, I took up whitewater kayaking, developed a passion for it and paddled in Chile when I did my meningococcal work down there. Many incredible rivers in South America and then in Botswana, the Zambezi River, which—Victorian Falls on down. Amazing whitewater. So

I did a lot of paddling there. Then I ended up marrying the woman, Frances Glass, that I met when I did a nineteen-day whitewater kayaking trip down the Colorado River in the Grand Canyon. So I think I lost track of your actual question. Oh, how I came back to—so, I came back to Atlanta and got married and was the epidemiology section chief. I had a lot of incredible sleuth-like epidemiology experiences mentoring many EIS officers as the epidemiology section chief. Then my wife and I were so fortunate to have boy-girl twins, and then about six months into being parents I was asked if I would consider being the CDC country director in Thailand, and recalled that I had done refugee medicine in Thailand and sort of had a soft place in my heart for the Thai people. Hear they had a big HIV epidemic, a country office opportunity opened up. I spoke with my wife about an overseas experience and being barefoot, recently pregnant and having boy-girl twins crawling around her feet, she said “I would love to have an overseas experience,” and so we went and had an adventure together and ended up being there from 2000 to 2006 when I reached the maximum amount of time that CDC allows its employees to be in any one overseas country location.

From there I went to Uganda. Started there in the summer of 2006 and immediately the family fell in love with the country. The capital city is Kampala. It’s right on Lake Victoria. We lived in an old home that had a terracotta tile roof and big green area space backyard. Down the hill you could see Lake Victoria and the trees were just full of tropical birds. Uganda is a major migratory route for birds, incredible bird watching. Great game parks that are infrequently if not visited at all. For whatever reason, unlike Kenya or Tanzania, people think that Idi Amin is still running Uganda some twenty

years later and people are fearful and don't really spend a lot of time looking at wild animals on safari in Uganda. So my wife and I and our kids did a lot of camping and a lot of bird watching and a lot of game watching and just had a magical experience. But even more so than the family experience was the opportunity to be country director in a sub-Saharan African country and contrast my experience in Botswana pre-antiretroviral treatment and resources on the scale that PEPFAR provided with that in Uganda where it was a big PEPFAR country program. We were reaching many thousands of HIV-infected people, providing lifesaving antiretroviral drug treatment, doing very advanced studies to look at mother-to-child HIV transmission prevention and simplify the drug treatment regimen for pregnant women and children, and to also look at an interaction between HIV and another highly prevalent and terrible scourge of morbidity and mortality, that being malaria. Recall that in Botswana I had looked at the relationship between HIV and TB in the pre-antiretroviral drug treatment era. In Uganda we got to look at the interaction between HIV and malaria in the antiretroviral drug treatment era, and there are many, many interesting questions to look at around HIV and malaria, especially in Tororo, Uganda, which has about the highest incidence of new malaria infections identified or documented of almost anywhere in the world. So it gave us a real opportunity to look at the many questions around preventing malaria in high prevalence HIV communities.

We also in Uganda got to look at what was then a novel preventive intervention. We had always looked with the discovery of HAART, highly active antiretroviral drug treatment, that you would treat the individual with HIV infection and that would decrease the risk of

transmission to their loved one. But the concept of providing antiretroviral drug treatment in sub-Saharan Africa was based on when an individual who is infected becomes so ill that then they're eligible to receive treatment. During the period, which is usually anywhere from six to eight years when you're infected, but your immune system, as measured by your CD4 cell count, is strong enough that you're not eligible for HIV treatment, you can still transmit HIV to your sexual partners, and so the concept of preventive therapy with antiretroviral drug treatment needed to be investigated. And so we looked in Uganda at the question of, are discordant couples, meaning one partner is infected and the other is not, are they less likely to become co-infected if the HIV negative partner is taking antiretroviral drug treatment either daily or intermittently, say two times per week? And can you prevent HIV transmission in a couple in the many years before the HIV-infected person is eligible to receive antiretroviral drug treatment through PEPFAR, Global Fund, and the Ministry of Health resources that provide the drug treatment to these individuals who are too poor to pay for that intervention on their own? So we worked with the University of Washington, the [Bill and Melinda] Gates Foundation and CDC resources to look at preventive therapy in discordant couples and that intervention proved to be also very successful. So preventive therapy is now one of the tools along with treatment of actively infected HIV-infected people who are eligible to receive HAART as an intervention tool.

We also during my time in Uganda had the opportunity to look at the risk of bilharzia among whitewater recreationalists. The White Nile River is the river that comes out of Lake Victoria and is the source of the Nile River and comes out of Lake Victoria in Juba.

Just right downstream is a source of whitewater rafting and whitewater kayaking and a big class-five high volume river and receives many, many tourists through—if they find themselves in Uganda for whatever reason, roughly about ten thousand recreationalists will go on a one-day whitewater rafting trip down the upper Nile on a weekend or a weekday adventure. In addition, people that are whitewater kayak enthusiasts also want to paddle the Nile and have that experience of world-class whitewater kayaking. My own children and my wife, who are all whitewater enthusiasts, and my wife and I kayak and my kids went rafting on a section of the Nile River and about six months later one of my two children, my daughter, became symptomatic with abdominal pain and fatigue and one thing led to another and discovered that she had acquired bilharzia or schistosomiasis. We treated that, of course, and we wanted to understand, what is the risk of limited exposure to whitewater of acquiring bilharzia? So we did a study among many hundreds of one-day whitewater rafters who were not citizens of Uganda and who'd come on a one-day whitewater adventure, and we also did one at a whitewater kayaking rodeo festival to look at the risk of transmission in a three-day whitewater kayaking event. And to our surprise we learned that about 5% of people with limited exposure to whitewater sports acquire infection with bilharzia, and it's a challenging problem because once you're infected, you have a blood test or a serologic test that shows you're infected, but once you're treated, the test doesn't turn negative. You're positive for life, and so once infected you can treat, but then you don't know if you have repeated exposure whether or not you should treat again because you've been re-infected or whether you shouldn't be treated because you were already treated and cured. So that was a challenging problem.

The other big experience I had as an epidemiologist in Uganda was back-to-back outbreaks with two hemorrhagic fever viruses. They're both filoviruses, one's called Marburg and one's called Ebola. The first outbreak was among—a miner who worked at a mine called the Kitaka Mine, and he was taken from this rural area in Uganda to the capital city because he was becoming quite ill. In transporting him to the hospital, someone suspected at the International Hospital in Kampala hemorrhagic fever, asked CDC to do testing, and it turned out to be Marburg. We also learned that one of the individuals who had helped to transport the individual to the hospital also acquired a Marburg infection, and a third piece of this puzzle was that they both had been mine workers. We thought that it could be possible that the mine was a source of the reservoir because like so many mines, bats roost in the ceilings. And so we got permission from the Ministry of [Energy and Mineral Development] and I invited the subject matter experts from the viral special pathogens branch here at CDC that has responsibility for these viruses, these hemorrhagic fever viruses, to come to Uganda and pursue investigative studies of the bat as a possible reservoir. And sure enough, after several bat trappings of which I was able to participate in, we were able to show that the fruit bats—there are several species of bats in the cave, two groups, micro bats that eat largely insects and fruit bats that eat fruit, needed to be trapped, and we found that the fruit bat was a reservoir for infection. And in fact, the Viral Special Pathogens group has been able to import several of these bats. We have a bat colony here at CDC of Uganda bats where we continue to look at all kinds of transmission questions.

The other piece of that puzzle that was fascinating was that because the mine was suspected as being a source before we actually had proof that the bats were viremic with the virus, we had hired one of the former mine workers, because the mine had been closed, to keep other miners from going back into the mine. Little did we know that he would not be the best security hire for the position and he actually did some of his own private mining on his private time and he became infected. And then we were able to actually provide him supportive care, but in addition got his virus, and we had the virus of the previous two mine workers and to our surprise we found that there were two subspecies of Marburg virus in these three individuals. And because we had been trapping bats in the bat cave, we also found that there were two species of—subspecies of Marburg virus in the bat community, and the two matched, which gave even stronger evidence that the bats are the reservoir for Marburg infection.

One of the other things that we looked at is we wanted to understand, what is the size of this bat population? And is there any evidence that bats that are a reservoir in a community in this cave can take the virus to other bat communities? And how much social interaction are there between bat colonies in the international wildlife setting? So the first thing that we did was we did a capture to recapture study where you put a little metal band on the foot of the bat, every one that you capture and release, then you come back and do a sampling the next few days and capture bats and find how many of them with the banding that you capture, and from that simple mathematical formula you can roughly estimate the size of the population. The Kitka Mine had roughly about ten thousand bats, we estimated. Six months into the future, at about one hundred kilometers

away as the bat would fly but about a four or five hour drive by SUV over to Queen Elizabeth National Park, there's another cave that's known as the Python Cave, and the Python Cave is a place where my wife and children and I had gone on a forest walk with a Uganda national wildlife ranger, as so many tourists do, to go to this big cave with lots and lots of resident bats. You can always see this huge python just basking in the sun of the cave because it doesn't have to go far to get a meal. In addition, there's a resident forest cobra there that you can often see so it's a remarkable place to go and it's also not far from the wildlife chimp colony where adults, not children, can go and do a forest walk and have a good chance of seeing a chimp colony. So it's a place that tourists do go and it just so happens that there was a Dutch tourist that had gone to the Python Cave and she went back to Amsterdam where she was hospitalized with a hemorrhagic fever-like illness and eventually shown to be Marburg virus infection. That led to CDC being invited by the government of Uganda to expand their study of the risk of Marburg reservoirs in Uganda to the Python Cave. In trapping bats at the Python Cave, we happened to find a bat that happened to have a band that was only possibly put on in Kitka, so we documented for the first time that there actually is an exchange of residents in bat colonies, and maybe not surprising to people who would wonder, is there an exchange between bat colonies of residents of the colonies, but we clearly showed that there is, and documented that this cave also had a high prevalence of Marburg virus infection active in the fruit bat community.

About six months after that we also had our first reports of an unusual cluster of deaths among a family in rural—in the Rwenzori Mountains of Uganda, which are an uplifting

of the Rift Valley on the border between Democratic Republic of Congo and Uganda. Really beautiful set of mountains, the Mountains of the Moon, if you will, and that are a big source of the water that makes up Lake Victoria. So the Rwenzori Mountains, the Ministry of Health went out and investigated, talked to survivors of this family that had had a couple of deaths—I think a grandmother and a granddaughter—and brought back some biological specimens for testing among the non-febrile un-ill community and found, of course to no surprise, no evidence of any infection. Then a few weeks later another cluster in this Rwenzori community, which led us to go out in tandem and actually identified ill patients with hemorrhagic fever-like signs and symptoms of illness and that turned out to be Ebola virus. In further investigation of the gene sequencing of that virus, identified a new species of Ebola virus that actually became named after the community in the Rwenzories by the name of Bundibugyo. So a fifth subspecies of Ebola was identified.

This was a large outbreak. I would have to go back to my notes to look at the figures but many hundred cases of Ebola virus and lots of EIS officers coming out to help us do the contact tracing and the work necessary to ensure that those infected with Ebola get isolated and prevent transmission from those ill to their family members and their community members. It also was my first time on a large Ebola outbreak and I got to see our relationship with Médecins Sans Frontières. If you look back to the early days of Ebola virus outbreaks, 1976 is the first one and the species was Ebola Zaire, that outbreak was largely done soup to nuts by CDC and WHO including clinical care and isolation and supportive care as well as contact tracing to end the epidemics, and that went on through

the seventies and early eighties. In the late eighties, Médecins Sans Frontières took upon this clinical care as a niche that they wanted to pursue in global health, and by the time you fast forward into the 1990s and into 2000 and 2010-15 era, Médecins Sans Frontières has really developed a clinical expertise. So they have—based on the size of a hemorrhagic fever outbreak that's identified—they have prepackaged Ebola treatment unit, tented structures, facilities, they have all the specs worked out for how to provide the supportive care, the chlorine that's necessary to clean the equipment and spray individuals, providing care with someone who's providing that preventive service when clinical care is being given. So MSF [Médecins Sans Frontières] has, over the last fifteen to twenty years, really been sort of a partner with CDC whenever there's a large Ebola or Marburg outbreak, and that proved to be true again in the largest outbreak, the first epidemic from Ebola virus in the world, that being the 2014-slash-2015 Ebola virus epidemic in West Africa.

Q: I have a question just listening to your description of being the country director in Uganda. I would imagine a lot of those responsibilities are administrative rather than like—to what extent are you still involved in all the epidemiology and all the studies?

Tappero: It's a very good question and fortunately the way that CDC is structured, I'm quite active. If you look at how CDC's operational structure works, usually the branch chief or the division director is a medical epidemiologist or a PhD epidemiologist and in many, many cases if not most cases, people that first got their exposure to CDC after medical school or graduate school, doctorate degrees, medical degrees, they come to do

the Epidemic Intelligence Service program and they get that shoe leather experience. And for about two-thirds of us it's like a kid in a candy store. It is what you wanted to become a doctor for, you just didn't know about it before you started medical school. And that's how it certainly was for me.

Our structure at CDC is an epidemiologist, medical epidemiologist, paired with a public health advisor or PHA, and that is more of the management and operation. It is more the administrative and support function that needs to provide the financial, budgetary, logistics, basically the whole infrastructure to allow the medical epidemiologists to do the creative scientific thinking and mentoring of young epidemiologists while the public health advisor corps makes sure that our administrative systems and support structure are in place. And as you mature through your career at CDC, the experience and relationship, the bonding between the epidemiologists and the administrative public health advisor becomes inseparable and it really is a wonderful relationship and in many cases the epidemiologist learns many of the administrative functions that are required to support a country office, but equally if not more so the public health advisor has many tracks upon which they can provide support, and the really good ones, they can do it all. They provide the support but also want to get out in the field and do the technical work, too. It's a wonderful partnership if not marriage that you'll see throughout the agency. Most division directors have a deputy director who is also a senior public health advisor with many, many experiences. Dr. Frieden is our director and his chief of staff is a public health advisor with domestic and global experiences. And you can look across the agency; similarly our overseas country offices are run by a PhD or medical

epidemiologist and a deputy director that is a senior public health advisor, and the extramural management of grants with partners and Ministry of Health could not be done without the public health advisor supportive linkage and the science of pushing forward our programs to learn more and do outbreak investigations and training field epidemiologists could not be done without the epidemiologist.

Q: Who are some senior PHAs who you've worked with who you had a really useful or interesting relationship?

Tappero: Great question. I think the most recent experience I had as a CDC country director was in Uganda from 2006 to 2008 and Kelly Kay was my deputy in that country office. Actually, my first year I had a short period of time with a soon to retire senior public health advisor, Harold Rasmussen, and then I had almost a good eight months with no deputy director and it was very challenging to do both and it was a blessing when Kelly arrived to help run that country office. So you feel the difference when the pairing is present and when it's absent, and you feel it in a big way.

The other experience that I would say is informative is the 2010 Haiti earthquake. Haiti is a country that has one of the CDC country offices that was opened under the President's Emergency Plan for AIDS Relief, or PEPFAR, and it was also very fortunate that CDC had a country office with several experienced and well-trusted-by-the-Ministry-of-Health locally employed staff because when the earthquake struck on January 12th, 2010, the fact that we had a country office, we had funding mechanisms in place with several partners, I

mean non-government organization partners, as well as the Ministry of Health, provided a real opportunity for us to work quickly in providing public health recovery and reconstruction. And at that time we had a country office that was sort of in transition with an outgoing director and one that was in need of a deputy director and so we stood up in response to the earthquake. Dr. Frieden activated the Emergency Operations Center and I became the public health post-earthquake senior medical epidemiologist. Then for the deputy director we got Brian [D.] Wheeler, who is another very experienced [epidemiologist] with lots and lots of field experience as the senior public health advisor. Actually first on TDY [temporary duty assignment] and then later took the position as the deputy director for the CDC country office there, which went from PEPFAR to being PEPFAR and more because the number of activities that needed to be strengthened in Haiti after the earthquake included not only restoring HIV services, which were critical, but also because there were over two million displaced people out of ten million in the population, or one in five people displaced, living in overcrowded conditions in tented, plastic-sheeted cities in a very densely populated urban setting of Port Au Prince, and many of the displaced in large slums below even the sea level that would flood during the rainy season. You knew that in the absence of plumbing and clean water that this population was now even more crowded through displacement. And with poor expanded programs for immunizations or childhood immunizations program services and poor access to clean water and sanitation and poor access to clinical care services, was going to be at risk for some kind of outbreak or epidemic. We focused our energies on, one, establishing a Field Epidemiology Training Program to train young epidemiologists for the ministry; two, establishing a functional reportable disease surveillance system that

could look for either syndromes or signs and symptoms of illness that could be confirmed by the laboratory; three, strengthening the public health laboratory so that it could provide the diagnostic services for suspected potential outbreaks; and four, the capacity to respond through emergency incident management services to a large outbreak. It is very fortuitive that we were able to do that. The earthquake in January of 2010 was followed eight months later by a very massive cholera epidemic that started in October and within the course of six weeks made its way across the entire—not only nation, but the island of Hispaniola which is shared between Haiti and the Dominican Republic. That effort of restoring public health infrastructure, surveillance and laboratory capacity resulted in the outbreak being detected within days of its onset with laboratory confirmation of the pathogen which could let the international community know that because of the huge displacement in population and even in the absence of displacement, the very inadequate access to clean water and sanitation, plumbing, sewer systems, etcetera just nascent, that this was going to be a terrible epidemic with many, many thousands of cases and thousands of deaths in the absence of establishing a clean water infrastructure across the country and training of healthcare workers for the management of cholera as it hadn't been seen in Haiti in over a hundred years and there was literally no natural immunity to cholera anywhere on the island.

Q: Can you talk about some personal experiences of your time in Haiti, or working on the Haiti post-earthquake and cholera?

Tappero: I think there are some sad memories and there are some fond memories. I would say first of all I was proud of the way that CDC responded to the epidemic because we lost a CDC employee in the earthquake that happened to be in a hotel room that collapsed during the earthquake, and so that real risk when you lose one of your colleagues has you wondering in the back of your mind. It's still an earthquake-prone environment, there were aftershocks. Secondly, a personal experience would be that there really was no place for our workforce to stay. There were no hotel rooms that were open. Most had collapsed. Seismic evaluation by the US Embassy to say whether or not it was safe for us to take residence in any of the occupying hotels was a complete unknown. So we ended up setting up a tented city, if you will, for our own deployed staff, on the compound of the US Embassy. We would have probably, I don't know, ten six-man tents with anywhere from thirty-five to sixty CDC deployed people living on a cot in an extremely warm tropical environment. By the time the sun rose at 5:30, within fifteen minutes you could not be inside the tent anymore because the heat would just go up dramatically. And then at the end of a long twelve-hour day, people would come back in this communal area around the tents and—you know, there weren't restaurants open because of the earthquake—eating MREs [meals ready to eat] and canned goods or things that you would bring with you, in this communal environment talking about the work for tomorrow, and then crashing in your cot and doing it again and again. And just the remarkable camaraderie in a challenging environment and the willingness of people to deploy and re-deploy, we were fortunate that we were so physically close to the United States. Though getting to Haiti should be a three and a half hour flight, there were no direct flights, so it's really a full day exercise, but fortunately not a change in time zones.

Other personal experiences I would say are you really are touched by the people. Haiti seems like they never catch a break. They were the center point in the Caribbean for the HIV epidemic. They have the highest rates of tuberculosis in the Caribbean. They for whatever reason seem to be the magnet in the pathway of hurricanes coming across the Atlantic from West Africa in the hurricane season year after year, they get a disproportionate amount of hurricane and tropical rainstorm hits that lead to flooding and mudslides and the diseases that are associated with heavy rains. The island of Hispaniola is the last country in the Caribbean to have malaria. They also are troubled by corruption and challenged to maintain democracy, or at least a resemblance of democracy over the years. And yet the people that work for CDC in the CDC country office are some of the best trained and most motivated and committed people, that despite this challenging environment and the opportunities that they have to say I'm going to go elsewhere, I'm going to go to France or I'm going to go to the US and give it up, but they're committed to try and make Haiti not only a livable place but a much better place and they haven't given up hope that it can be like many of its neighboring Caribbean islands and really step forward into a free democracy with better infrastructure. If you throw the earthquake and the cholera epidemic on top of all that history, it just doesn't seem fair, and yet there are many really good Haitian people that haven't given up hope.

And I think that the earthquake also created the opportunity for something good in public health. I say that because I think something like twenty-seven of twenty-nine ministries collapsed in that earthquake because the center for the earthquake was the downtown

capital. But there was the National Public Health Laboratory not far from central downtown in Delmar that had been built by Taiwanese about ten years before, and Taiwan is an earthquake zone so they build according to earthquake code, it's just a force of habit. So that structure not only survived the earthquake, it was also built beyond the needs of the National Public Health Laboratory, at least the resources that could support a National Public Health Laboratory, so it had a floor that really wasn't in use and it was built on grounds or a compound that could absorb more workers and potentially even more of a physical structure. And so what happened after the earthquake was all of the epidemiologists and administrators lost their place of work and they were transported to the National Public Health Laboratory compound and they actually had a physical place to work and like CDC here, our laboratory scientists and epidemiologists and administrators and public health advisors all work side by side and it makes a much more functional environment for a public health response. This, for the first time, created an environment where public health epidemiologists worked side by side with their laboratory colleagues and the laboratory colleagues saw the value of what the epidemiologists were trying to do and the minister of health and leadership were able to introduce policies and programs in an environment where everyone was sort of in the same boat. So that was a positive that came out of it and CDC also was able to utilize the CDC Foundation to build a structure that is now the home of the Field Epidemiology Training Program and provides additional physical support for public health.

Q: That's great. I'm thinking right now that perhaps if it's okay with you maybe we can push Ebola to tomorrow. Today we can just dedicate to the background if that's alright.

Tappero: Sure.

Q: Okay, cool. Can you take me briefly from the time of the post-earthquake and cholera response in Haiti up to the Ebola outbreak?

Tappero: Yeah. So I led the Public Health Systems and Response Recovery Office for the earthquake response to Haiti from 2010 through 2012, and then in 2013 I spent a year as the associate director for science in the Center for Global Health, so in the office of the director for the Center for Global Health. That was an interesting transition year for the Center for Global Health because a new division was created by then-acting center director, Rear Admiral Anne Schuchat. There were two divisions. One, the Division of Public Health Systems and Workforce Development, which was where the Field Epidemiology Training Program was housed. The FETP program is the EIS-like program that CDC supports around the world. When the EIS program started, I think it was in 1957, there was almost uniform 100% US citizens in the program. And through the sixties and seventies the interest globally of training epidemiologists by CDC grew so that every incoming EIS class size went from 10 to 15 to 20% of foreigners coming to the program. We really saw the need to provide these training programs internationally because the speed and the proportion with which we could absorb field epidemiology shoe leather disease detectives was never going to meet the demand, and so we started the FETP program. So the Division of Public Health Systems and Workforce Development, its principle program was the FETP program. Another program division in the Center for

Global Health was the Global Disease Detection and Emergency Response Division, and that was the division where the Haiti post-earthquake response resources were administered from. So the health systems reconstruction office for Haiti that I ran was in the division of Global Disease Detection and Emergency Response. So fast forward three years into the future, I'm the associate director for science in the Center for Global Health and Admiral Schuchat, in reorganizing the center, puts the two divisions together and makes a larger division, the Division of Global Health Protection, also at that time as the associate director for science.

Dr. Frieden had been thinking about how we can improve public health infrastructure and public health response around the world, and it was in its infancy but in 2013 the concept of the Global Health Security Agenda was getting its legs and Dr. Frieden pulled together subject matter experts from across the agency, provided resources from the OD [Office of the Director] and asked us to develop Global Health Security Agenda demonstration projects, and two countries were selected: Uganda and Vietnam. And the concept was, what are the things that we can do in laboratory detection? What are the things we can do in surveillance for reportable disease? What are the things that we can do in emergency response and in the incident management system, like we have in our own emergency operations center, that can be demonstrated and put to use in our partnership with ministries of health around the world and provide some real practical experience about Global Health Security Agenda? That can inform what type of resources are needed to help our ministries of health become better prepared to respond to natural disasters like the Haiti earthquake, displaced persons and refugee situations like two million people in

Jordan from Syria because of their civil unrest; or three, a large cholera outbreak of immense proportion; or four, if the 2009 H1N1 influenza pandemic had been a highly pathogenic influenza virus like the 1917, 1918 epidemic, we would need the kind of global health security infrastructure in place to dampen the severe morbidity and mortality associated with such a terrible pandemic.

So because of my experience in Uganda as having been country director from 2006 through 2008, I was asked as associate director of science to be the team lead for the demonstration project in Uganda. And similarly there was a demonstration project that was done in Vietnam and I think we demonstrated a lot of good work with minimal resources that could be done. First, as we did in Haiti, we put into partnership the existing infrastructure built by PEPFAR. Instead of building another parallel siloed structure, we looked at, what was the infrastructure for monitoring the HIV program? And how could we utilize that physical infrastructure and wrap around a reportable disease surveillance system and wrap around a biologic specimen referral network? For example, a blood specimen from a remote area to test for a possible hemorrhagic fever virus. Do we need a totally separate structure for a hemorrhagic fever virus specimen referral network or could we use the infrastructure already put into place with the early infant diagnosis dried blood spot infrastructure for testing children born to HIV-infected mothers after they complete breastfeeding, every child born to an HIV-infected mother at the completion of breastfeeding needs to have an HIV test to see if they're still HIV-free or need lifesaving antiretroviral drug treatment. So we put those things in place. We also found a physical location where an emergency operations center could be built, that it would be more than

just the equipment of a few fancy monitoring screens and the interconnectivity to communicate with ministers of public health, director-generals, and their leadership but actually be a workspace where Field Epidemiology Training Program residents could work side by side with some leadership dedicated to outbreak response.

That proved to be very useful, and soon after the completion of the demonstration project, the Ministry began to activate its emergency operations center for Ugandan citizens returning from the Hajj. About 30% of Ugandans are Muslim and many throughout their lifespan as anywhere else throughout the world want to make that at least one lifetime annual pilgrimage to Mecca, but in 2013 there was circulating Middle East Respiratory Syndrome coronavirus in Saudi Arabia. So the concern in many countries who had their citizens go to the Hajj would be that they might introduce MERS coronavirus into their own country. So they activated, for about a two-week period, their emergency operations center and their public health response infrastructure to screen for febrile illness and had found to isolate and make sure that the cause of illness was not Middle Eastern Respiratory Syndrome virus.

They also had a response to an outbreak of meningococcal meningitis in northwestern Uganda. The meningitis belt in sub-Saharan Africa throughout the seventies, eighties, nineties, was known to have six-to-eight-year cyclical large epidemics of meningococcal disease, and that would be because of the large Harmattan winds that blow across sub-Saharan Africa, northern sub-Saharan Africa, damage the esophageal mucosa and create that environment where there is carriage of meningococcal bacteria in the pharynx and

for reasons not clearly totally understood but that every eight years or so you would see large outbreaks of meningococcal disease in this part of very dry desert northern sub-Saharan Africa. By the mid 2000s or so, it was clearly understood that conjugant meningococcal vaccine used as a routine can eliminate these meningococcal epidemics, and that is largely what has happened. You just don't see it anymore because of children and adults. Young adults are widely vaccinated now. But that was largely a serogroup A, C meningococcal disease problem, and this outbreak in northern Uganda in 2013 was not only a surprise but it needed a way to confirm that it was meningococcal disease because it shouldn't be happening, and then using that infrastructure built rapidly allowed a specimen to be tested, to be serogrouped and shown that it was an unusual serogroup and serotype not protected by the current vaccine. WHO was able to quickly release the vaccine needed and the community that was experiencing this outbreak could be vaccinated quickly before the outbreak spread throughout other countries and parts of sub-Saharan Africa.

Another creative use of their emergency operations center was around roughly ten thousand tourists that were coming to Uganda to observe a unique solar eclipse, and this is something, a solar eclipse that happens very rarely, I don't remember the frequency, like once in a decade. Where it occurs you have to look at the latitude/longitude of the globe and see where the places in the world where you can best visualize it and where weather for the most part would accommodate observation without being blocked by clouds and bad weather. And it turned out that Uganda happened to be the place for this solar eclipse and there are some strange habits that people pursue out there and for some

ten thousand people observing solar eclipses is a passion and so they expected many, many tourists for this. So they activated, because the physical site of observing was in a county that is known to have endemic cholera and it would be during cholera season, so they made sure that they had good water and sanitation and infrastructure and chlorinated water and food prepared with clean water, etcetera so that all these tourists would not come to Uganda and either potentially spread a cholera epidemic or become ill themselves in coming to Uganda as tourists. So those are just three examples of how, once you provide the training, the infrastructure and utilization as routine public health practice, how this concept of Global Health Security Agenda demonstration project informed what became the Global Health Security Agenda.

Q: Okay, do you think there's anything else that we should discuss previous to getting into Ebola?

Tappero: I guess to answer your last question, that opportunity to work on the Global Health Security demonstration project and my experience in Haiti as well as my understanding of ten years working under PEPFAR and knowing how that infrastructure can be put together—I hate to say “leverage” because it sounds like it's taking advantage of and it really isn't that. It is making sure that we don't create parallel siloed public health systems because that is of no use to anyone, and really pulling all of that together for the Global Health Security Agenda I think was highly informative. It also is the reason why when Admiral Schuchat, in her reorganization of the Center for Global Health, put together the FETP program and the Globalization Disease Detection and

Emergency Response program into one division, the Division of Global Health Protection, it kind of had everything that I'm most passionate about. That is why I threw my name in the hat to be a candidate for the division director position. There are essentially four or five branches. One is clearly administrative. Then there is the branch that has the Field Epidemiology Training Program. There's the branch that has the global disease detection, we have about ten country offices that serve as regional, forward-deployed assets with staff for outbreak response and epidemic response and laboratory investigations and kind of doing that upstream science of public health in the global community, if you will. Then there's the concept of the Global Health Security Agenda that was growing, but also the need to think about how we would support a growing number of country offices. My experience in PEPFAR where we had a country support branch, if you will, that ensured that the administrative needs of a growing number of country offices, was a concept that needed to be brought to this new division. Otherwise you would have the FETP program doing their administrative support one way, the Global Disease Detection Program doing their administrative program another way, the Emergency Response and Recovery Branch doing their refugee and displaced person in natural disaster response another way. So we really had to pull those pieces together as well as the country support structure and make a division that could be uniform and efficient and streamlined. I saw this as an opportunity that my skill set and experiences in PEPFAR and Haiti and global disease detection demonstration project, that I was really passionate about this opportunity. And fortunately I happened to interview I guess well and succeed in being offered the division director position. The work that we do in the

division I think is very complementary to what we needed to respond as one of the many divisions across the agency that contributed to the West Africa Ebola epidemic.

Q: Okay. Sounds good for today.

END